



Zinman College for Physical Education and Sport Sciences at the Wingate Institute, Israel



# Test of wheeled mobility and the wheelie test

# for manual wheelchair users with spinal cord injury



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# **ISRAEL**









### In the water

#### Treating



#### Teaching



### On land



#### Practical







### Zinman College for Physical Education and Sport Sciences at the Wingate Institute, Israel



### IPC SSC





Research





#### Introduction

### The aim of the study

- To develop a test of wheeled mobility (WM) and a short Wheelie test for manual wheelchair users with SCI
- This instrument should measure the level of relevant WM skills, be valid, reliable, and practically feasible



Wheelie = Balancing on the rear wheel



#### Introduction

### Wheeled Mobility - Definition

### "Moving around using equipment:

moving the whole body from place to place, on any surface or space, by using specific devices designed to facilitate moving or create other ways of moving around, ... moving down the street in a wheelchair or a walker"

(WHO 2001)



Study 1

systematic review of wheelchair skills gests for manual wheelchair users with a spinal cord injury

### Main conclusion

There is no standardized WM skill test on a regular basis use, neither norms or standards for wheeler ir skills performed by people in Sch

WC-PFP

**Publication** Viess-Douer O, Vanlandewijck, YC, Lubel Manor G, van der Woude LH. A. (2010). Systematic review of wheelchair skills rests for Dranta Wrealchair users with a spinal cord injury: Towards a standardized outer the measure, *Cinical Gehabilitation*, 24: 867–886

### Perceived Self-Efficacy in Wheeled Mobility Scale (SEWM)



#### Publications:

Fliess-Douer O, van der Woude LH. Vanlandewijck, YC, (2011). Development of a new scale for perceived self-efficacy in manual wheeled mobility: A pilot study. *Journal of rehabilitation medicine*. 43: 602–608

Fliess-Douer O, Vanlandewijck YC, van der Woude LH, (2012). Reliability and validity of perceived "self-efficacy in wheeled mobility" scale among elite wheelchair-dependent athletes with a spinal cord injury. *Disability and Rehabilitation*, Accepted for publication

To use this scale in correlation with the test of wheeled mobility scores for the validity testing in a later stage



To create an "expert group" for discussions, planning and piloting the new WM tests



Study 2

#### Self-Efficacy in Wheeled Mobility Scale (SEWM)

Please tell us how confident you are with regard to carrying out the wheeled mobility tasks below. (*Please check only one box for each question*)

No.	I am confident that:	Not at all true	Rarely true	Moderately true	Always true
1	I can overcome barriers and challenges regarding wheeled mobility skills if I try hard enough				
2	I can find means and ways to be independently mobile, using my wheelchair in everyday life setting				
3	I can accomplish tasks that require independent wheelchair mobility such as ascending sidewalks and ramps.				
4	When I am confronted with obstacles to wheelchair mobility, I can find solutions to overcome them				
5	I can overcome mobility barriers and challenges even when I am tired				
6	I can be independently mobile with my wheelchair even when I am depressed				
7	I can be mobile with my wheelchair without the support of my family or friends				
8	I can motivate myself to carry out a difficult wheeled mobility skill				
9	I can learn new skills of wheeled mobility by myself				
10	While using my wheelchair, I can usually handle whatever comes my way				



#### Study 3

# Most essential wheeled mobility skills for daily life: an international survey among elite athletes with SCI



This study was approved and supported by the International Paralympic Committee





**Publication:** Fliess-Douer O, Vanlandewijck, YC, van der Woude LH. (2012). Most essential wheeled mobility skills for daily life – an international survey among Paralympic wheelchair athletes with SCI. *The Archives of Physical Medicine and Rehabilitation*; 98: 629-635.

#### Study 3 Objectives

### Study Objectives

- To create a hierarchical list of the most essential WM skills for daily life of wheelchair users with SCI
- To compare perceptions of WM gained during and after clinical rehabilitation





#### Study 3 Results

### Most essential skills

The skill	Paralympic study (n=79)	SEM + (%RSE)
Transferring into a car / out of a car	4.7 ±0.7	0.08 (2)
50 meter forward	4.4 ±1.0	0.12 (3)
Going up a ramp and opening a door	4.3 ±0.9	0.11 (2)
Up and down hill gentle slope (6 meter)	4.3 ±0.8	0.09 (2)
Ascending/descending 2.5cm sidewalk	4.2 ±1.1	0.13 (3)
Transferring from one wheelchair to another	4.1 ±1.3	0.14 (3)
Transferring from the floor to a wheelchair	4.1 ±1.3	0.14 (3)
Ascending/descending 5cm sidewalk	4.0 ±1.2	0.14 (3)
Moving on irregular surface propulsion	4.0 ±1.1	0.12 (3)

1-5 scale: 1 = not essential; 5 = extremely essential





Perceived level of WM gained & amount of time dedicated for teaching WM at rehab, and WM at present

Study 3 Results



"WM at present" was **significantly higher** than WM gained during rehab." (p<0.001, n=69).

#### Study 3 Results

# WM gained in rehab/country\*

1-10 VAS scale: *Poor* To *Excellent* 







\*Only countries with more than 3 representatives were included in this analysis \*\* Athletes from Greece went to rehab. in Sweden

Swidish rehabilitation centers received the highest score

Pilot study Results

## WM gained in rehab/country

Pilot study result (N=47)



Britain's rehabilitation centers received the highest score "Very good"



#### Study 3 Recommendations

### Recommendations

- To incorporate the skills that were graded as very essential during inpatient rehabilitation and in WM workshops
- The list of skills could be the base for establishing a global pathway for teaching WM skills during clinical rehabilitation
- Comparing WM teaching methods in different SCI units around the world



 Future studies should focus on peer learning potential to promote WM skills development Test Development

# Development of the TOWM and the Wheelie

#### test

- Content based on literature review and the sorted list of the most essential WM skills
- An "expert team"
- A short WT was also developed
- The TOWM 30 tasks, the WT 8 tasks









### Test's Protocol:

#### www.scionn.nl/inhoudp28.htm

#### TEST OF WHEELED MOBILITY (TOWM)

And

#### THE WHEELIE TEST

MATURITY PATTERN OF WHEELED MOBILITY SKILLS PERFORMANCE IN SPINAL CORD INJURY

#### Goals of the tests

The purpose of the tests is to evaluate the wheeled mobility skills of people with spinal cord injury. The results of these tests will provide useful information for further training and treatment; it will also allow making a comparison of the skill level among different persons with similar lesion levels.

#### **Time requirements**

Including preparation and evaluation time, the estimated duration of the test is 40 minutes. The testing time will vary among participants and administrators and should be considered as a guideline.

#### **Testing environment**

The tests should be administered in a location with an even surface and a size big enough to execute the tasks. A gym or a similar multipurpose room generally suits these requirements. All of the tasks can be administered in discotation.

In order to create a safe environment, a safety per on will always have to be alert and stay close to the participant

#### **Required equipment**

The cost and space requirements are kept as low as possible. The following equipment will be needed to perform the test:

- 4 traffic cones or other marking devices.
- Stopwatch.
- 4 wooden platforms (dimensions 1.5m × 1.0 m heights 5,10,20,40cm), able to hold a maximal weight of 200 kg.
- A portable wheelchair ramp with a length of 1.8m, a minimum width of 0.76m and able to support at lease 250kg.
- 5 threshold ramps as portrayed in the figure below + 1 electric "hider".
- A daily wheelchair with brakes
- · The participant should use his daily wheelchair throughout the test.
- Duct Tape
- Measuring tape 20m
- Camera (2) + tripods (2)
- Scale (weight measurement)
- Inclinometer
- Paper and pencils
- Plummet
- Yoga mat

#### 3. Ascending / descending sidewalk starting with front wheels in front of a step (5cm, 10cm, 15cm, 20cm)



Safety Note: examiner stands close to the curb and behind the participant, both hands are ready to catch the chair to avoid falling backward

#### 5. Going up & down a ramp (8% [10cm], 12% [15cm], 16% [20cm], 24% [30cm], 32% [40cm], 40% [50cm])

Measurements:

**Preparations:** The platform (starting with 10cm) is placed against the wall with the sharp edge. Place one end of the portable ramp on the ground and the other end on top of the wooden plate and fix with screws. The participant is positioned with the front wheels on the platform.

**Instructions A:** "Go up the ramp in a straight line, turn around on the platform, go downhill and return to the floor,

Ability Score: (yes/no), Reason (if not) Qualitative score for A-30 cm, B & C tasks (0-5) Maximal height (cm) with / without run up Anxiety score (0-10)



cable



### The score sheet

#### Score sheet: Universal Test of Wheeled Mobility (TOWM)

Name or subject ID	Assessment date	Name of examiners
	//	

17. Up a slope 12% (15cm)

18. Down a slope 12% (15cm)
 19. Up a slope 16% (20cm)
 20. Down a slope 16% (20cm)

Part 1: Personal information								
1. Date of birth		//		13. Neurological level			R	L
2. Date of injury		//		2		Sens		
3. SEWM-score						Mot		
4. Height (m)				14. Zone of partial pres	ervation		R	L
5. Weight (kg)						Sens		
6. Wheelchair Weight (kg)						Mot		
7. BMI (kg/m <sup>2</sup> )				15. ASIA Impairment so	ale			
8. PASIPD score (MET-hr/d)				16. Complete/Incompl	ete			
9. Center of gravity	An	gle (°)						
	Dis	st. (cm)						
	We	eight (kg)						
	X 8	k y						
	• .		-	-	A L 111			
Part 2: Test of Wheeled Mobil	ity	Anxiety		• / - · ·	Abilit	Y	_	
		(VAS)	Wh	y not? / Remarks	(1/0)		т	Q
1. Level propulsion forward (4x4)								
2. One hand propulsion (10m on a marked l	ine)							
3. Ascend sidewalk 5cm (between 30cm lin	e)							
4 Descend sidewalk 5 cm								
5. Ascend sidewalk run up 5cm (3m run up	)							
6. Ascend sidewalk 10cm								
7. Descend sidewalk 10 cm (help Asc. If ne	ed)							
8. Ascend sidewalk run up 10cm								
9. Ascend sidewalk 15cm								
10. Descend sidewalk 15 cm								
11. Ascend sidewalk run up 15cm								
12. Ascend sidewalk 20cm								
13. Descend sidewalk 20 cm								
14. Ascend sidewalk run up 20cm								
15. Up a slope 8% (10cm) (front wheels on	it)							
16. Down Slope 8% (10cm)								

	$\frown$		$\frown$		
Part 2: Test of Wheeled Mobility - continue	Anxiety (VAS)	Why not? / Remarks	Ability (1/0)	Tme/Height	Q
21. Up a slope 24% (30cm)					
22. Down a slope 24% (30cm)					
23. Up a slope 32% (40cm)					
24. Down a slope 32% (40cm)					
25. Up a slope 40% (50cm)					
26. Down a slope 40% (50cm)					
27. Down a slope, stop in wheelie					
(last succeeded, write height)					
28. Up a slope with a run up					
(last failed, write height)					
29. Chair transfer stable - unstable					
30. Chair transfer unstable-unstable					

Part 3: The Wheelie Test	Anxiety		Ability (1/0)			_	
	(VAS)	Why not? / Remarks			Г		Q
1. Stationary (15 sec)							
2. One handed wheelie (15s hand face the camera)							
3. Forward 10m ("Go" with 4 wheels on floor)							
4. Backward 10m ("Go" with 4 wheels on floor)							
5. Circle forward (around a cone)							
6. Uuneven surface ("Go" - 4 wheels on floor)							
<ol> <li>Accelerate and stop in wheelie (10m) Time score from start line to crossing 10m</li> </ol>							
8. Backward over curb 5cm							

#### Total outcome measures

	Part 2: TOWM	Part 3: Wheelie test	Total
Total Ability score			
Total Time score			
Total Anxiety score			
Total quality score			
Maximal height of a curb			
Maximal slope			

Ability score (yes=1,no=0) Why not= reason to refuse Anxiety score (0-10) T=Time score (seconds) H=Height (cm) Q=Quality score (0-5) Asc = Ascend Sens = sensor Mot = Motor

### The quality score sheet

Quality Score sheet         Name or subject ID	Ility Score sheet: Universal Test of Wheeled Mobility (TOWM)         e or subject ID       Assessment date       Name of examiners				27. Down a Slope stop in a wheelie for 3 sec. 28. Up a slope with a 5 meters run up	<ul> <li>Hands: allow rims glides through, in a controlled movement, keeps the acceleration constant until the desired speed is achieved</li> <li>Hands places at the front of the tires/rims to control the speed in braking movements</li> <li>General Quality Note: prefers to descend in a wheelie, rear wheels touch the floor fir</li> <li>SP: Pushes forward until the rear wheels are over the edge</li> <li>Pelvic/lower trunk: pushed against the backrest, adapts wheelchair decline position the slope (the steeper the slope, the more inclination is needed)</li> <li>Hands: allow rims glides through, in a controlled movement, Keeps the acceleration constant until the desired speed is reached</li> <li>Elbows: to stop in wheelie, the elbows extend nearly to about 135°</li> <li>Head: flex a bit forward during the wheelie</li> <li>SP: 2-3 pushes forward, Leaning forward when reach the ramp</li> <li>General Quality Note: utilize the coucome run-up inertia to ascend the slope without slowing down</li> <li>Hands: push downward, shortest recovery time</li> <li>Upper trunk and head: leaning forward maximally (no contact with the backrest)</li> <li>Elbow: Maximal flexion when nearly reaching the top</li> </ul>	st.
28. U	p a slope with a 5	• SP: 2-3 pushes for	ward, I	Lean	ing forward when	reach the ramp	
6. Ascend 10cm si meter	General Quality Note: utilize the outcome run-up inertia to ascend the slope without slowing down     Hands: push downward, shortest recovery time     Upper trunk and head: leaning forward maximally (no contact with the backrest)     Elbow: Maximal flexion when nearly reaching the top					n-up inertia to ascend the slope without	
8. Ascend 10cm sidewalk with a 3 meters run up 21. Up a slope 24% (30cm)	placing front wheels down       -         General Quality Note: Descend the sidewalk symmetrical y, in an elegant and smooth landing       -         rend 10cm sidewalk       • SP: 2-3 pushes forward, pelvic and lower trunk are lowered and pushed against the backrest when reaching the step       -         • General Quality Note: utilize the outcome run-up inertia to ascend the sidewalk without slowing down       -       -         • Trunk: bends forwards when places down the front wheels       -       -         • Arms: push downward at the front of the rear wheels, when the front wheels are lowered       -       -         • a slope 24% (30cm)       • SP: Leaning forward, places hands towards the back of the top of the tire       -       -         • Hands: push forward and downward       -       -       -       -         • Hands: Shortest recovery time       -       -       -       -         • Trunk and head remains in the same leaning forward position while ascending       -       -       -					<ul> <li>Hands: Maintains position and balance, keeping the body completely still</li> <li>General Quality Note: gets into balanced wheelie in less the 2 seconds</li> <li>SP: 1 Hand placed on the wheels in approximately the 10 o'clock position</li> <li>Upper body: stays still when the one hand is pushed forward, the head bends sligh forward</li> <li>Hand is in the 2 o'clock position and approximately 140° flexion in the elbow</li> <li>Head: Maintains position and balance, keeping the body completely still</li> <li>General Quality Note: gets into balanced 1 handed wheelie in less the 3 seconds</li> <li>SP: Hands placed on the wheels in approximately the 10 o'clock position</li> <li>Hands are in the 2 o'clock position, Elbow: approximately 140° flexion to maintai the wheelie position</li> <li>Trunk and Head: brings a little bit forward simultaneously to the pushing forward</li> <li>Hands: brings immediately back to 10 o'clock position (short recovery time)</li> <li>General Quality Note: maintain the same speed and the same front wheels height thorough the task</li> </ul>	
22. Down a slope of 24%       • SP: pushes forward until the rear wheels touch the ramp       □         (30 cm)       • Pelvic/lower trunk: pushed against the backrest, adapts wheelchair decline position to the slope (the steeper the slope, the more inclination is needed)       □							

Study 4

Development of the Test Of Wheeled Mobility (TOWM) and a short Wheelie test: A feasibility and validity study of two new tests assessing wheeled mobility skills in persons with spinal cord injuries



**Publication:** Fliess-Douer O, van der Woude LH. Vanlandewijck, YC, (2012). Development of the test of wheeled mobility (TOWM) and a short Wheelie test: A validity and feasibility study of new tests assessing wheeled mobility skills in persons with spinal cord injuries. *Clinical Rehabilitation*, Submitted for publication

#### Study 4 Objectives

### Study objectives and design:

- To assess the feasibility, convergent and construct validity of the TOWM and the Wheelie test
- Design: Cross-sectional study; test- retest procedures one week apart
- Setting: KU Leuven gymnasium











#### Study 4 Descriptive

### Descriptive

Descriptive group statistics and mean scores of TOWM, WT, SEWM at  $t\ensuremath{\textbf{1}}$ 

Variable	n	Mean + SD
Age, years, mean (SD) [range]	29	38.8 (±8.0) [23-53]
Time since injury, years, mean (SD) [range]	29	12.4 (±10.5) [1-35]
BMI (kg/m²),mean (SD) [range]	29	24.2 (±3.9) [16.5-32.2]
SEWM scale 0-40, mean (SD) [range]	29	34.5 (±4.2) [22-40]
TOWM ability score scale 0-30, mean (SD) [range]	29	20.6 (±4.5) [11.5-28]
TOWM time score in sec. mean (SD) [range]	15	17.6 (±8.3) [10.9-41]
TOWM quality score scale 0-50, mean (SD) [range]	20	28.8 (±13.5) [7-48]
TOWM anxiety score VAS 0-10 X 30 items, mean (SD) [range]	29	14.6 (±21.5) [0-66]
Wheelie test ability score scale 0-8, mean (SD) [range]	29	5.2 (±2.3) [0-8]
Wheelie test time score in sec. mean (SD) [range]	15	13.2 (±5.5) [6.6-23.6]
Wheelie test quality score scale 0-40, mean (SD) [range]	20	17 (±11.9) [0-35]
Wheelie test anxiety score (VAS 0-10 X 8 items) , mean (SD) [range]	29	6.2 (±10.7) [0-32]



Wheelie test ability & quality scores relative to the TOWM ability & quality scores, per participant (n=29)



Study 4 Descriptive Study 4 method

### Statistical procedures

- Convergent validity correlating the TOWM and the WT test
- Correlations for interrelationships of the four scales' scores within a test
- Predictive validity the ability of the WT to predict the TOWM
- Construct validity testing whether tests scores are related to self-efficacy in WM, physical activity level, age, lesion level, BMI, time since injury, and sport participation



### Results

- Feasibility Duration, equipment cost, wheelchair type
- Convergent validity
  - Positive correlation TOWM & WT
    - Ability scores (*r*=0.84; *p*<0.001)
    - Quality scores (*r*=0.88; *p*<0.001)
    - Anxiety scores (*r*=0.81; *p*<0.001)



Moderate correlation TOWM & WT
 Time scores (r=0.47; p=0.08)

#### Study 4 Results

### Construct validity - correlation of the TOWM and the Wheelie test scores with WM related variables

Variable	Time since in	njury (y)	SE\	мм	Anxiety score (VAS)		Sport participation after injury		
Test and scale	Corr.	Sig.	Corr.	Sig.	Corr.	Sig.	Sig.	Mean diff.**	
TOWM ability scores	0.31	0.09	0.36	0.05	-0.38	0.06	0.001	-5.29	
TOWM quality scores	0.45	0.04	0.42	0.06	-0.45	0.07	0.001	-18.9	
TOWM time scores	-0.34	0.22	-0.12	0.67	0.20	0.48	-	-	
TOWM anxiety scores	0.02	0.92	-0.56	0.003	-	-	0.26	13.4	
Wheelie test ability scores	0.42	0.02	0.37	0.04	-0.43	0.03	<0.001	-3.51	
Wheelie test quality scores	0.57	0.007	0.37	0.11	0.019	0.45	0.001	-17.44	
Wheelie test time scores	-0.28	0.30	-0.21	0.45	0.32	0.25	-	-	
Wheelie test anxiety scores	.009	0.96	-0.50	0.01	-	-	0.31	3.04	



#### Study 4 Conclusion

### Conclusion & recommendations

• The TOWM and the Wheelie test seem feasible and valid instruments for assessing WM in persons with SCI after clinical rehabilitation

• The validity of the tests should be investigated in a larger and more diverse sample, including spinal cord injured males and females during their rehabilitation period, as well as with nonactive individuals with tetraplegia.



The reliability of the Test of Wheeled Mobility and the short Wheelie Test







Study 5 Objectives & methods

### Study objectives, design & method

- **Objective**: To assess the reliability of the TOWM and the WT
- **Design**: Test-retest
- **Participants**: 29 participants with SCI
- Method:
  - Test-retest reliability ICCs and non-parametric statistics.
  - Intrarater and interrater reliability based on the quality scores of 20 participants' videos.
- Responsiveness: standard error of measurement (SEM), method error (ME), coefficient variation of method error (*CV*ME), minimal detectable change (MDC95), and technical error of measurement (TEM).

### Intrarater, interrater and test-retest reliability





Study 5

Procedures

### Test-retest reliability results

Scale	n	t1	t2	t2-t1	Sig.	ICC	95% CI	SEM	ME	CV <sub>ME</sub>	MDC <sub>95</sub>
		mean (SD) [range]	mean (SD) [range]	Mean diff.							
тоwм											
Ability score	29	20.6 (4.5) [11.5-28]	20.8 (4.5) [11.5-29]	0.2	0.34	0.98	.9699	0.63	0.88	4%	1.74
(scale 0-30)											
Quality score	20	28.8 (13.5) [7-48]	28.6 (12.7) [7-44]	0.2	0.81	0.99	.9999	1.29	1.16	4%	3.59
(scale 0-50)											
Time score (in sec.)	15	17.6 (8.3) [10.9-41]	17.5 (8.3) [9.6-39]	-0.1	0.82	0.94	.8897	5.73	9.08	26%	15.87
Anxiety score	29	14.6 (21.5) [0-66]	8.7 (16.4) [0-71]	-5.9	0.01*	0.91	.8095	5.75	7.93	68%	15.93
(VAS 0-10 X 30 items)											
Wheelie test											
Ability score (scale 0-8)	29	5.2 (2.3) [0-8]	5.5± (2.2) [0-8]	0.3	0.17	0.96	.9198	0.44	0.62	12%	1.23
Quality score (scale 0- 40)	20	17 (11.9) [0-35]	16.5 (11.5) [0-37]	-0.5	0.15	0.99	.9999	1.15	1.38	8%	3.20
Time score (in sec.)	15	13.2 (5.5) [6.6-23.6]	12.6 (5.1) [6.9-23.9]	0.7	0.28	0.97	.9299	3.63	4.81	9%	10.07
Anxiety score (VAS 0-10 X8 items)	29	6.2 (10.7) [0-32]	4.7 (9) [0-36]	-1.5	0.08	0.94	.8797	2.41	3.27	62%	6.68

#### Study 5 Results

### Intrarater reliability of the quality scores (n=20)

Task	t1 (1st)	t1 (2nd)	Sig.	ICC	95% CI	TEM
	Mean ± SD	Mean ± SD				
тоwм						
Level Propulsion Forward 4x4	4.3 ± 0.7	4.2 ± 0.6	0.37	0.49	2780	0.55
One hand propulsion (10m)	2.8 ± 1.7	2.6 ± 1.6	0.10	0.96	.9098	0.57
Ascend sidewalk 10 cm	$0.8 \pm 1.8$	$0.8 \pm 1.8$	1.00	1.00	1.00	0
Descend sidewalk 10 cm	3.6 ± 1.7	3.7 ± 1.7	0.41	0.97	.9398	0.39
Ascend sidewalk run up 10 cm	$2.8 \pm 2.4$	3.0 ± 2.5	0.07	0.99	.9899	0.32
Up a slope 15%	$3.8 \pm 1.6$	$4.0 \pm 1.5$	0.06	0.98	.9599	0.35
Down a slope 15%	3.5 ± 1.6	3.6 ± 1.6	0.32	0.99	.9899	0.16
Up a slope with a run up	$1.6 \pm 2.1$	1.5 ± 1.9	0.08	0.99	.9799	0.27
Down a slope, stop in wheelie	$2.1 \pm 2.4$	$2.1 \pm 2.4$	1.00	1.00	1.00	0
Chair transfer stable	3.1 ± 1.8	2.9 ± 1.7	0.10	0.97	.9499	0.39
Total quality score TOWM	28.7 ± 13.5	28.5 ± 12.7	0.66	0.99	.9999	1.07
Wheelie test						
Stationary wheelie	$3.4 \pm 1.3$	3.4 ± 1.3	1.00	0.95	.8898	0.27
One handed wheelie	$1.2 \pm 1.8$	$1.4 \pm 2.0$	0.41	0.96	.9098	0.35
Wheelie forward 10 m	$2.9 \pm 1.9$	2.6 ± 1.8	0.11	0.95	.8898	0.67
Wheelie backward 10 m	1.9 ± 1.5	$1.9 \pm 1.6$	0.65	0.97	.9398	0.27
Circle forward	$2.9 \pm 2.1$	3.0 ± 2.1	0.48	0.97	.9399	0.39
Uneven surface	1.5 ± 1.8	$1.1 \pm 1.4$	0.02*	0.96	.9198	0.47
Accelerate and stop in wheelie	1.7 ± 2.0	1.3 ± 1.6	0.01*	0.97	.9398	0.32
Backward over curb	$1.4 \pm 1.8$	1.5 ± 1.9	0.41	0.97	.9499	0.27
Total quality score Wheelie test	17.0 ± 11.9	16.4 ± 11.4	0.17	0.99	.9899	1.06



#### Study 5 Results

### Interrater reliability of the quality scores (n=20)

Task	t1 R2	t1 R3	Sig.	ICC	95% CI	TEM
	Mean ± SD	Mean ± SD				
тоwм						
Level Propulsion Forward 4x4	4.3 ± 0.7	4.4 ± 0.6	0.76	0.44	4078	0.52
One hand propulsion (10m)	2.8 ± 1.7	2.6 ± 1.6	0.38	0.89	.7395	0.71
Ascend sidewalk 10 cm	0.8 ± 1.8	0.7 ± 1.6	0.16	0.99	.9799	0.22
Descend sidewalk 10 cm	3.6 ± 1.7	3.2 ± 1.7	0.03*	0.94	.8798	0.59
Ascend sidewalk run up 10 cm	2.8 ± 2.4	2.7 ± 2.3	0.48	0.98	.9599	0.45
Up a slope 15%	3.8 ± 1.6	$4.0 \pm 1.4$	0.06	0.98	.9599	0.42
Down a slope 15%	3.5 ± 1.6	3.6 ± 1.6	0.32	0.99	.9899	0.16
Up a slope with a run up	1.6 ± 2.1	1.7 ± 2.2	0.71	0.98	.9599	0.42
Down a slope, stop in wheelie	2.1 ± 2.4	1.9 ± 2.2	0.32	0.96	.9198	0.59
Chair transfer stable	3.1 ± 1.8	3.2 ± 1.8	0.65	0.98	.9499	0.35
Total quality score TOWM	28.7 ± 13.5	28.1 ± 12.9	0.15	0.99	.9999	1.23
Wheelie test						
Stationary wheelie	3.4 ± 1.3	3.3 ± 1.4	0.74	0.93	.8397	0.47
One handed wheelie	1.2 ± 1.8	$1.1 \pm 1.7$	0.58	0.96	.8898	0.50
Wheelie forward 10 m	2.9 ± 1.9	2.8 ± 2.0	0.48	0.97	.9399	0.45
Wheelie backward 10 m	1.9 ± 1.5	1.9 ± 1.7	0.65	0.97	.9399	0.35
Circle forward	2.9 ± 2.0	2.9 ± 2.1	0.71	0.98	.9499	0.42
Uneven surface	1.5 ± 1.8	1.6 ± 1.9	0.41	0.98	.9499	0.39
Accelerate and stop in wheelie	1.7 ± 2.0	1.6 ± 1.9	0.32	0.99	.9699	0.32
Backward over curb	$1.4 \pm 1.8$	1.5 ± 1.9	0.16	0.99	.9899	0.22
Total quality score Wheelie test	17.0 ± 11.9	16.90 ± 12.51	0.57	0.99	.9999	1.04



Study 5 Results

### Intra-interrater results

- ICC TOWM and WT total quality score 0.99
- <u>TEM (technical error of measurement)</u> <u>total quality</u> <u>score:</u>
  - Intrarater relative TEM : TOWM = 3.7%; WT = 6.3%
  - Interrater relative TEM : TOWM = 4.3%; WT = 6.1%
- Per task assessment:
  - Significant difference:
    - Intrarater: 'uneven surface' & 'accelerate and stop in a wheelie'
    - Interrater: 'descend 10 cm sidewalk'



- ICCs above 0.95 except for 'level propulsion forward' (Intrarater 0.49, Interrater 0.44)
- 95% CIs varied from: Intrarater 0.88 -1.0; Interrater 0.73 0.99 (except for 'level propulsion forward' 0.27-0.80)
- **TEM** (per task average)
  - Intrarater TOWM 0.30, WT 0.38 Interrater TOWM 0.44, WT 0.39

#### Study 5 Conclusions

### Conclusions

- Based on the ability and quality total scores, the TOWM and the WT are reliable when assessing WM of manual wheelchair users with SCI
- The time scale was less sensitive & the anxiety scale showed a learning effect



Differences in wheeled mobility between SCI patients upon discharge and experienced individuals, based on the Test of Wheeled Mobility and the Wheelie Test





Study 6 Abstract

- Purpose: This study examined the differences in wheeled mobility
  between SCI patients upon discharge (up to maximum 1 year
  after hospital discharge) and experienced individuals (more than 5
  years after hospital discharge).
- Methods: The TOWM and WT were used to test the differences in WM between both groups
  - upon discharge N=14, experienced group N=13
  - Contributing factors to wheeled mobility were examined (Self-efficacy wheeled mobility (SEWM), Center Of Gravity and Physical Activity Scale for Individuals with Physical Disabilities (PASIPD)).



- The most differentiating tasks were selected.

Study 6 Abstract

#### **Results**:

- The experienced individuals scored significantly better on the TOWM and WT for quality and ability scores.
- Moderate correlations were found between time since injury, center of gravity and quality and ability scores of both tests.
- The most differentiating tasks of the TOWM were 'Ascend 10cm sidewalk with a run up' and 'Descend 15cm sidewalk' and for the WT 'Uneven surface'.
- **Conclusion**: This study highlights the importance of a standardized inpatient WM rehabilitation program and further WM training after discharge.



Future study

### Recommendations

- The quality scale should be refined (shorten) and retested during a field test
- The TOWM and the Wheelie test should be used to assess the effectiveness of intervention programs in a randomized controlled trial.
- It is suggested to test if, by teaching, training and assessing wheelchair users to master a wheelie (based on the Wheelie test protocol), the performance of the TOWM skills will also improve substantially. A positive result may suggest that the shorter and more economical Wheelie test may serve as an alternative for the TOWM.



Future study

### Recommendations

No data regarding sensitivity to change over time are available yet.
 Therefore, the TOWM and the Wheelie test should be tested in a longitudinal study testing the same participants at different times: during rehabilitation, at the time of discharge and after rehabilitation.



### Final words

I hope that the final version of the TOWM and the Wheelie test will be adopted by the rehabilitation community, and will be applied regularly, in order to derive norms and standards for wheeled mobility in SCI







Thank you so much for your time and good will.

### THANKS! Bedankt!









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