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An ICF-based approach to evaluating the functional profile and independence in the daily life of people after Spinal Cord Injury participating in the Foundation for Active Rehabilitation camp

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A Study Design
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E Funds Collection

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Dictionary:

Paraplegia – paralysis that affects the lower half of the body, including both legs, usually caused by disease or injury to the spinal cord. It is often accompanied by loss of sensation below the injury level and disturbed bladder function [32].

Tetraplegia (quadriplegia) – paralysis caused by illness or injury that results in the partial or total loss of use of all four limbs and torso; sensation and control are usually lost below the level of the injury [32].

ICF (International Classification of Functioning, Disability and Health) – a classification system developed by the WHO that provides a comprehensive framework to describe functioning, disability, and health in people with various conditions, integrating biopsychosocial perspectives [10].

Abstract:

Background and Study Aim: Spinal Cord Injury (SCI), often leading to paraplegia or tetraplegia, affects many aspects of life and requires complex environmental adjustments, new responsibilities for patients, and their caregivers. The International Classification of Functioning, Disability and Health (ICF) presents functioning and disability as a complex interaction between an individual's health status and contextual factors, and provides the basis for a methodology for managing the rehabilitation process of people with disabilities. The cognitive objective is to gain knowledge concerning independence in daily life of individuals after SCI in the early post-acute phase who are participating in the Foundation for Active Rehabilitation (FAR) camp, based on their functional profile using the Brief ICF Core Set for SCI. The applied objective is the recommendation of visualization tools designed to support the diagnosis and evaluation of progress in the rehabilitation process, useful for the therapeutic team.

Material and Methods: The study was conducted among 16 participants of a 21-day FAR rehabilitation camp, including 3 women and 13 men (7 with paraplegia and 9 with tetraplegia). Individuals participated in physical activities during the camp and improved their independence in performing activities of daily living (ADL) under the supervision of instructors. During lectures with a psychologist, they shaped and strengthened mental functions, cognitive skills, and social competencies A cross-sectional study consisting of a subjective examination in the form of individual structured interviews and a physical examination using a functional physiotherapy tests and validated assessment tools was carried out in a standardized manner by two physio-therapists. The obtained results of each subject were verified with the assessment of the therapeutic and instructional team of the FAR.

Results: Individuals diagnosed with tetraplegia indicate greater difficulty in capacity and performing activities. Those with tetraplegia and paraplegia necessitate partial assistance with activities of daily living.

Conclusions: The three types of visualization proposed in the article (1-Categorical ICF profile; 2-Individual outcome charts; 3-Patient group specificity charts for each participant group category) can be used by therapy-instructional teams to plan targeted interventions.

Keywords: activities of daily living, ICF, environmental factors, paraplegia, tetraplegia

DICOM (Digital Imaging and Communications in Medicine) – The international standard for transmitting, storing, retrieving, printing, processing, and displaying medical imaging information, often used as a reference for traditional visualization methods in medicine [15].

WISCI (Walking Index for Spinal Cord Injury) – A functional capacity scale designed to measure improvements in ambulation in individuals with spinal cord injury, evaluating the physical assistance and devices required for walking [15].

SCIM (Spinal Cord Independence Measure) – A comprehensive disability scale developed specifically for patients with spinal cord lesions to assess their ability to perform activities of daily living (ADL) independently, covering self-care, respiration, and mobility [17,18].

VAS scale (Visual Analogue Scale) – A psychometric measuring instrument used to document the characteristics of disease-related symptom severity in individual patients, most frequently used to assess pain intensity [14].

1. Introduction

Spinal Cord Injury (SCI) is a traumatic event that affects many aspects of life and can result, irreversibly, in the loss of motor and sensory functions of the body leading to paraplegia or tetraplegia. Published data in the literature on the prevalence of people with SCI is divergent. It is estimated that there are approximately 250,000 to 500,000 people with SCI each year [1-4]. Dysfunctions resulting from SCI significantly affect the quality of life in terms of social contacts and economic activity, overall life satisfaction, activity and social participation, and cause severe limitations in activities of daily living (ADL) [2, 5, 6, 4].

Reduced activity and participation in society results in social exclusion, which – in turn – is related to economic exclusion and higher unemployment for people with SCI compared to other groups. The reasons for this include environmental barriers. Examples of environmental factors hindering or even preventing active participation in social life and interfering with ADL for people after SCI and consequently negatively affecting their health, quality of life and maintenance of optimal health are: inappropriate health policies; impeded access to specialized health and social security services, including services of an activating nature; low availability of assistive objects, devices and technologies with the appropriate procedures and specialized counselling; a lack of knowledge and proper skills of health professionals in the broad sense; social workers; a lack of assistive products, architectural, communication and urban planning barriers; negative attitudes towards people with disabilities and inadequate understanding of their needs [7, 5, 4, 8]. The International Perspective of Spinal Cord Injury (IPSCI) report shows that people with SCI die prematurely and are more likely to experience physical and mental deterioration. This situation is caused by several factors that make it difficult for people with SCI to participate fully in society and maintain optimal health. Among these factors, the environmental barriers already mentioned are of key importance [9].

The International Classification of Functioning, Disability and Health (ICF) is a classification system developed by the World Health Organization (WHO) to provides a comprehensive and universally accepted framework to classify and describe functioning, disability and health in people with all kinds of diseases or conditions, including SCI. It is used not only in research, but also as the basis of a methodology for managing the rehabilitation process for people with disabilities [10].

According to the ICF, the problems associated with a disease may involve 'Body Functions' and 'Body Structures' and the 'Activities and Participation' in life situations. Health states and the development of disability are modified by contextual factors such as 'Environmental factors' and 'Personal factors' [10]. Disability is a complex concept that integrates impairments, activity and participation limitations with personal and environmental factors [11].

In 2010, Kirchberger et al. [12] suggested using the ICF Core Sets for individuals with SCI in the early post-acute context. A Comprehensive and a Brief ICF Core Set were defined for the early post-acute. total of 162 ICF categories were chosen to form the Comprehensive ICF Core Set for SCI in the early post-acute phase. Subsequently, 25 of these categories were designated for the Brief ICF Core Set[10].

The biopsychosocial model has become a mainstay in assessing the functional profile of patients with SCI. Numerous medical entities and public utility organizations incorporate activation programs that cover all aspects of functioning for individuals living with significant motor disabilities from SCI, taking into account both the external perspective of the project implementers and the subjective perspective of the beneficiaries themselves, incorporating the ICF approach [13].

In the scientific literature, the problem of medical data visualization is extensively explored; however, the prevailing approaches remain traditional and fail to meet the requirements of the holistic ICF model. Current visualization methods employed in rehabilitation predominantly rely on static charts, time-series graphs of isolated functional indicators (e.g., muscle strength), simplistic anatomical diagrams for pain localization [14], or two-dimensional presentations of medical imaging data (e.g., DICOM), the spatial limitations of which impede a comprehensive understanding of functional complexity [15].

Despite the fact that the ICF concept and its qualifiers are universally recognized as crucial for managing the rehabilitation process [16], current commercial Electronic Health Record (EHR) software and dedicated rehabilitation systems typically utilize the ICF merely as a taxonomy of codes or a static categorical profile. Consequently, these systems critically lack integrated, dynamic tools that move beyond standard tables and textual summaries to provide a graphical representation of the key clinical comparison between a patient's capacity and their actual performance, based on ICF qualifiers.

This functional deficit prevents therapists from rapidly and visually tracking progress, immediately identifying the impact of environmental barriers [17], and efficiently managing changes in therapeutic goals. The clear demonstration of this methodological and technological gap in the domain of dynamic, two-level ICF data visualization provides a strong rationale for the innovation and necessity of the present study.

The cognitive objective is to gain knowledge concerning independence in daily life of individuals after SCI in the early post-acute phase who are participating in the Foundation for Active Rehabilitation (FAR) camp, based on their functional profile using the Brief ICF Core Set for SCI. The applied objective is the recommendation of visualization tools designed to support the diagnosis and evaluation of progress in the rehabilitation process, useful for the therapeutic team.

2. Materials and Methods

Study design

A cross-sectional study consisting of a subjective examination in the form of individual structured interviews and a physical examination using a functional physiotherapy tests and validated assessment tools was carried out in a standardized manner by two physiotherapists. The obtained results of each subject were verified with the assessment of the therapeutic and instructional team of the Foundation of Active

Rehabilitation (FAR). Since 1988, this foundation has been running a comprehensive program for the social and vocational activation of wheelchair users with permanent spinal cord injuries. It is a non-governmental organization set up on the initiative of wheelchair users for wheelchair users – and, therefore, has an excellent understanding of their needs and abilities. Observed patients participated in physical activities during the camp and improved their independence in performing ADL under the supervision of instructors. During lectures with a psychologist, they shaped and strengthened mental functions, cognitive skills, and social competencies.

The study was conducted in accordance with the Declaration of Helsinki and approved by the Bioethics Committee of the Medical University of Lodz, Poland (RNN/692/14/KB).

Participants

The study was conducted among 16 participants of a 21-day FAR rehabilitation camp, including 3 women (paraplegia) and 13 men (n = 7 with paraplegia and n = 9 with tetraplegia). Average age 34.0 ±15.1 years (Min 21; Max 65) including paraplegia and tetraplegia 41.1 ±12.9 years (Min 20; Max 60).

Detailed methods and tools

Original visualization ideas

In developing the results of the study, the author's method of graphically presenting the results achieved was proposed. It concerned an analysis of the results of the 'Activity and participation' surveys as being particularly relevant in assessing functioning in light of the selection of interventions for FAR camp participants.

To analyse the differences emerging in the level of capacity and performance of an activity and its performance, the following were used: 1) radar charts determining the individual participant's capacity and performance in a given activity; 2) scatter plots showing summary results for the study group of paraplegics and tetraplegics, allowing analysis of the most frequent indications in each group and comparison of differences between groups (when scatter plots are made collectively for all participants, the imaging of differences is based on an approach that takes into account the experience of physiotherapists and researchers).

The radar chart is an excellent tool for presenting multiple quantitative variables simultaneously. Radar charts consist of a series of arms, each representing one variable. Several features or cases of interest can be compared simultaneously on the chart. It makes it easier to see which variables have similar values and which have outliers. The analysis of radar charts provides information on the occurrence of clinical significance in a simple and quick way (radar charts were created individually for each study participant).

The study used radar charts to compare the capacity and performance of one participant assessed by eight codes (eight arms of the chart). Each code specifies the degree of difficulty in performing certain activities. The higher the value, the greater the performance difficulty (scale of 0-4). The following codes used were: *Changing basic body position (d410); Transferring oneself (d420); Hand and arm use (d455); Walking (d450); Washing oneself (d510); Dressing (d530); Eating (d550); Drinking (d560).*

Example of monitoring performance/capacity results: the higher the point values, the greater the degree of difficulty (Figure 1).

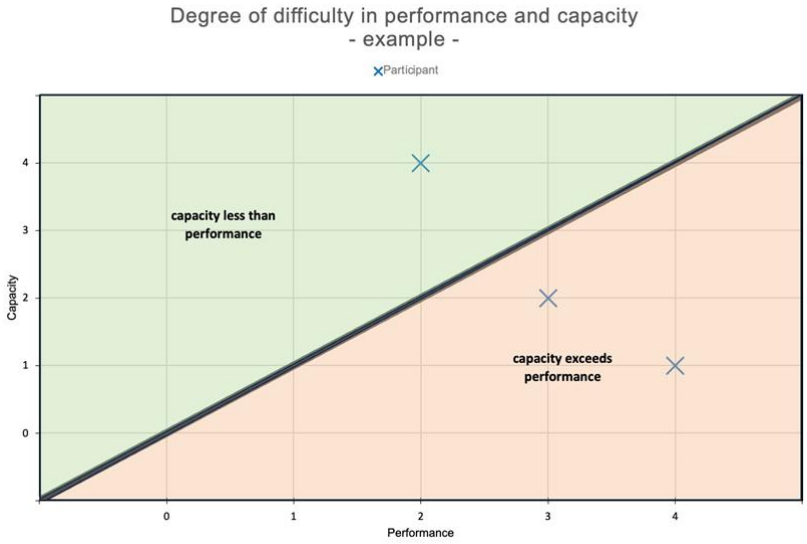


Figure 1. Example of a scatter diagram – degree of difficulty in execution: participants whose degree of difficulty and performance equals each other are on the oblique line – the diagonal of the graph; participants whose difficulties in performing activities are less than difficulties in capacities are above the diagonal; participants whose difficulties in performing an activity are greater than their difficulties in capacity are below the diagonal.

Brief ICF Core Set for SCI in the early post-acute context

The results of the survey assessing the participant's independence in ADL, supported by the analysis of information obtained during interviews, allowed us to determine the health, capacity and functioning of the subjects using the Brief ICF Core Set for SCI and define their functioning profile. The study calculated three qualifiers (1. Extent of impairment; 2. Nature of impairment and 3. Location of impairment) for the codes defining 'Body structure', while only the first qualifier was considered when constructing the functional profile.

Assessment of the participant's independence in ADL

The WISCI II scale [15] and the SCIM III questionnaire [17, 18] were used to assess mobility and functional ability.

Statistical analysis

The estimation of the results is based on the following indicators: frequency (n); mean/average (M); median (Me); minimum (Min); maximum (Max); standard deviation (SD or ±); significance level, probability (p).

The significance of differences in arbitrarily adopted empirical variables between patients with paraplegia and tetraplegia was calculated using the nonparametric Mann-Whitney U Test.

Independently, the median (Me) and lower quantile ($Q_{0.25}$) and upper quantile ($Q_{0.75}$) values are monitored for all observed patients (n = 16) and separately for paraplegia (n = 7) and tetraplegia (n = 9) in the case of monitoring SCIM III indicators.

3. Results

No significant differences were found between age paraplegia and tetraplegia patients: U Mann-Whitney Test, W = 44, p-value = 0.2033.

Clinical characteristics of the sample

In the subjects studied, the SCI occurred at several levels, both in those with tetraplegia and paraplegia. Damage to the following spinal segments predominated: C4, C3, T7. Among patients with paraplegia, the cause is an individually greater number of spinal injuries. (Table 1).

Table 1. Clinical characteristics of participants: tetraplegia (n = 9) and paraplegia (n = 7).

	Time since injury (years)		
	M & SD	**Min**	**Max**
Paraplegia	1.6 ±1.9	1	8
Tetraplegia	2.2 ±2.4	0.5	6
	Type of wheelchair used		
	number of patients:	**classic**	**active**
Paraplegia		4	3
Tetraplegia		6	3
	Level of SCI: in some subjects, the injury occurred at multiple levels of the spinal cord		
(abbreviations of spinal columns)		**code**	**n**
Paraplegia (n = 7; M = 2) L1–L5: lumbar spine (lower back) T1–T12: thoracic spine (chest/upper back)		L	1
		T3	1
		T4	2
		T5	1
		T6	2
		T7	4
		T8	2
		T12	1
Tetraplegia (n = 9; M = 1.88) C1–C7: cervical spine (neck)		C3	4
		C4	5
		C5	2
		C6	2
		C7	3
		T3	1

No significant differences were found between time since injury (U Mann-Whitney Test, W = 43.5, p-value = 0.1615) of participants with tetraplegia and paraplegia.

Visualization of the relationship between performance and capacity

The relationships between performance and capacity exemplified by the profiles of four patients demonstrate the usefulness of using radar charts (Figure 2).

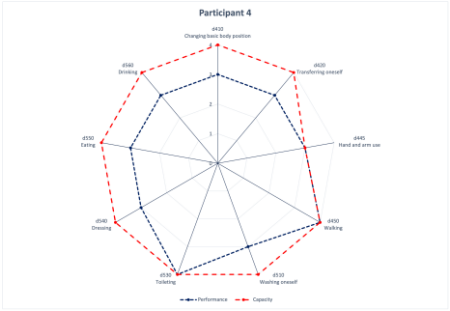
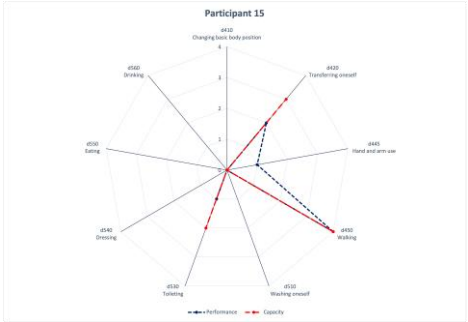
The larger the circle on the graph, the more difficulty the patient has in performing the activity.	
Capacities at level '4' indicate complete difficulty – orange circle, the participant has a performance of 1 degree better.	
The apparent deflection of the circle (codes: *d550, d560*) indicates a group of activities causing less difficulty (both execution and capacity).	
If the graph takes the value '0', then the participant has no difficulties in that category. Codes: *d410, d510, d540, d550, d560*	

Figure 2. Examples of variants of radar charts – profiles of four patients.

Analysis of the ICF Classification Results for 'Body functions'

Analysing the 'Body functions' domain in the group with paraplegia, a moderate impairment was indicated in code *Muscle tone functions (b735).* The remaining

functions posed a mild impairment or no impairment for the subjects. In the group with tetraplegia, a moderate impairment was identified in the assessment of codes *Emotional functions (b152)* and *Muscle tone functions (b735),* while severe impairments were presented by codes *Muscle power functions (b730)* and *Defecation functions (b525)* (Table 3).

Table 2. Distribution of qualifier indications for codes defining body functions in relation to the type of condition.

Type of condition (SCI)	**Degree of impairment (code/description)**				
	0/no	**1/mild**	**2/moderate**	**3/severe**	**4/complete**
	'Body functions' (code) number of qualifier indications with a given value				
	***Emotional functions* (b152)**				
Paraplegia	3	3	0	1	0
Tetraplegia	1	2	5	0	1
SCI	***Sensation of pain* (b280)**				
Paraplegia	3	2	0	2	0
Tetraplegia	3	5	1	0	0
SCI	***Respiration functions* (b440)**				
Paraplegia	7	0	0	0	0
Tetraplegia	7	2	0	0	0
SCI	***Defecation functions* (b525)**				
Paraplegia	2	0	2	3	0
Tetraplegia	2	0	1	6	0
SCI	***Urination functions* (b620)**				
Paraplegia	0	5	1	1	0
Tetraplegia	2	3	4	0	0
SCI	***Muscle power functions* (b730)**				
Paraplegia	0	1	6	0	0
Tetraplegia	0	0	6	3	0
SCI	***Muscle tone functions* (b735)**				
Paraplegia	0	1	6	0	0
Tetraplegia	0	0	6	3	0
SCI	***Protection functions of the skin* (b810)**				
Paraplegia	6	1	0	0	0
Tetraplegia	5	3	0	1	0

Analysis of the ICF Classification Results for 'Body functions'

The 'Body structures' domain showed severe impairment in codes *Spinal cord and related structures (s120)* and *Structure of the urinary system (s610)* in the group with tetraplegia. Meanwhile, the most common finding for the group with paraplegia was moderate impairment in code *Spinal cord and related structures (s120)* and mild impairment in code *Structure of the urinary system (s610)* (Table 3).

Table 3. Distribution of qualifier indications for codes defining body structure in relation to the type of condition.

Type of condition (SCI)	Degree of impairment (code/description)				
	0/no	**1/mild**	**2/moderate**	**3/severe**	**4/complete**
	'Body structures' (code) number of qualifier indications with a given value				
	***Spinal cord and related structures* (s120)**				
Paraplegia	0	0	7	0	0
Tetraplegia	0	0	0	9	0
SCI	***Structure of the respiratory system* (s430)**				
Paraplegia	7	0	0	0	0
Tetraplegia	9	0	0	0	0
SCI	***Structure of the urinary system* (s610)**				
Paraplegia	0	6	1	0	0
Tetraplegia	1	3	1	4	0

Analysis of the ICF Classification Results for 'Environmental factors'

Analysing the 'Environmental factors' domain, a severe barrier for two subjects from the tetraplegic group and one from the paraplegic group was code *Immediate family (e310)*. Moderate facilitator for subjects from the tetraplegic group was provided by codes *Products and technologies for personal use in daily living (e115)* and *Products and technology for personal indoor and outdoor mobility and transportation (e120)* (Table 4).

Table 4. Distribution of qualifier indications for codes defining environmental factors in relation to the type of condition.

Type of condition (SCI)	Degree of impairment (code/description)				
	0 **no barrier/ facilitator**	**1/+1** **mild barrier/ facilitator**	**2/+2** **moderate barrier/ facilitator**	**3/+3** **severe barrier/ facilitator**	**4/+4** **complete barrier /facilitator**
	'Environmental factors' (code) number of qualifier indications with a given value				
	***Products and technologies for personal use in daily living* (e115)**				
Paraplegia	0	0/4	0/3	0	0
Tetraplegia	0	0/1	0/6	0/1	0/1
SCI	***Products and technology for personal indoor and outdoor mobility and transportation* (e120)**				
Paraplegia	0	0/5	0/2	0	0
Tetraplegia	0	0	0/6	0/3	0
SCI	***Immediate family* (e310)**				
Paraplegia	0	0/2	0/1	1/3	0
Tetraplegia	0	0	0/2	2/5	0
SCI	***Personal care providers and personal assistants* (e340)**				
Paraplegia	7	0	0	0	0
Tetraplegia	6	0	0/2	0	0/1
SCI	***Health professionals* (e355)**				
Paraplegia	0	0/3	0/4	0	0
Tetraplegia	0	0/1	0/6	0/1	0/1

Analysis of the ICF Classification Results for 'Activity and participation'

Analysis of the results obtained in the 'Activity and participation' domain showed that people with tetraplegia indicate the occurrence of greater difficulties in capacity (C) than in performance (P), with the exception of one person in activity: *Changing basic body position (d410).* In the case of people with paraplegia, there are individuals in three out of ten activities analysed: *Hand and arm use (d445); Toileting (d530); Dressing (d540),* which all indicate greater difficulty in performance in relation to capacities. The indicated differences in performance and capacity are not large – by one point in the qualifiers' assessment with the exception of one indication in *Hand and arm use (d455),* where the difference was as high as three points (Table 5).

Table 5. Distribution of qualifier indications (**P** performance; **C** capacity;) for activity and participation codes.

Code	Paraplegia (n = 7)		Tetraplegia (n = 9)	
	P/C	**n**	**P/C**	**n**
Changing basic body position (d410)	0/0	3	0/0	2
	1/1	2	1/0	1
	1/2	1	1/2	1
	4/4	1	3/4	2
			4/4	3
Transferring oneself (d420)	1/2	1	1/2	1
	2/2	1	2/2	1
	2/3	5	2/3	1
			2/4	1
			3/3	3
			3/4	2
Hand and arm use (d445)	0/0	5	1/1	1
	1/0	1	1/2	2
	3/0	1	2/3	2
			2/3	3
			3/4	1
Walking (d450)	2/3	1	0/0	1
	4/4	6	2/3	1
			4/4	7
Washing oneself (d510)	0/0	3	0/0	2
	1/2	3	1/2	1
	3/4	1	2/3	1
			3/4	2
			4/4	3
Toileting (d530)	0/0	1	0/0	1
	1/2	5	1/2	2
	4/4	1	3/4	1
			4/4	5
Dressing (d540)	0/0	1	0/0	3
	0/1	3	3/4	4
	1/2	1	4/4	2
	2/3	1		
	3/2	1		
Eating (d550)	0/0	6	0/0	3
	2/3	1	1/2	2
			3/4	4
Drinking (d560)	0/0	6	0/0	3
	2/3	1	1/2	2
			3/4	4

difficulty*:* **0** no; **1** mild; **2** moderate; **3** severe; **4** complete

'Activity and participation' with graphical visualization of the presented results

The patient profile (radar chart) with code '3' shows extreme difficulty in all activities, with only movement and hand and arm use being significantly difficult. Performance and capacity in most activities balance each other; only in self-care activities such as dressing, eating, and drinking is performance better than capacity. The distribution indicates a selection of skill-shaping interventions in all ranges to improve functioning in a wide range of areas, with greater attention to shaping body motor skills (Figure 3).

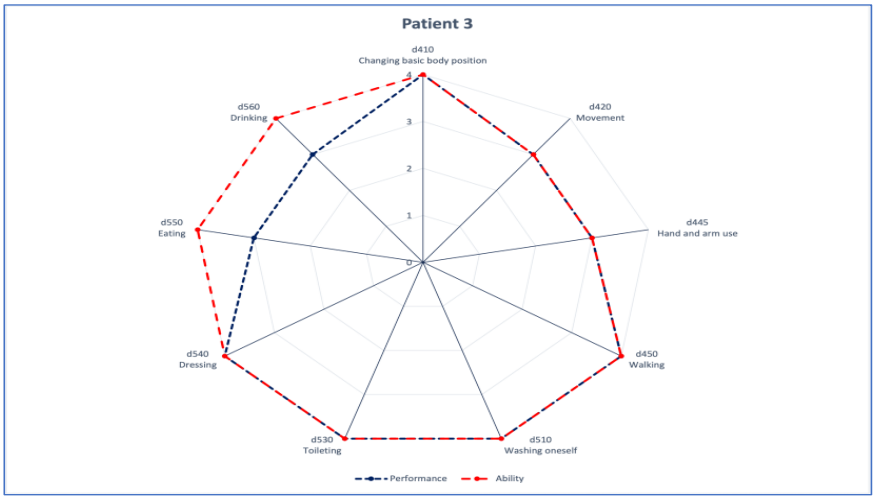


Figure 3. Patient code '3' with tetraplegia.

The patient profile (radar chart) with code '10' shows significant difficulty in walking and transferring oneself and moderate difficulty in dressing, toileting and washing oneself. When it comes to dressing, washing oneself, and toileting, performance is better than capacity. The distribution indicates a selection of interventions towards training self-care activities and repositioning (Figure 4).

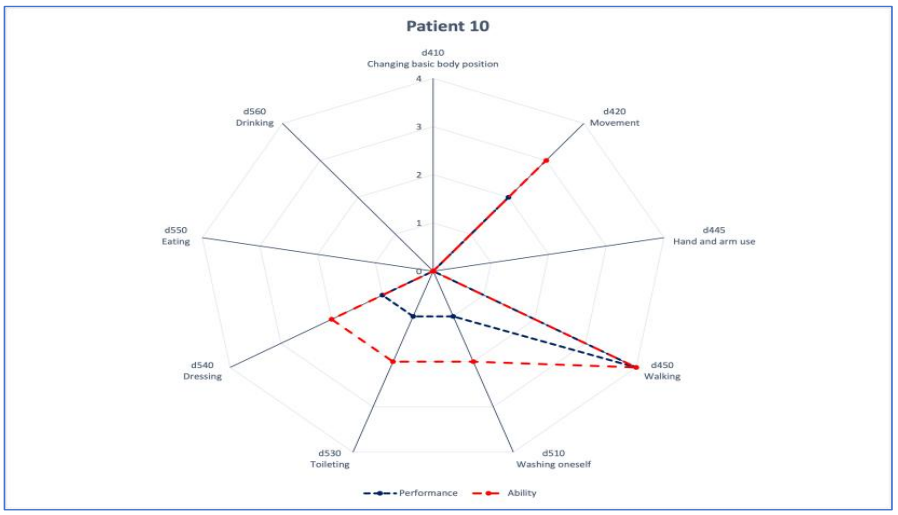


Figure 4. Patient code '10' with paraplegia.

Detailed, individual charts for other participant showing the degree of difficulty in the capacity and performance of the activities studied, together with a description of the limitations and a proposal for the application of the selected interventions are in the possession of the corresponding author.

Analysis of the results of an empirical variable Analysis of the results of an empirical variable *Changing basic body position (d410)* revealed that in the tetraplegic group, three people indicated less difficulty in performance than in capacity, five people indicated the same values for performance and capacity, and one person had more difficulty in performing the activity relative to their capacity to perform it. In the paraplegic group, one person indicated less difficulty in performance relative to their capacity, and six people had the same level of performance as difficulty (Figure 5).

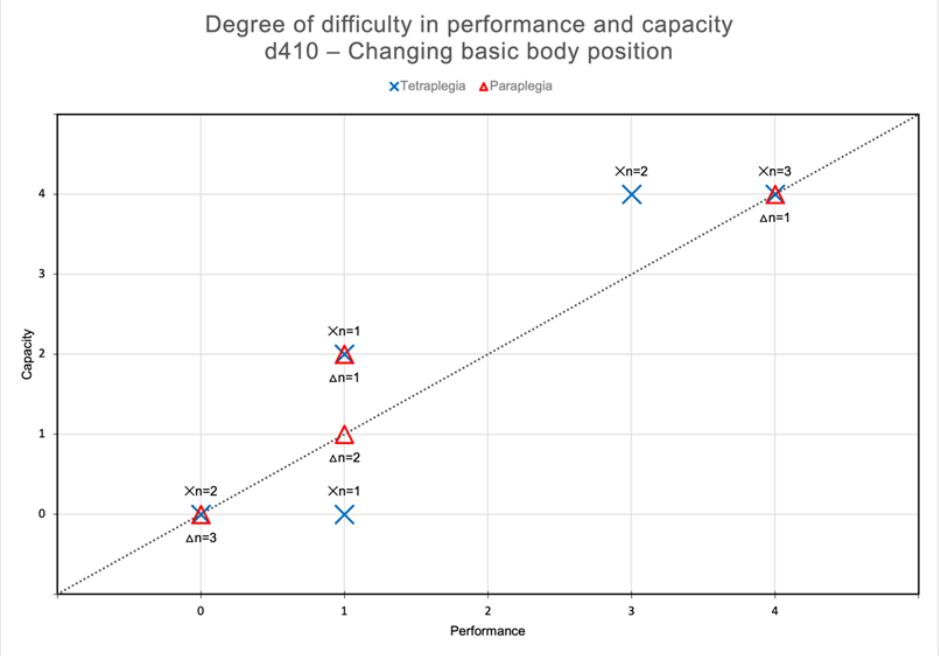


Figure 5. Degree of difficulty in performance and capacity *Changing basic body position (d410).*

Gait analysis according to the WISCI II scale identified 81.25% of participants as unable to walk, 12.5% as able to walk with the aid of a walker, without braces (including one person with paraplegia and one with tetraplegia), and 6.25% of participants able to walk with a crutch wearing braces with assistance from 1 person – this was one participant from the tetraplegic group. The in-depth analysis is based on the results using the SCIM III scale was used (Table 6).

Table 6. Descriptive characteristics of SCIM III (^ means: a range of points possible to obtain under SCIM III and the component score).

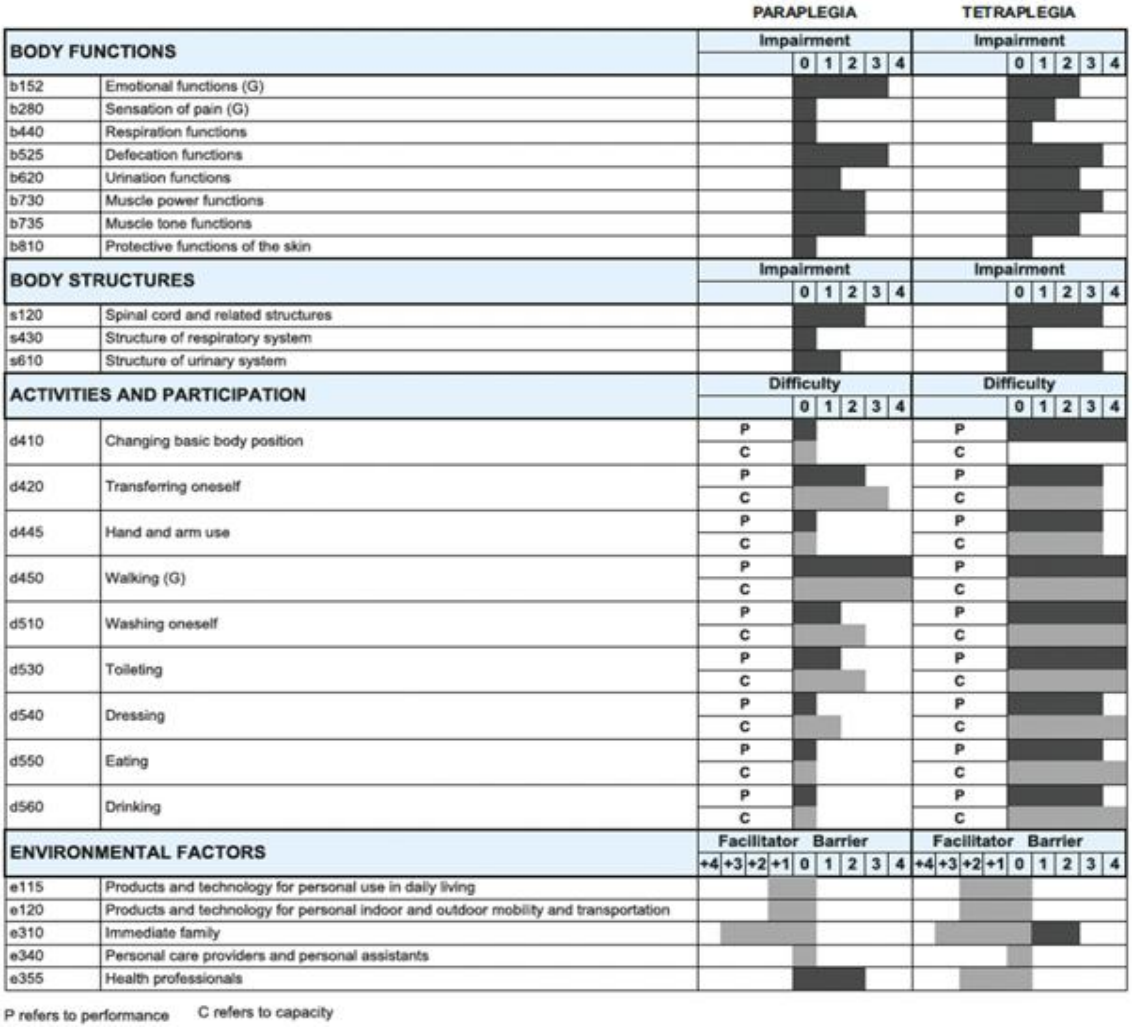
SCIM III component and item (from 1 to 16)	Patients		
	all (n = 16)	paraplegia (n = 7)	tetraplegia (n = 9)
		Me ($Q_{0.25}$; $Q_{0.75}$)	
Self-care (0-20)^	**17 (6; 20)^**	**18 (17; 20)^**	**10 (4; 19)^**
1. Food intake	**5** (2.5; 5)	**5** (5; 5)	**4** (2; 5)
2. Washing oneself	**4** (1; 5)	**4** (4; 5)	**1** (0; 4)
3. Dressing	**3.5** (1; 5)	**5** (3; 5)	**1** (1; 5)
4. Hygiene, grooming	**4** (2; 5)	**5** (4; 5)	**3** (2; 5)
5. Respiratory function	**10** (10; 10)	**10** (10; 10)	**10** (10; 10)
Respiration and sphincter management (0-40)^	**24 (15; 9.5)^**	**29 (24; 29)^**	**22 (15; 30)^**
6. Urinary tract care	**10** (5; 10)	**10** (5; 10)	**10** (5; 10)
7. Bowel movement care	**0** (0; 7.5)	**5** (0; 10)	**0** (0; 5)
8. Use of the toilet	**4** (0; 4)	**4** (4; 4)	**0** (0; 4)
Mobility (0-40)^	**14.5 (9; 17)^**	**15 (13; 17)^**	**9 (7; 17)^**
9. Mobility in the bed, prevention of pressure sores	**4.5** (1; 5)	**5** (4; 5)	**1** (1; 6)
10. Bed-wheelchair transfer	**1** (1;1.5)	**1** (1; 2)	**1** (1; 1)
11. Wheelchair to bathtub transfer	**1** (1; 1)	**1** (1; 1)	**1** (1; 1)
12-14. Functional locomotion over distance	**6** (6; 6)	**6** (6; 6)	**6** (5; 6)
15. Walking up/down the stairs	**0**	**0**	**0**
16. Getting into the car from a wheelchair	**1** (1; 1)	**1** (1; 1)	**1** (0; 1)
SCIM III Index	**58.5 (30.5; 3.5)**	**61 (54; 66)**	**39 (27; 60)**

The median value of participants' pain intensity according to the VAS scale is **1** (0;1), and the modal value is 1 – which means that participants have insignificant pain.

Functioning Profile of patients with paraplegia and tetraplegia

The results obtained from the breakdown of qualifiers in the individual ICF domains (Table 3 to 6) enabled the presentation of the functioning profile of individuals with paraplegia and tetraplegia in the form of a categorical profile. The analysis of the functioning profile provides information on the deficits/limitations present in the studied patient group, succinctly presents the distribution of qualifiers in the respective ICF domains, and provides an empirical basis for the selection of appropriate therapy (Table 7).

Table 7. Graphical representation of functional profiles of patients with paraplegia and tetraplegia (basic on criteria [19]).



P refers to performance C refers to capacity

4. Discussion

The following structures were identified in the assessment of function, disability, and health using the Brief ICF Core Set for SCI in the early post-acute context: *Spinal cord and related structures (s120); Structure of respiratory system (s430).* Participants with paraplegia indicated spinal cord impairment as moderate, while participants with tetraplegia indicated severe impairment. The distributions of indications of the qualifier *Structure of urinary system (s610)* for people with tetraplegia range from no impairment (11% of indications) to severe impairment (44% of indications). The predominant indication of people with paraplegia was mild impairment (6 people). No impairment in Structure of respiratory system *(s430)* was found among the subjects. The body functions in the Brief ICF Core Set for SCI in the early post-acute context are defined by eight codes: *Emotional functions (b152); Sensation of pain (b280); Respiration functions (b440); Defecation functions (b525); Urination functions (b620); Muscle power functions (b730); Muscle tone functions (b735); Protective functions of the skin (b810).* Among those with paraplegia, no impairment or mild impairment occurred in *Emotional functions (b152),* moderate impairment in *Defecation functions (b525)* 75% of respondents, *Muscle power functions (b730), Muscle tone functions (b735);* a severe impairment in 29% in *Sensation of pain (b280).* Patients with tetraplegia

identified a mild impairment in *Sensation of pain (b280),* a moderate impairment in *Emotional functions (b152)* and *Muscle tone functions* (b735), a moderate to severe impairment in *Muscle power functions (b730)* and a severe impairment in *Defecation functions (b525).* For *Respiration functions (b440),* no impairment was found in both study groups. Within *Urination functions (b620),* both respondents with paraplegia and tetraplegia indicated the most frequent occurrence of a mild impairment. Results of analysis of qualifier distributions for five environmental factors: *Products and technologies for personal use in daily living (e115); Products and technology for personal indoor and outdoor mobility and transportation (e120); Immediate family (e310); Personal care providers and personal assistants (e340); Health professionals (e355)* indicate that respondents with tetraplegia perceive the factors listed as facilitators to a greater difficulties than those with paraplegia. Analysis of the activities and participation by the respondents showed that people with tetraplegia indicate the occurrence of greater difficulties in capacity (C) than in performance (P), except for one person in the activity *Changing basic body position (d410).* In the case of people with paraplegia, there are single individuals in seven out of the ten activities analysed: *Changing basic body position (d410); Hand and arm use (d445); Washing oneself (d510); Toileting (d530), Dressing (d540); Eating (d550);* and *Drinking (d560),* which all indicate greater difficulties in performance in relation to capacity. All indicated differences in performance and capacity are not large – by 1 point in the qualifiers' assessment.

The selection of categories included in the Brief ICF Core Set for SCI in the early post-acute context reflects the typically problematic functions in people with SCI – i.e., pain, touch functions, blood pressure functions, defecation functions, urination functions, muscle power and muscle tone functions, emotional functions, and skin functions. The structures mainly affected by SCI are the spinal cord, the respiratory and urinary systems, the upper and lower limbs, the trunk, the head and neck region, the shoulder region, the pelvic region, and the skin are also mentioned. Among the activities and participation, the variety of problems associated with SCI is highlighted, particularly those related to mobility in the broadest sense [12]. International studies of the situation of people with SCI worldwide make it possible to compare them and provide a key starting point for an international educational experience [20]. In contrast, the level of SCI and the overall ICF Brief Core Sets score, especially the activity and participation categories scores, show a direct significant relationship with quality of life (QoL). Furthermore, a significant indirect relationship with QoL was found between ICF composite scores in body structure and functions, environmental factors, the level of SCI, and gender. As no association of the Spinal Cord Independence Measure with QoL was found, categories related to instrumental ADL and participation were considered to have the most significant impact on QoL [21].

The study by Nam et al. [22] confirms the most frequent occurrence of problems among subjects with SCI in terms of the following functions: *Muscle power* (*b730*, 100% of subjects); *Urination* (*b620*, 90.3%); *Sensation of pain* (*b280*, 75.8%); *Defecation* (*b525*, 67.7%), *Emotional* (*b152*, 46.8%); *Protective of the skin* (*b810*, 43.5%); *Blood pressure* (*b420*, 14.5%); *Respiration* (*b440*, 12.9%); *Muscle tone* (*b735*, 12.9%). The impairment of body structures among self-reported participants was as follows: *Spinal cord structures (s120)* in 100% of participants; *Respiratory system (s430)* in 9.7%; and *Urinary system (s610)* in 4.8%. In the domain of activity and participation, the difficulties for the respondents were: *Transferring oneself (d420)* at 96.8%; *Walking (d450)* at 93.5%; *Toileting (d530)* at 90.3%; *Dressing (d540)* at 88.7%; and *Washing*

oneself (d510) at 87.1%; *Changing basic body position (d410)* at 71.0%; *Hand and arm use (d445)* at 67.7%; *Drinking (d560)* at 58.1%; and *Eating (d550)* at 53.2%. In the domain of environmental factors, the association of *Immediate family (e310)* was found in 100% and *Products and technology for personal indoor and outdoor mobility and transportation (e120)* in 95.2%, *Health professionals (e355)* in 98.4% of *Personal care providers and personal assistants* (*e340*, 17.7%), *Products and technology for personal use in daily living (e115)* in 12.9% [22].

In a study conducted in Turkey by Tatli et al. [23], approximately 76.7% of Turkish patients presented a problem in the *b280* code of *Sensation of pain*, and 77.5% of patients presented problems in *Defecation functions*. *Respiratory dysfunction (b440)* was experienced by 25% of subjects, and *Structural impairment of the respiratory system (s430)* was found in 49.2% of subjects. Bladder dysfunction is another problem observed in more than 80%; problems with the *Protective functions of the skin (b810)* were observed in 48% of the subjects. The second most frequently observed structural problem (approximately 81.3% of patients) was the *Urinary system (s610). The structure of the spinal cord and related structures (s120)* was identified as a problem in 100% of respondents.

In the domain of activity and participation, in both the paraplegic and tetraplegia groups, the majority of subjects showed the same or higher level of capacity to perform the tested activity concerning their executive capacities. This phenomenon can be explained by the study group's high level of motivation for independence and self-reliance in life and the activation of all possible compensations. Only one person in the paraplegic group showed more difficulty in performance as compared to their capacity in *Eating (d550)* and *Drinking (d560), Toileting (d530),* and *Dressing (d540).* Two people in the paraplegic group had greater performance difficulties in relation to their capacity in *Arm and arm use (d445);* the difference was significant for one of them [23]. Similar difficulties were reported by participants in the aforementioned Nam team study [22]. In the domain of environmental factors, the most common facilitators (indicated by more than 85% of participants) were: *Products and technology for personal use in daily living (e115), Products and technology for personal indoor and outdoor mobility and transportation (e120),* and *Immediate family (e310)* [23]. The function: *Sensation of pain (b280)* and the activity of *Transferring oneself (d420)* in both clinical expert opinion and a review of the literature on SCI appear to be fundamental aspects of functioning in SCI [24].

The study conducted by Herrmann's et al. [25] comparing the functioning of individuals with paraplegia and tetraplegia showed a higher risk of problems in three ICF categories pertaining to 'Body structures' in patients with tetraplegia, with the greatest in the head region. An interesting result was obtained in the assessment of *Structure of trunk (s760),* where patients with tetraplegia reported significantly fewer problems compared to those with paraplegia. In the ICF component of 'Activity and participation', individuals with tetraplegia were more at risk of impairment in the area of *Hand and arm use (d445),* similar to our own study. The difficulties accompanying this function in the operation of communication devices and performing precise movements and self-care activities, especially in *Eating (d550)* and *Drinking (d560),* were emphasized. Among the environmental factors, *Personal care providers and personal assistants (e340)* posed a barrier more frequently for individuals with tetraplegia compared to those with paraplegia. Additionally, it was noted that compared to individuals in a long-term context, those in the early stages post-acute showed fewer problems in functioning across 30 ICF categories [25].

Meanwhile, in the assessment conducted by Val's team using the ICF classification for patients after SCI in the 'Body functions' domain, a significant or complete problem was identified in: *Emotional functions (b152).* In the domain of 'Activities and participation', in functions such as *Washing oneself (d510)* and *Toileting (d320),* no or moderate difficulty was reported in execution. This result can be explained by the fact that the studied group was predominantly individuals with paraplegia as compared to those with tetraplegia, who have greater difficulties in performing these tasks. Codes *Eating (d550)* and *Drinking (d560)* were assessed as without difficulty, which can be explained in the same way. In the domain of 'Environmental factors', *Products and technologies for personal use in daily living (e115), Products and technology for indoor and outdoor mobility and transportation (e120),* and *Immediate family (e310)* were considered facilitators [26].

In a study by Pires et al. [27] assessing the impact of neurogenic bowel dysfunction (NBD) after SCI on QoL using the ICF, 59.4% of patients reported a significant impact of NBD on QoL. When analysing impact of the ICF domain, environmental and personal factors were found to have the greatest negative impact, with 46.9% of patients reporting a loss of privacy, 45.3% reporting a need for help with defecation functions, 45.3% reporting feelings of frustration, anxiety or depression due to NBD, and 39.1% believing that NBD was associated with increased economic costs [27]. The importance of early determination of functional and health status using the ICF in a comprehensive patient assessment is emphasized as the foundation for a rehabilitation planning, structured, targeted approach to patients with acute SCI [22, 28]. Rehabilitation programs should focus on limitations related explicitly to instrumental ADL and limitations in participation [21]. An important element of rehabilitation interventions in SCI patients is the improvement of ADLs, mobility, and self-care and mobility skills. A critical measure of the success of rehabilitation of patients after SCI is the patient's degree of independence in such activities. Therefore, it is necessary to develop a set of guidelines that comprehensively assess and define potential activity and participation problems before starting a rehabilitation program [23]. This is borne out by our study, which places a particular emphasis on accurately diagnosing capacity and performance difficulties as the starting point for selecting targeted rehabilitation interventions. The proposed way of visualizing the results of the survey is an important aid.

In line with the results of other researchers, our study, including the SCIM II scale, found differences in the functioning of people with tetraplegia and paraplegia. However, due to the sample size, no significant statistical differences could be obtained. Ehrmann's et al. [29] study of n = 1549 people with SCI from Europe and the Western Pacific using graphical modelling confirmed differences in the functioning of people with paraplegia and tetraplegia, especially in emotional functions and stress management and also in activities such as transferring oneself, caring for oneself and home life, transferring from bed to wheelchair, and getting dressed [29]. A subsequent study by Ehrmann et al. [30] showed that problems with accessibility to friends' and relatives' homes, access to public places, and long-distance transport were consistently key determinants of functioning. Architectural barriers preventing social and family interaction are a significant environmental factor affecting the functioning and quality of life of people with SCI. In the self-report survey, subjects cited relationships with loved ones as factors that significantly facilitated functioning.

Despite the homogeneity of the study group, selected in terms of high motivation for independent functioning, differences can be observed between people with paraplegia

and tetraplegia. We can find confirmation of our own findings in a review of the literature, including the work of the InSCI Group [30, 31].

Limitation of the study

A limitation of the study is the small sample size. To confirm the results obtained, studies should be performed on a larger number of participants, which would allow more extensive use of statistical methods and more complete conclusions.

Emerging differences in the distributions of code qualifiers included in the Brief ICF Core Set for SCI in the early post-acute context, as well as in the mean values in the scales and questionnaires used in the study, need to be confirmed on a larger group of people with paraplegia and tetraplegia.

A study was conducted on a non-randomized group. The participants were extremely motivated to improve their functioning and achieve independence, aspiring to be FAR coaches.

5. Conclusions

The functioning profile of participants with SCI as determined by code qualifiers highlights the differences that exist in the activities and participation of people with tetraplegia and paraplegia. People with tetraplegia indicate greater difficulty in capacity and performing activities. No statistically significant differences were observed for the other domains, possibly due to the sample size.

People with SCI with tetraplegia and paraplegia require partial assistance with ADL. The study also included a group of participants with greater performance than capacity. This was due to their high level of commitment as aspiring coaches within the ranks of the FAR team. This required a modified therapeutic approach.

The Brief ICF Core Set for SCI in the early post-acute context provides a quick and accurate functional profile of the participants after SCI.

The visualization of individual results in the form of radar charts offers the possibility of a comprehensive assessment, with the identification of individual participant needs and the selection of optimal interventions.

The scatter plots showing the specificity of the participant group in terms of capacity and performance for each category of activity and participation make it possible to distinguish three groups of participants according to the relationship of capacity and performance.

The three types of visualization proposed in the article (1-Categorical ICF profile; 2-Individual outcome charts; 3-Patient group specificity charts for each participant group category) can be used by therapy-instructional teams to plan targeted interventions.

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