Preserving shoulder health in wheelchair users: The role of wheelchair propulsion induced fatigue and capacity

Fransiska M. Bossuyt [a], Ursina Arnet [a], Ann Cools [b] and Michael L. Boninger [c]

[a] Swiss Paraplegic Research (CH) and Department of Health Sciences and Health Policy, University of Lucerne (CH)

[b] Department of Rehabilitation Sciences and Physiotherapy, University of Ghent (BE) and Department of Occupational and Physical Therapy and Institute of Sports Medicine, University of Copenhagen (DNK)

[c] Human Engineering Research Laboratories, Department of Veterans Affairs (USA), Department of Physical Medicine and Rehabilitation and Department of Rehabilitation Science and Technology, University of Pittsburgh (USA)

Objectives

Fatigue

Perceived fatigability Performance fatigability

1. To examine how wheelchair propulsion-induced fatigue effects neuromuscular activation and propulsion biomechanics
2. To determine persons susceptible to fatigue

Enoka, R.M. and J. Duchateau, *Translating Fatigue to Human Performance.* Med Sci Sports Exerc, 2016. **48**(11): p. 2228-38

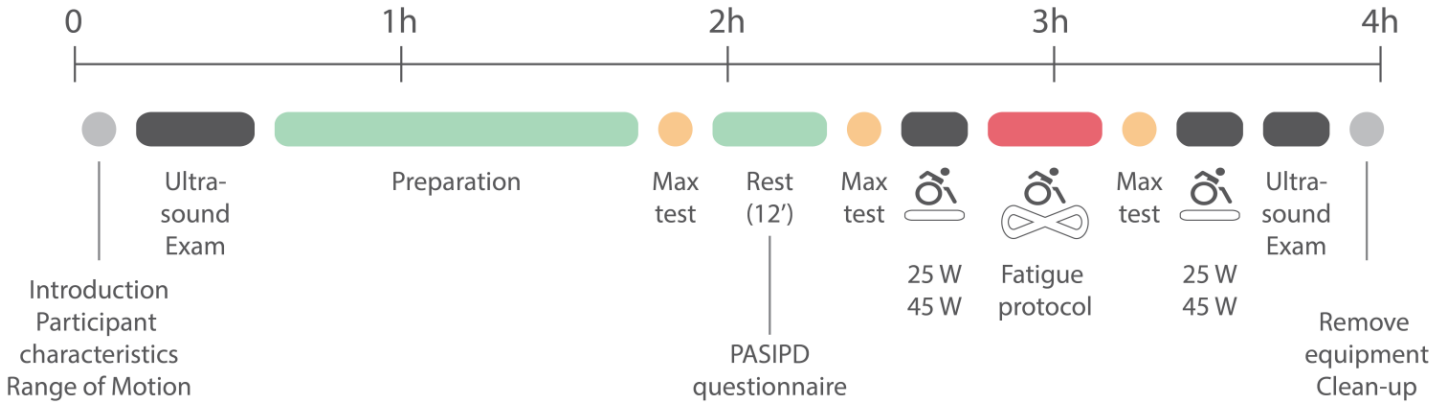
Methods

Quasi-experimental study

Pre-test post-test design

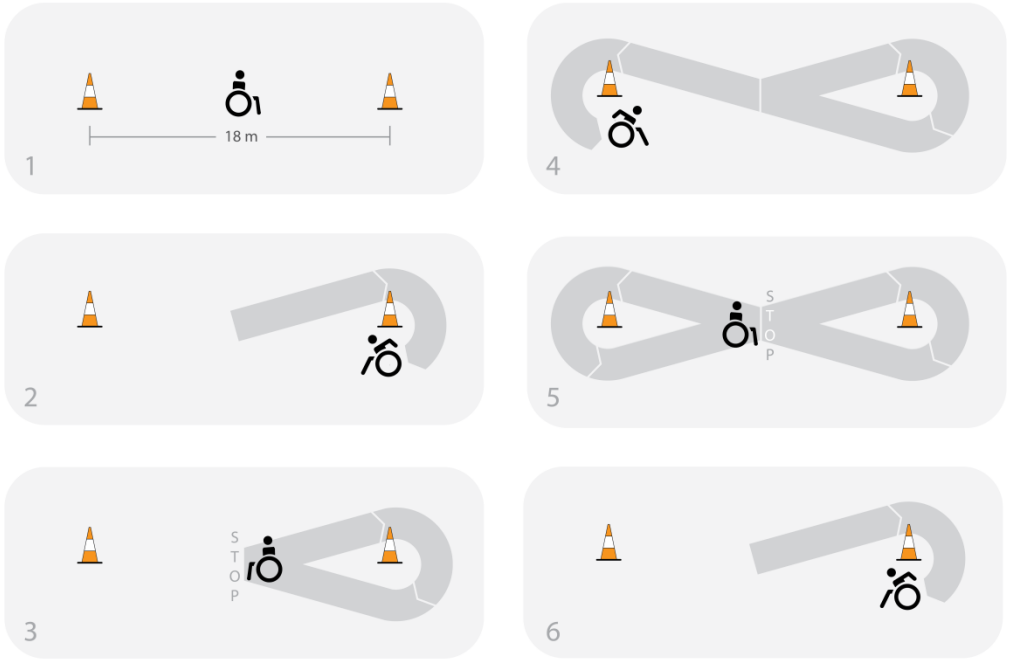
Study population	
34 wheelchair users	No pain that limits ability to propel
SCI at T2 or below	No history of upper limb fractures/dislocations causing symptoms
18 % females	
51 ± 10 years of age	
28 ± 12 years since injury	

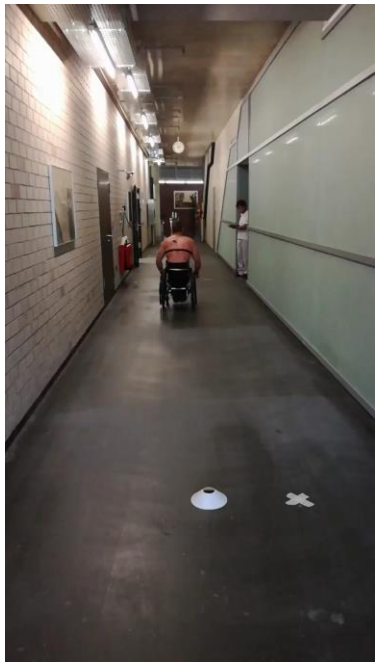
Methods


0
1h
2h
3h
4h
Ultra-
sound
Exam
Preparation
Max
test
Rest
(12')
Max
test
Max
test
Ultra-
sound
Exam
Introduction
Participant
characteristics
Range of Motion
PASIPD
questionnaire
25 W
45 W
Fatigue
protocol
25 W
45 W
Remove
equipment
Clean-up

Methods

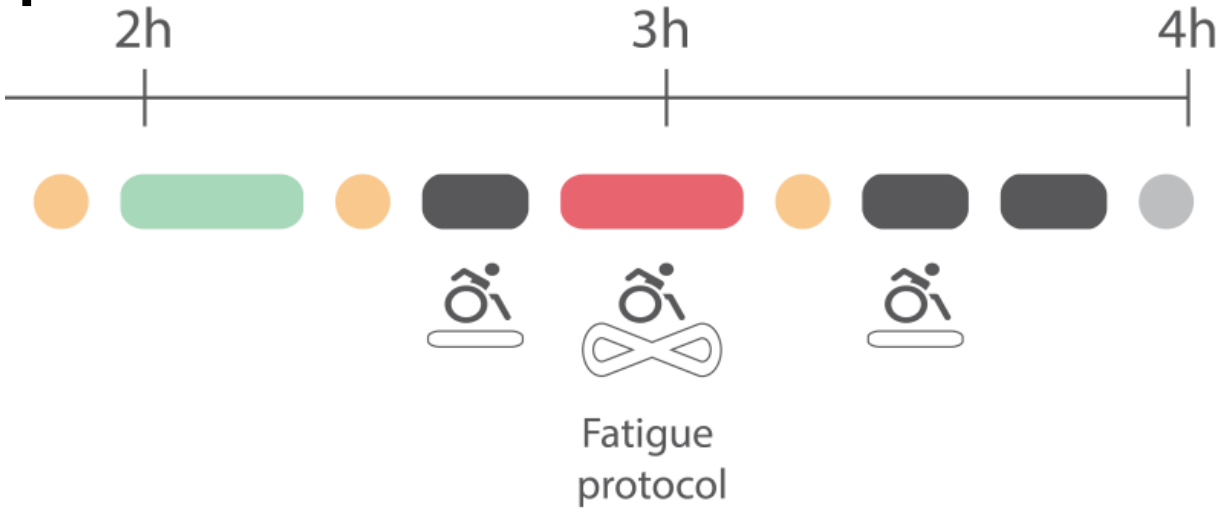
3 x



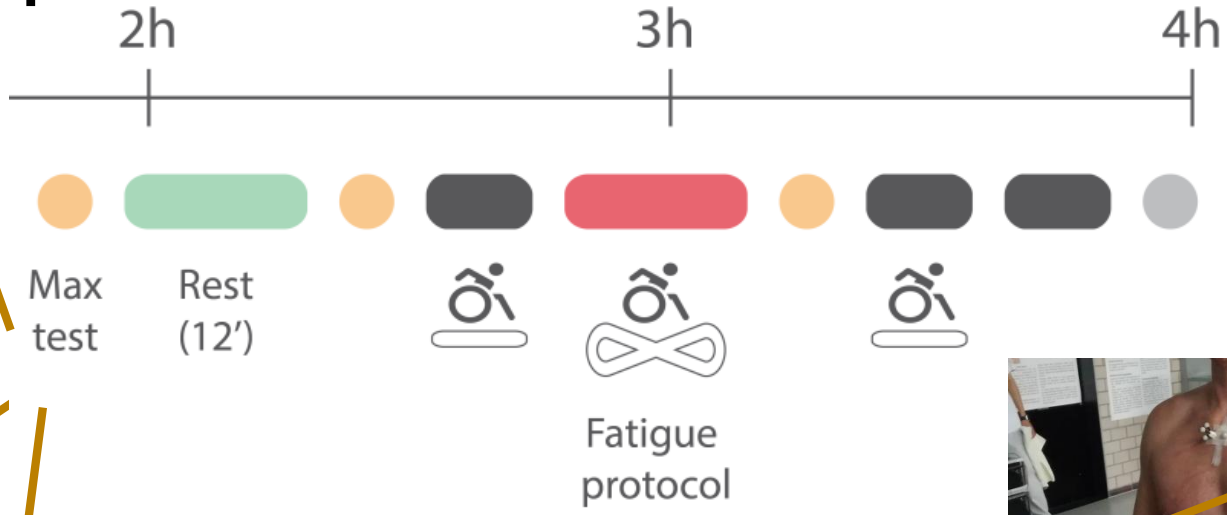


Collinger, J.L., et al., Effect of an intense wheelchair propulsion task on quantitative ultrasound of shoulder tendons. PM R, 2010. 2(10): p. 920-5.

Methods: Dependent variables



Methods: Dependent variables

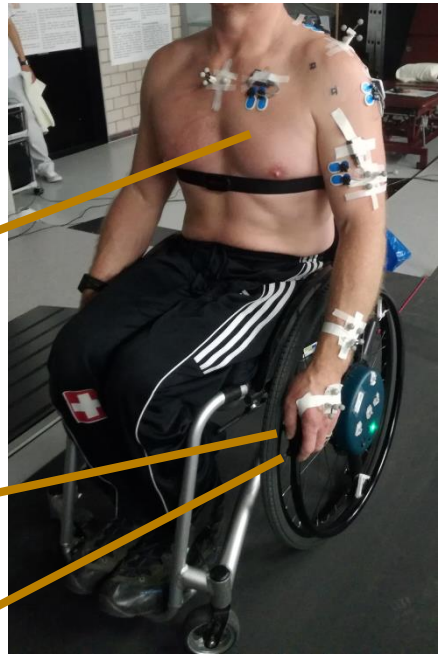


Anaerobic work capacity: 15-m sprint

EMG: RMS and MPF EMG%MVC

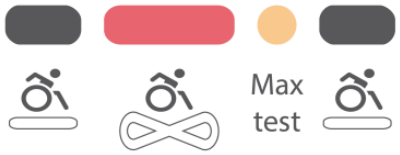
Resultant force

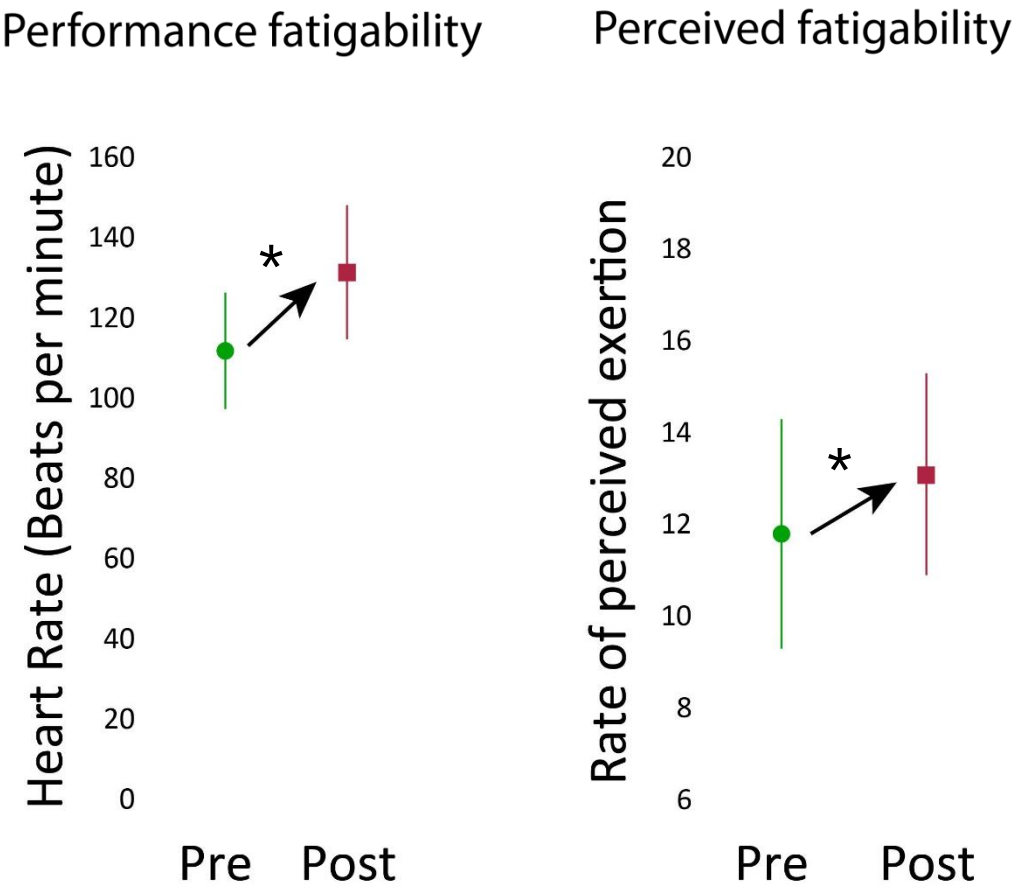
Push angle



Statistical analysis: One way repeated measures ANOVAs, statistical parametric mapping (SPM), and two sample t-tests (α = 0.05)

Results and discussion



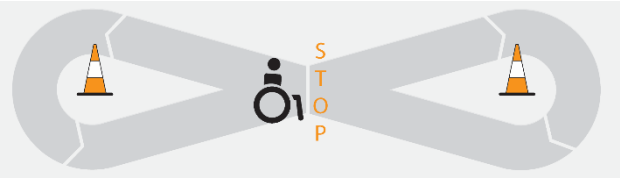


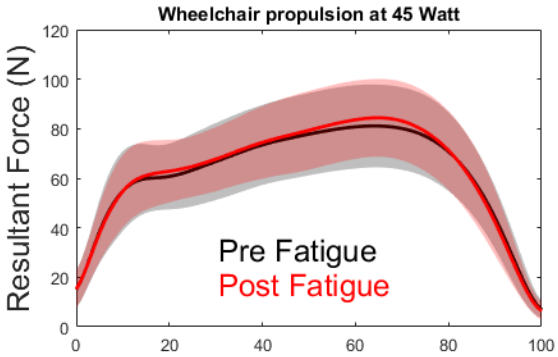
→ 47 % of the sample was identified as being susceptible to fatigue

* denotes significant difference (α = 0.05).

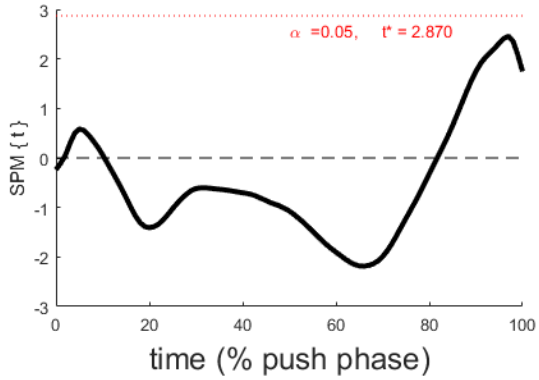
Results and discussion

Max test





78° -> 76°



RMS MPF EMG % MVC

Pectoralis
Deltoideus
Biceps

Pectoralis
Deltoideus
Upper Trapezius

Results and discussion

Complete lesion

Age at injury ^

Anaerobic capacity ^

Max push strength ^

MET =

EMG%
MVC v

Pushangle v
Frmax ^

Limitations

- Fatigue protocol remains artificial and does not represent real-life situations

- No measures of aerobic capacity or the wheelchair and its setup

Conclusions and future perspectives

Fatiguing wheelchair propulsion → Compensation: Increased muscular activation; Shorter push angle → Shoulder Health

Predictor variables of susceptibility to fatigue

Lesion characteristics and capacity

Interventions to improve resistance to fatigue and preserve shoulder health

- ❖ Wheelchair training, neuromuscular activation, aerobic capacity
- ❖ Focus on persons susceptible to fatigue

NEXT ➔

Tendon appearance
Glenohumeral contact force
Training strategies: HIIT ?

Acknowledgements

Dr. Ursina Arnet

Prof. Dr. MD. Michael L. Boninger

Prof. Dr. Ann Cools

Am J Phys Med Rehabil. 2019 Jul 15. doi: 10.1097/PHM.0000000000001267. [Epub ahead of print]

Compensation strategies in response to fatiguing propulsion in wheelchair users: Implications for shoulder injury risk.

Bossuyt FM[1,2], Arnet U[1,2], Cools A[3,4], Rigot S[5,6], de Vries W[1,2], Eriks-Hoogland I[7], Boninger ML[5,6,8,9], SwiSCI Study Group.

ility Living, National Institute on Disability, In- dependent Living, and Rehabilitation Research (90SI5014). Swiss Spinal Cord Injury Cohort study (SwiSCI).

Thank you for your attention!

Extra slides

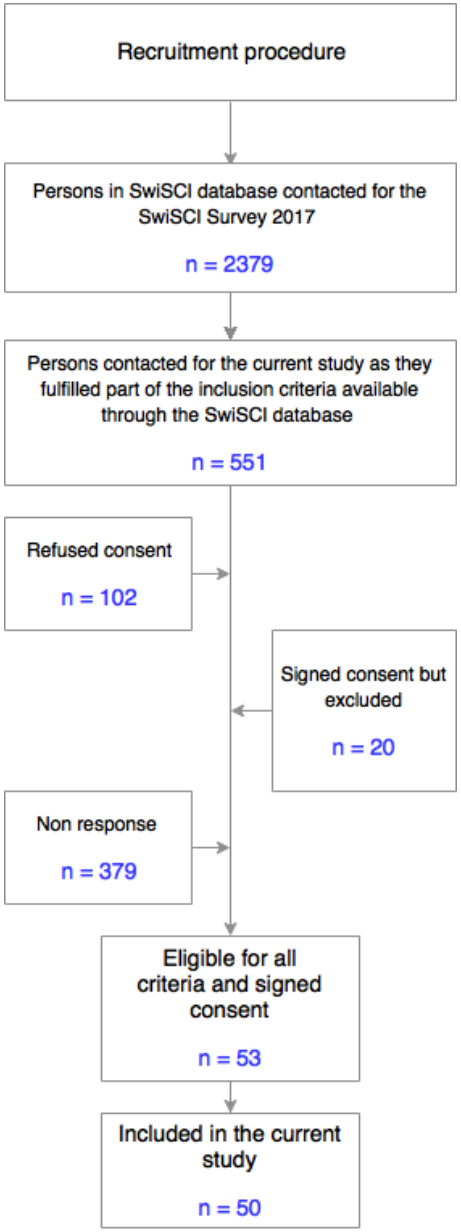

Recruitment procedure
Persons in SwiSCI database contacted for the SwiSCI Survey 2017
n = 2379
Persons contacted for the current study as they fulfilled part of the inclusion criteria available through the SwiSCI database
n = 551
Refused consent
n = 102
Signed consent but excluded
n = 20
Non response
n = 379
Eligible for all criteria and signed consent
n = 53
Included in the current study
n = 50

Table 1: Subject characteristics and capacity measures for entire sample and by group (non-fatigued vs fatigued).

	Total (n=34)	Non fatigued (n=18)	Fatigued (n=16)	*p*	95% CI
Sex (% male)	82	78	88	0.458	
Cause injury (% traumatic)	91	94	88	0.476	
Completeness (% incomplete)	79	94	63	**0.021**	
Lesion level (%)				0.823	
T2-T6	41	44	38		
T7-T12	38	33	44		
L1-L2	21	22	19		
Age (years)	50.8 ± 9.7	50.6 ± 11.1	50.9 ± 8.3	0.924	[-7.24;6.59]
Height (m)	173.4 ± 7.7	171.7 ± 6.8	175.4 ± 8.5	0.172	[-8.97;1.67]
Weight (Kg)	72.8 ± 13.0	69.0 ± 14.1	77.1 ± 9.2	0.059	[-16.54;0.32]
Weight Wheelchair (Kg)	14.5 ± 2.1	14.1 ± 2.3	15.0 ± 1.6 (n=14)	0.215	[-2.40; 0.56]
Time since injury (years)	27.8 ± 12.0	32.2 ± 12.6	22.9 ± 9.3	**0.021**	[1.49;17.16]
Age at injury (years)	22.9 ± 10.4	18.4 ± 8.4	28.0 ± 10.4	**0.005**	[-16.21;-3.09]
Total laps		29.6 ± 3.0	29.8 ± 4.7	0.898	[-2.90;2.55]
Maximum push strength (N)		183.7 ± 47.7	224.8 ± 42.8	**0.015**	[-73.63;-8.63]
Anaerobic work capacity (W)		76.0 ± 23.8	101.6 ± 29.2	**0.008**	[-44.04;-7.04]
Activity levels (MET)		21.7 ± 11.6	18.2 ± 16.6	0.476	[-6.41;13.43]

NOTE. *p*-values ($\alpha = 0.05$) and 95% confidence interval (95% CI) represent comparison of non-fatigued and fatigued group.