

ORIGINAL REPORT

## WHEELCHAIR SKILLS PERFORMANCE BETWEEN DISCHARGE AND ONE YEAR AFTER INPATIENT REHABILITATION IN HAND-RIM WHEELCHAIR USERS WITH SPINAL CORD INJURY

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**Objective:** To study possible changes in wheelchair skills in participants with spinal cord injury between discharge and 1 year after rehabilitation, and to determine whether changes in wheelchair skills performance are related to lesion and personal characteristics, self-efficacy, and wheelchair satisfaction.

**Study design:** Prospective cohort study.

**Setting:** Eight rehabilitation centres with spinal cord injury units in the Netherlands.

**Methods:** A total of 111 participants performed the Wheelchair Circuit twice: at discharge (t1) and 1 year after discharge (t2). Personal/lesion characteristics, self-efficacy, and wheelchair satisfaction were measured. Normalized ability score and performance time score were analysed with a linear multilevel regression analysis for possible associations with wheelchair skills.

**Results:** No statistically significant changes were found in the ability and performance time scores of the Wheelchair Circuit over the first year after discharge. Younger persons, those with paraplegia, and those with a better self-efficacy score showed higher ability scores and faster performance time scores on both test occasions.

**Conclusion:** Wheelchair skills performance, measured with the Wheelchair Circuit, did not change during the first year after discharge from inpatient rehabilitation. Wheelchair skills performance was associated with age, lesion level and self-efficacy perceptions.

**Key words:** manual wheelchair; wheelchair skills learning; wheeled mobility; self-efficacy; wheelchair satisfaction.

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### INTRODUCTION

Community integration has been described as the ultimate goal in the rehabilitation of individuals following an injury or disability (1). In order to function independently, manual wheelchair users must acquire a variety of wheelchair skills to deal with the physical barriers encountered in various environments in daily life (2). Mastering wheelchair skills can make a difference between dependence and independence in the daily life of people with spinal cord injury (SCI) who are primarily wheelchair users (3, 4). Studies have shown that, during the early phase of inpatient rehabilitation of persons with SCI, wheelchair skills performance improved significantly (5, 6). In a cross-sectional study, wheelchair skills performance of persons with SCI was found to be positively associated with participation (i.e. involvement in life situations) 1 year after discharge from inpatient rehabilitation (7). At discharge from inpatient rehabilitation, persons with acute SCI can propel their wheelchair and perform various wheelchair skills, such as negotiating kerbs and transferring (6). However, other studies have shown that, after rehabilitation, wheelchair users may be immature in their performance of wheelchair skills (8).

Following discharge from inpatient rehabilitation, patients with SCI face the difficult challenge of adapting to life with a disability (9, 10). Previous studies have shown that, once discharged, persons with SCI are confronted with problems that negatively affect functioning (11). In a study by Hammell et al. (8), concern was frequently expressed that “the therapists in the spinal units had no knowledge or awareness of what it really means to live with a disability in the community”. Frustration was directed to a generic rehabilitation process that aims to teach certain predetermined skills and is out of context with the specific and unique environment of the client, and his or her values or lifestyle.

Reported problems post-discharge include physical problems, such as pain (12, 13, 15, 16, 18, 19, 20), spasm, (12–15,

20) pressure sores, (12–15, 19–21) or bladder (13–15, 19–20) and bowel problems (13, 15, 19, 20). The literature also mentions transportation and technical (wheelchair) problems, (12, 13, 15, 17, 19), difficulties in care management, (17, 19), feelings of sadness (15, 19) and lack of adequate housing (12, 17, 19). These problems may directly influence the development of wheelchair skills performance and, therefore, lead to limitations in, or even complete avoidance of, participation in the community.

Publications regarding changes in wheelchair skills performance in the first year after discharge from inpatient rehabilitation are lacking. It can be assumed that after being mobile in a wheelchair for 12 months post-discharge, the level of wheelchair skills performance will have increased as a result of experience. On the other hand, the problems persons with SCI face in the first months post-discharge from the rehabilitation centre may have led to a decrease in wheelchair skills performance.

The Physical Activity behaviour and functioning of people with a Disability (PAD) model, developed by van der Ploeg et al. (22), conceptualizes the possible relationship among physical activity, its determinants, and functioning in people with disabilities, taking into account personal and environmental factors. In the present study, wheelchair skills performance is the physical activity that may affect participation in social activities. Demographic characteristics, SCI lesion level and completeness, and self-efficacy are the personal and lesion variables that were selected to analyse their relationship with wheelchair skills performance, while “wheelchair satisfaction” represents the environmental factor that may affect changes in wheelchair skills performance over time.

Perceived self-efficacy is defined as “belief in one’s capabilities to organize and execute the courses of action required for producing given attainments” (23). The stronger an individual’s sense of efficacy in physical tasks, the more positive is this person’s perceived psychological well-being (24). Increased self-efficacy in wheelchair skills performance may encourage wheelchair users with SCI to approach, persist, and persevere at executing wheelchair-related tasks that were previously avoided. In contrast, wheelchair users with low perceived self-efficacy in wheelchair skills performance may become inactive when facing daily physical challenges; evidently, perceived self-efficacy may ultimately affect changes in wheelchair skills performance over time.

“When assistive technology (i.e. a wheelchair) is successful in helping people maintain or regain control, important results are increased self-efficacy and decreased negative emotional reactions to disability. These effects, in turn, are hypothesized to enhance subjective well-being” (25). This is the reason for choosing wheelchair satisfaction as a variable that might also be related to changes in wheelchair skills performance over time.

The objectives of this study were: (i) to determine possible changes in wheelchair skills in participants with SCI between discharge and 1 year after discharge from inpatient rehabilitation; and (ii) to determine whether these changes in

wheelchair skills performance are related to lesion, personal characteristics and/or the subject’s perceived self-efficacy and wheelchair satisfaction. The hypothesis was that wheelchair skills performance of persons with an SCI will improve during the first year after discharge from the rehabilitation centre.

## METHODS

The present longitudinal study was part of the Dutch research programme “Physical Strain, Work Capacity, and Mechanisms of Restoration of Mobility in the Rehabilitation of Persons with Spinal Cord Injuries” (26) ([www.scienn.nl](http://www.scienn.nl)). For the present study, persons with SCI were measured at the time of discharge from inpatient rehabilitation (t1) and 1 year after discharge (t2). Eight Dutch rehabilitation centres specializing in the rehabilitation of persons with SCI participated in this research programme. Eight trained research assistants conducted the measurements according to a standardized protocol. Persons were eligible to enter the programme if they had an acute SCI; were between the ages of 18 and 67 years; were classified as A, B, C or D on the American Spinal Injury Association (ASIA) Impairment Scale; were manual wheelchair-users; did not have a progressive disease or psychiatric disorder; and knew the Dutch language well enough to understand the goal of the study and the testing methods. Before being tested, subjects were extensively screened by a rehabilitation physician. Potential participants were not included if they had: (i) cardiovascular diseases (the absolute contraindications as they are stated by the American College of Sports Medicine guidelines, or a resting diastolic blood pressure > 90 mmHg or a resting systolic blood pressure > 180 mmHg); or (ii) severe musculoskeletal complaints of the upper limbs, neck, or back. To avoid influencing test results, participants were asked to consume only a light meal; to refrain from smoking, drinking coffee and drinking alcohol at least 2 h before each measurement; and to void their bladder directly before testing. Furthermore, a medical examination was performed and participants completed self-report questionnaires. Participants were tested in the rehabilitation centres in which they had been inpatients. All participants completed a consent form after they had been given information about the testing procedures. All tests and protocols were approved by the Medical Ethics Committee of the Institute for Rehabilitation Research (Hoensbroek, The Netherlands).

### *Wheelchair skills performance: the Wheelchair Circuit*

The Wheelchair Circuit (27, 28) is a test assessing wheelchair skills performance.

The Wheelchair Circuit consists of 8 different standardized tasks that are performed in a fixed sequence, on a hard and smooth floor surface, and on a motor-driven treadmill (Treadmill Giant, Bonte BV, Zwolle, The Netherlands). All participants used a standard test wheelchair, which was available in 2 seat widths: 0.42 and 0.46 m (Sopur Starlight 622, Sunrise Medical GmbH, Germany). The 8 tasks of the Wheelchair Circuit are: performing a figure-of-8; crossing a doorstep (height 0.04 m); mounting a platform (height 0.10 m); performing a 15-m sprint, 3% slope, 6% slope, 3 min wheelchair propulsion, and transferring from the wheelchair to a treatment table. For the slope tests, participants are asked to drive at the given slope for 10 s. The performance of the Wheelchair Circuit thus leads to 2 test scores: performance time score and ability score. The *Performance Time Score* is the sum of the performance times of the figure-of-eight and the 15-m sprint tasks. The *Ability Score* is assigned by giving 1 point for each of the 8 tested items that are performed adequately and independently. Three items (crossing a doorstep, mounting a platform, and transferring) may also be scored “partially able” and assigned half of a point. All points are summed to give an overall ability score and the ability score ranges from 0 to 8. For a more detailed description of the Wheelchair Circuit see Kilkens et al. (27, 28).

### Personal and lesion characteristics

Age and gender were registered at t1. At each test occasion (t1–t2), the lesion characteristics (level and completeness) were assessed by a physician according to the International Standards for Neurological Classification of Spinal Cord Injury. Neurological lesion levels below T1 were defined as paraplegia, while lesion levels at or above T1 were defined as tetraplegia. AIS grades A and B were considered motor complete, and grades C and D were considered motor incomplete.

### Self-efficacy

Self-efficacy was measured at discharge and 1 year after discharge with the self-efficacy scale (SES) developed by Sherer et al. in 1982 (29). The SES has been translated into Dutch by Bosscher & Drums (1998) (30). A subscale on social self-efficacy was not translated and 1 item was deleted later due to ambiguous wording, and as a result, General Competency Scale with 16 questions remained (ALCOS-16). In this questionnaire, participants are asked to indicate on a 5-point Likert scale how much they agree or disagree with each statement concerning their ability to handle their current situation. The item scores are then added up to a total score ranging between 16 and 80. A high score indicates a high level of perceived general self-efficacy.

### Wheelchair satisfaction

To test wheelchair satisfaction, the Dutch version of the Quebec user evaluation of satisfaction with assistive technology questionnaire (D-quest) was administered 1 year after discharge (31). In this valid and reliable instrument, the respondent is asked to rate his or her satisfaction with the daily used wheelchair with respect to 13 different aspects using a 5-point scale. The scale ranges from 1 (not satisfied at all) to 5 (very satisfied). In this study, only general satisfaction with the wheelchair (question number 13) was analysed. Scores 1 or 2 were considered as not satisfied (0) and scores >3 were considered as satisfied (1).

### Statistical analysis

Descriptive statistics (means (standard deviation; SD)) were applied to all variables. To determine whether wheelchair skills performance improved significantly 1 year post-discharge (research question number 1), a multilevel modelling method with a MLwiN (32, 33) program was performed. The benefits of this method are that it accounts for the dependency of repeated measures within the same person, it is suitable when differences between rehabilitation centres are expected, and that it accounts for the hierarchical nature of the longitudinal data of the present study. In the longitudinal data set of this study, 3 levels of hierarchy were set: the repeated measurement (test occasion t1–t2) (level 1), which were grouped within individual participants (level 2), that were grouped in the rehabilitation centres (level 3).

Since the ability score was not normally distributed, a transformation to normal scores was made (32). Thereafter, both the normalized ability score and performance time score were analysed with a linear multilevel regression analysis.

To answer the first research question, the performance time score and the ability score (separately) were related to time, which was entered into the analyses as a categorical variable with the first measurement as reference (dummy t1–t2: t1 = 0, t2 = 1).

To describe the relationship between personal/lesion characteristics, self-efficacy or wheelchair satisfaction and wheelchair skills, we first analysed which of the independent variables were, in addition to the time-based model, univariately related to either the performance time score or the ability score. Apart from time, the independent variables were age (years), gender (male = 1, female = 0), lesion level (paraplegia = 1, tetraplegia = 0), motor completeness of the lesion (complete = 1, incomplete = 0), self-efficacy (ALCOS-16, mean scores) or wheelchair satisfaction (yes = 1, no = 0). Independent variables with  $p$ -values < 0.1 in these models were included in a subsequent multivariate model. Using the backward selection procedure, stepwise excluding non-significant determinants ( $p > 0.05$ ), final multivariate models for the dependent variables ability score and performance time were created.

To determine possible differences in the course of wheelchair skills (between groups (age, gender, lesion level, completeness, self-efficacy, wheelchair satisfaction) over time, we added the interaction term time \* group to the models that also included the time dummy and the specific determinant. This analysis was performed for each group separately.

Since the ability score might have a ceiling effect, we also dichotomized the ability score (score 0–7.5 = 0; score 8 = 1) and performed the analyses above with a logistic regression analysis.

## RESULTS

### Descriptive

This study was based on participants who performed the Wheelchair Circuit at the end of the rehabilitation and one year after the end of rehabilitation. Since only two measurement occasions were involved we deemed it necessary to include only participants who fully obtained the ability and time scores on these two occasions, although this was not strictly necessary for multilevel regression analysis.

Performance time scores were available only for those participants who were able to perform both the figure-of-eight shape and the 15-m sprint. A total of 111 participants had a performance time score at both test occasions. Participants' mean age at t1 was 38.2 years (SD 13.8, range 18–67 years) and 80 participants (72%) were men.

There were 76 participants with paraplegia, including 20 with a motor incomplete lesion; and 34 with tetraplegia, including 13 with a motor incomplete lesion (1 missing data).

Ability scores at both test occasions were available for 100 participants. Participants' mean age at t1 was 37.8 years (SD 14) (range 18–67 years), and 74 participants (74%) were men (1 missing data for lesion level, 2 missing data for completeness of injury). At t1, 3 persons were unable to perform any of the items of the Wheelchair Circuit and had an ability score of zero; 40 persons obtained the maximum ability score of 8 and 34 persons scored between 7 and 7.50 (74% > 7). Out of the 26 persons who did not achieve an ability score of 7 and above, 17 were participants with tetraplegia (65%).

### Descriptive analysis for changes in wheelchair skills performance over time

The mean and SD of the performance time scores at t1 were 22.7 s (SD 11.7), and 22.8 s (SD 13.6) at t2 (Table I). Descriptive statistics of the performance time score over time showed that 61 persons had a lower time score at t2 (= improvement, 55%,  $n = 19$  tetra), 35 persons had a higher time score at t2 (= deterioration, 31%,  $n = 14$  tetra) and 15 persons had the same time score at t1 and t2.

The mean ability score at t1 was 6.4 (SD 2.3, median 7.5) and 6.6 (SD 2.3, median 8) at t2 (Table II). Descriptive statistics of trends in the ability score over time showed that the score for 16 persons decreased, for 60 persons there was no change in their score ( $n = 13$  with tetraplegia), and for 24 persons ( $n = 8$  with tetraplegia) their ability score improved, between discharge and 1 year after discharge from the rehabilitation centre. The mean performance time and ability score for the total group

Table I. Descriptive (mean and standard deviation; SD) of the (change in) performance time

	n	T1 Mean (SD)	T2 Mean (SD)	T2-T1 Mean (SD)
Total group	111	23.3 (13.3)	22.8 (13.6)	-0.5 (8.8)
Gender				
Men	80	22.2 (13.2)	22.3 (15.0)	0.1 (9.0)
Women	31	25.8 (13.4)	23.9 (9.0)	-1.9 (8.7)
Age				
≤40.5 years	65	20.9 (11.4)	21.0 (13.9)	0.06 (8.8)
≥40.6 years	46	26.4 (15.1)	25.3 (12.8)	-1.2 (8.8)
Lesion level				
Tetraplegia	34	32.5 (17.3)	31.9 (16.8)	-0.6 (15.0)
Paraplegia	76	18.7 (7.4)	18.5 (9.2)	-0.2 (3.6)
Completeness of SCI				
Motor complete	76	21.6 (9.8)	22.3 (13.9)	0.7 (8.5)
Motor incomplete	33	24.3 (15.8)	22.9 (12.8)	-1.4 (5.4)
Self-efficacy scale				
Self-efficacy ≤65	49	23.6 (12.1)	23.2 (12.4)	-0.3 (5.0)
Self-efficacy >65	47	21.4 (13.4)	20.2 (10.9)	-1.1 (7.4)
Satisfaction				
Not satisfied with wheelchair	15	27.8 (11.7)	26.5 (13.5)	-1.3 (7.5)
Quite to very satisfied with wheelchair	83	21.7 (12.0)	22.0 (13.7)	0.3 (8.8)

and the specific groups (based on gender, age, lesion level and completeness, self-efficacy score and wheelchair satisfaction) are shown in Tables I and II, respectively.

Course of wheelchair skills performance over time

Regression analyses for the total group showed no significant changes in the (normalized) ability scores and the performance time scores during the first year after discharge from inpatient rehabilitation (research question 1, Table III). When the di-

Table II. Descriptive (mean and standard deviation; SD) of the (change in) ability score

	n	T1 Mean (SD)	T2 Mean (SD)	T2-T1 Mean (SD)
Total group	100	6.7 (2.1)	6.7 (2.2)	0.01 (0.6)
Gender				
Men	74	6.8 (2.0)	6.8 (2.1)	0.01 (0.6)
Women	26	6.2 (2.2)	6.2 (2.4)	0.0 (0.7)
Age				
≤40.5 years	59	6.9 (2.0)	6.9 (2.1)	0.03 (0.6)
≥40.6 years	41	6.3 (2.1)	6.3 (2.3)	-0.01 (0.7)
Lesion level				
Tetraplegia	30	5.3 (2.5)	5.2 (2.5)	-0.1 (1.0)
Paraplegia	69	7.3 (1.4)	7.4 (1.5)	0.1 (0.4)
Completeness of SCI				
Motor complete	69	6.7 (2.1)	6.7 (2.2)	0.01 (0.6)
Motor incomplete	29	6.8 (1.9)	6.8 (1.8)	0.0 (0.8)
Self-efficacy scale				
Self-efficacy ≤65	46	6.6 (2.2)	6.5 (2.3)	-0.1 (0.8)
Self-efficacy >65	44	6.8 (1.9)	6.8 (2.1)	0.02 (0.5)
Satisfaction				
Not satisfied with wheelchair	14	6.4 (1.8)	6.0 (2.3)	-0.4 (1.0)
Quite to very satisfied with wheelchair	78	6.7 (2.1)	6.8 (2.1)	0.1 (0.5)

Table III. Results of the basic regression models to describe the change over time in the performance time score and the (normalized) ability score for the whole group

	Performance time			Ability score (normalized)		
	B (SE)	95% CI	p-value	B (SE)	95% CI	p-value
Constant	23.3 (1.9)			-0.2 (0.1)		
Time	0.1 (1.7)	-3.1-3.4	0.94	0.1 (0.1)	-0.07-0.4	0.19

CI: confidence interval; SE: standard error.

chotomized ability score was analysed, it was found that 1 year after discharge the odds of scoring the maximal ability score was 1.8 higher compared with the discharge measurement.

Correlation of wheelchair skills performance with age, gender, lesion level, completeness of injury, self-efficacy and wheelchair satisfaction

Performance time score. Age, lesion level and self-efficacy were significant determinants of the performance time score (Table IV). Ten years older participants had on average a 2.5 s slower performance time score than younger participants ( $p < 0.001$ ). Persons with paraplegia were on average 13.1 s faster than those with tetraplegia ( $p < 0.001$ ). A 10-point higher perceived self-efficacy score led to a 1.5 s faster performance time score ( $p = 0.03$ ).

Ability score. Age was inversely related to the ability score ( $p < 0.001$ ) (Table IV). Participants with paraplegia had significantly higher ability score than those with tetraplegia ( $p < 0.0001$ ) (Table IV). Perceived self-efficacy had a significant relationship with the ability score ( $p = 0.02$ ) (Table IV). In the logistic regression model, age, lesion level and perceived self-efficacy also remained in the final model. The odds for being able to perform all wheelchair skills tests were 1.9 for persons who are 10 years younger ( $p < 0.001$ ), 1.5 for persons with a 10-point higher ALCOS score ( $p = 0.04$ ), and 15.2 for persons with paraplegia ( $p < 0.001$ ).

Gender, completeness of injury and wheelchair satisfaction had no significant correlation with the performance time score or ability score.

Course of wheelchair skills performance over the first year after discharge in correlation with personal and lesion characteristics, perceived self-efficacy and wheelchair satisfaction

No significant interaction terms between personal/lesion characteristics and time were found, indicating that the change over time in wheelchair skills in the first year after discharge was not different between groups with paraplegia or tetraplegia (performance time:  $p = 0.70$ ; ability score:  $p = 0.78$ ), those with complete or incomplete SCI (performance time:  $p = 0.67$ ; ability score:  $p = 0.80$ ), males or females (performance time:  $p = 0.81$ ; ability score:  $p = 0.90$ ), older or younger persons (performance time:  $p = 0.98$ ; ability score:  $p = 0.53$ ), low or high ALCOS score (performance time:  $p = 0.55$ ; ability score:  $p = 1.0$ ), and those who are not satisfied or satisfied with their



Table IV. Results of the regression models to investigate determinants of the (normalized) ability score and the performance time for the whole group

	Performance time			Ability score (normalized)		
	B (SE)	95% CI	<i>p</i> -value	B (SE)	95% CI	<i>p</i> -value
Constant	32.9 (5.4)			-0.8 (0.4)		
Time	-1.4 (1.4)	-4.2 1.3	0.31	0.2 (0.1)	-0.03 0.34	0.10
Age, years	0.3 (0.1)	0.2 0.4	<0.001	-0.02 (0.003)	-0.03 -0.01	<0.001
Lesion level	-13.2 (1.6)	-16.2 -10.1	<0.001	0.9 (0.1)	0.7 1.1	<0.001
ALCOS	-0.2 (0.1)	-0.3 -0.01	0.03	0.01 (0.005)	0.002 0.02	0.02

Tetraplegia=0; Paraplegia=1.

CI: confidence interval; SE: standard error; ALCOS: General Competency Scale.

wheelchair (performance time:  $p=0.62$ ; ability score:  $p=0.60$ ). In addition, no significant interaction terms were found when performing the logistic regression.

## DISCUSSION

The preliminary assumption of this study was that wheelchair skills performance of persons with a SCI will improve 1 year after discharge from the rehabilitation centre. This study provides a follow-up to Kilkens et al. (5) (who studied improvement in wheelchair skills during inpatient rehabilitation), by focusing on the first year after discharge from inpatient rehabilitation and on 2 additional possible determinants of wheelchair skills: self-efficacy and wheelchair satisfaction. The assumption of the current study was that wheelchair skills performance of persons with SCI will improve during the first year after discharge from the rehabilitation centre. However, the results of the study provided evidence of no changes in wheelchair skills performance over the first year after discharge of inpatient rehabilitation, except for a higher odds to be able to perform all 8 wheelchair skills 1 year after discharge compared with discharge. The lack of clear improvement might be explained by the difficulties and complications that people with SCI have to deal with during the first year after discharge from the rehabilitation centre. The security of the rehabilitation centre is replaced by a world in which anxieties about home and family life, relationships, access, employment, care provision, finance, attitudes and isolation are all real threats (34).

A study by Bloemen-Vrencken & de Witte (11) showed that problems with informal care, pressure sores, unadapted environments and weight increase occurred and were most apparent after discharge. In contrast, the study by DeSanto-Madeya (35) examining the physical, emotional, functional, and social components of adaptation to SCI at 1 year and 3 years post-injury showed that "on average, year 1 spinal cord injured individuals had considerably higher adaptation scores than spinal cord injured individuals at year 3. Based on these findings, one could speculate perhaps year 1 spinal cord injured individuals are more hopeful that they will overcome their injury-imposed limitations than their year 3 counterparts". Craig et al. (36) stated that it may be that a minimum of 2 years is needed to achieve some stability in life, although this will vary from person to person".

However, the non-significant improvement in wheelchair skills performance could be also the result of a lesser suit-

ability of the Wheelchair Circuit for testing wheelchair skills performances in post-acute rehabilitation phase of people with SCI. The Wheelchair Circuit consists of a selection of different possible wheelchair tasks and most relevant skills are included, yet, some tasks that may be relevant for participation in the community setting are not included in this test, for example, performing a wheelie (i.e. balancing on the rear wheel) is not tested. Furthermore, in this study, the ability score of the Wheelchair Circuit clearly showed a ceiling effect with a median score of 7.5 on a 0–8-point scale. This could be either the outcome of a situation where most of the participants reached the top level at the end of the rehabilitation programme and could not improve further, or due to the use of a qualitative scale (pass/fail and partial pass scores), which might not be sensitive enough.

### Personal and lesion characteristics

Age and lesion level were associated with the Wheelchair Circuit scores. These results are in accordance with those of other studies, which found that age was inversely related to functional abilities after SCI (5, 37), as well as with the studies that have shown relations between lesion level and functional outcome after inpatient rehabilitation (5, 38, 39). Warschausky et al. (37) examined the recovery of the Functional Independence Measure (FIM) motor scores in 142 subjects with SCI during inpatient rehabilitation. Unlike this study result, they found that changes in the FIM motor scores were significantly influenced by gender.

The absence of interaction between time, age, gender and SCI lesion level indicated that these variables did not influence the rate of change in wheelchair skills performance over a period of 1 year after discharge. As far as we know, no other studies described the longitudinal development of wheelchair skills performance 1 year after discharge from inpatient rehabilitation, and the few studies that were found in the literature included only self-report measures, such as the Activity Measure of Post-Acute Care (40); therefore, we could only compare our results with longitudinal studies that were conducted during inpatient rehabilitation (5, 41, 42). Taricco et al. (41) evaluated the impact of rehabilitative interventions on the functional status of SCI patients using the VFM (*Valutazione Funzionale Mielolesi*) test at the beginning and end of the rehabilitation programme. Scores had significantly improved for persons with tetraplegia and those with a high-level paraplegia only. Kilkens et al. (5)

found that personal characteristics, lesion characteristics, and secondary complications significantly influenced the course of wheelchair skills performance between the start and discharge of inpatient rehabilitation. Middleton et al. (42) reported positive responsiveness to change over time in 5 mobility and locomotor items, mainly in the group with tetraplegia, while a ceiling effect was mentioned for the group with paraplegia. These studies (5, 42) showed that the largest improvement occurred during the first 3 months of the inpatient rehabilitation period. This fact may be suggestive for the current stabilization in wheelchair skills performance in the first year after discharge.

#### *Self-efficacy and wheelchair satisfaction*

The association between self-efficacy and the Wheelchair Circuit scores emphasizes the importance of psychological factors on learning new skills and reintegrating to the society (43). Self-efficacy beliefs is defined as the confidence an individual has in performing a set of skills required to succeed in a specific task (44). Self-efficacy influences choice of activities and motivational level, and contributes to the acquisition of knowledge and refinement of new abilities (23). It is assumed that maximizing wheelchair skills and overall independency is also (and perhaps mainly) influenced by psychological and attitudinal factors rather than disability-related factors alone. Therefore, in future studies, it is highly recommended to involve more psychological components, and to examine their relationships and their effect on learning wheelchair skills.

The lack of relationships found between wheelchair satisfaction and wheelchair skills performance is in accordance with a study by de Groot et al. (31), which examined the relationship between manual wheelchair users' satisfaction, and active lifestyle and participation in persons with SCI. In their study too, no correlation was found between the wheelchair-related aspects total satisfaction score and the activity and participation scores.

#### *Study limitations*

Apart from what has been said about the greater suitability of the Wheelchair Circuit to assess wheelchair skills performance during the acute phase of SCI rehabilitation rather than for post-discharge individuals, the present study design also needs some consideration. The participants performed the Wheelchair Circuit in a standard wheelchair due to the necessity to ensure comparability of the measurements in the main longitudinal study in which persons with SCI are followed from the start of functional rehabilitation to 1 year after discharge. However, the experimental wheelchair is not individually optimized and the participants were not trained to use this wheelchair. It is possible that the participants would demonstrate their wheelchair skills more accurately had they been allowed to use their own wheelchairs.

Finally, one should bear in mind that the study investigated only the variables self-efficacy and wheelchair satisfaction besides personal and lesion characteristics, whereas SCI readjustments to community life are influenced by many other

physical and psychological factors that are beyond the scope of the current investigation. In addition, relevant pre-injury factors, such as emotional history, belief about disability, perceived ability to cope and social support and active vs passive lifestyle, must be studied in future research.

In conclusion, manual wheelchair skills performance of persons with SCI, as measured with the Wheelchair Circuit, did not improve significantly in the year after discharge from inpatient rehabilitation. Better wheelchair skills performance during that time was associated with younger age, paraplegia and higher self-efficacy perceptions. People with SCI should further be stimulated to maintain and improve wheelchair skills performance after discharge from rehabilitation centres. The incorporation of strategies to enhance self-efficacy during wheelchair skills interventions might result in better outcomes.

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