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Predictive modeling for peak power output in handcycling

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HandbikeBattle

- Uphill handcycling mountain race
- Teams: ex-rehabilitation patients from 12 Dutch centers

HandbikeBattle

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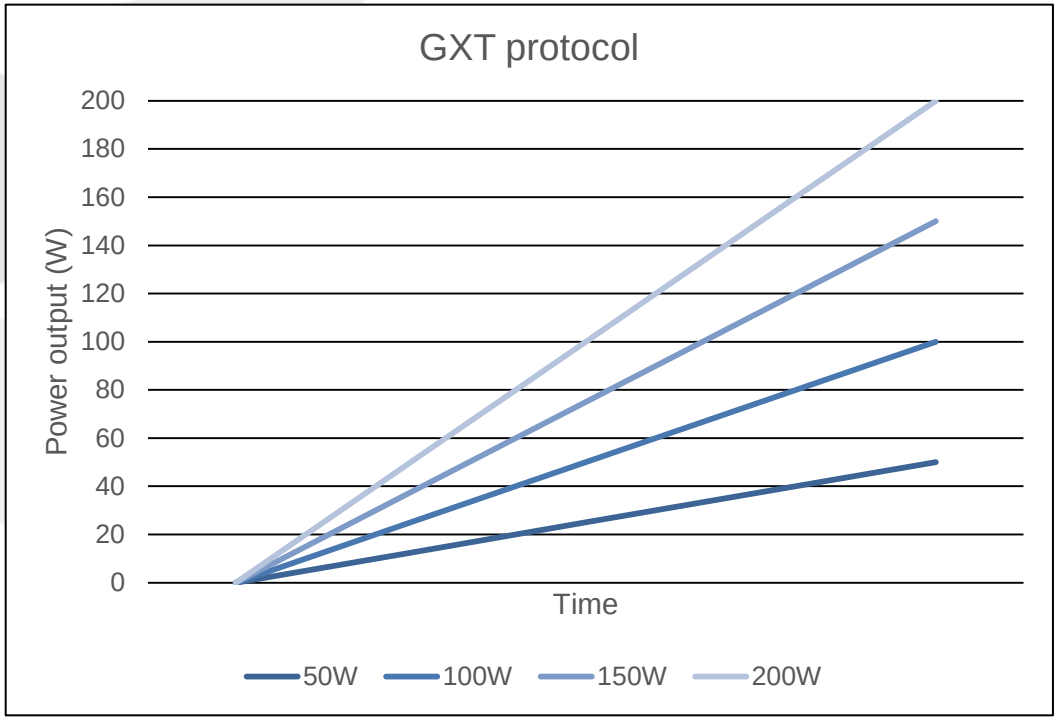
Level of fitness: graded exercise test (GXT)

- To measure physical capacity (POpeak / VO_2peak)
- Step size?
- Ramp slope?



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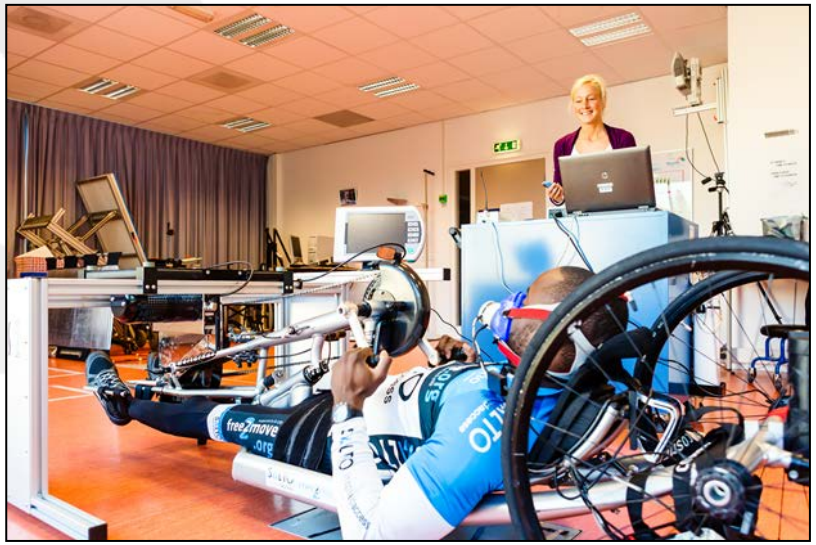
Level of fitness: in individuals with spinal cord injury (SCI)?

- Graded exercise test: arm ergometry
- Which factors will influence fitness?
- What protocol to select?



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Aim

To develop and validate a predictive theoretical and statistical model for POpeak (in W/kg) in a handcycling GXT for people with SCI

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Methods

- Participants: N=128
- SCI (N=118) and spina bifida (N=10)
- 11 different rehabilitation centers

- Graded exercise test (POpeak)
- Possible determinants

- Aim:
- POpeak/kg = constant + .. * age + .. * sex + .. etc

Determinants
Age (years)
Sex (M/F)
Body mass index (kg/m^2)
Time since injury (TSI in years)
Lesion level (>Th6 vs ≤Th6)
Completeness (ASIA A+B vs C+D)
Handcycling weekly training (hours)

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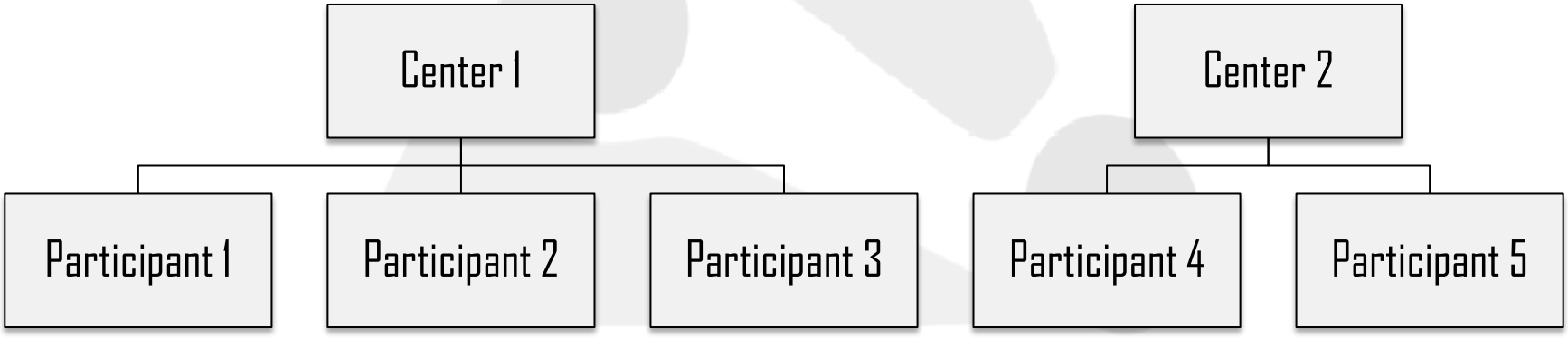
Statistical methods

- Multilevel regression analysis: correction for center



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Statistical methods

- Split the group: 80% (model group) vs 20% (validation group)

- Validation of the model (validation group):
- Calculation of POpeak/kg using the equation
- Predicted POpeak/kg vs. measured POpeak/kg
- Intraclass correlation coefficient (ICC)
- Bland-Altman plots

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Statistical methods

- Theoretical model: all determinants were included

- Statistical model:
- Univariate regression analysis
- Backward regression analysis

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Results

Theoretical model POpeak/kg
(-) Age (years)
(-) Sex (M/F)
(-) Body mass index (kg/m^2)
(+) Time since injury (TSI in years)
(+) Lesion level (>Th6 vs ≤Th6)
(+) Completeness (ASIA A+B vs C+D)
(+) Handcycling weekly training (hours)
R^2 42%
ICC 0.60 (good)

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Results

Theoretical model POpeak/kg	Statistical model POpeak/kg
(-) Age (years)	Age (years)
(-) Sex (M/F)	Sex (M/F)
(-) Body mass index (kg/m^2)	(-) Body mass index (kg/m^2)
(+) Time since injury (TSI in years)	Time since injury (TSI in years)
(+) Lesion level (>Th6 vs ≤Th6)	(+) Lesion level (>Th6 vs ≤Th6)
(+) Completeness (ASIA A+B vs C+D)	Completeness (ASIA A+B vs C+D)
(+) Handcycling weekly training (hours)	(+) Handcycling weekly training (hours)
R^2 42%	**R^2 30%**
ICC 0.60 (good)	**ICC 0.43 (fair)**

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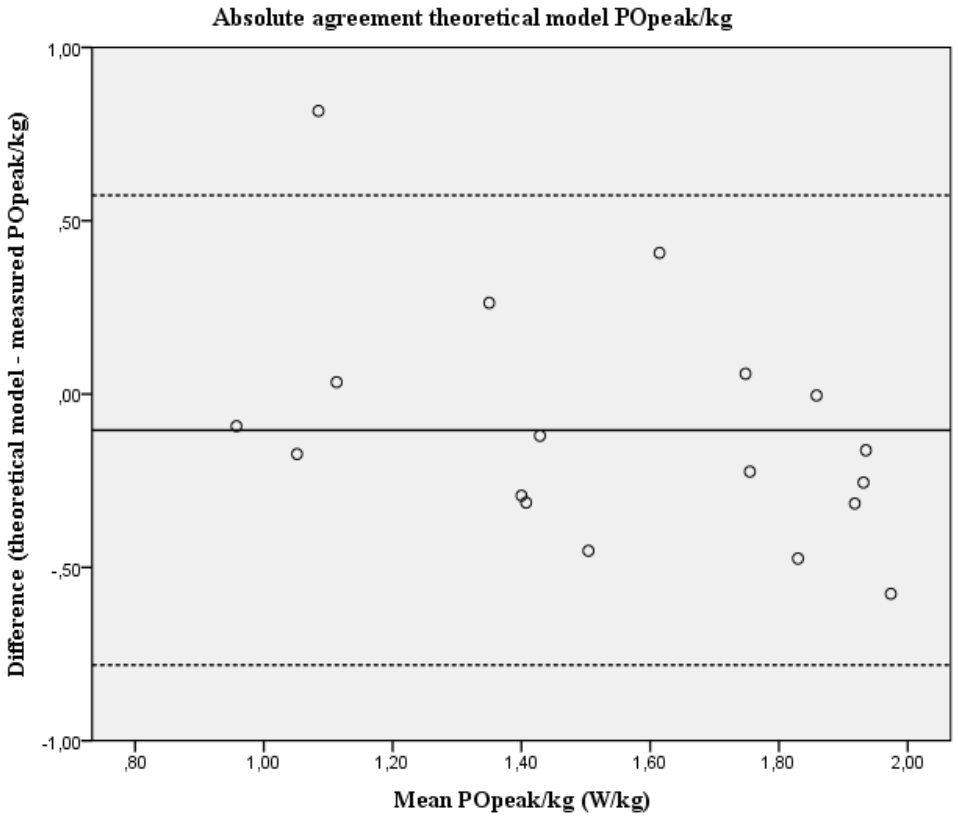
Results



ICC = 0.60 (good)

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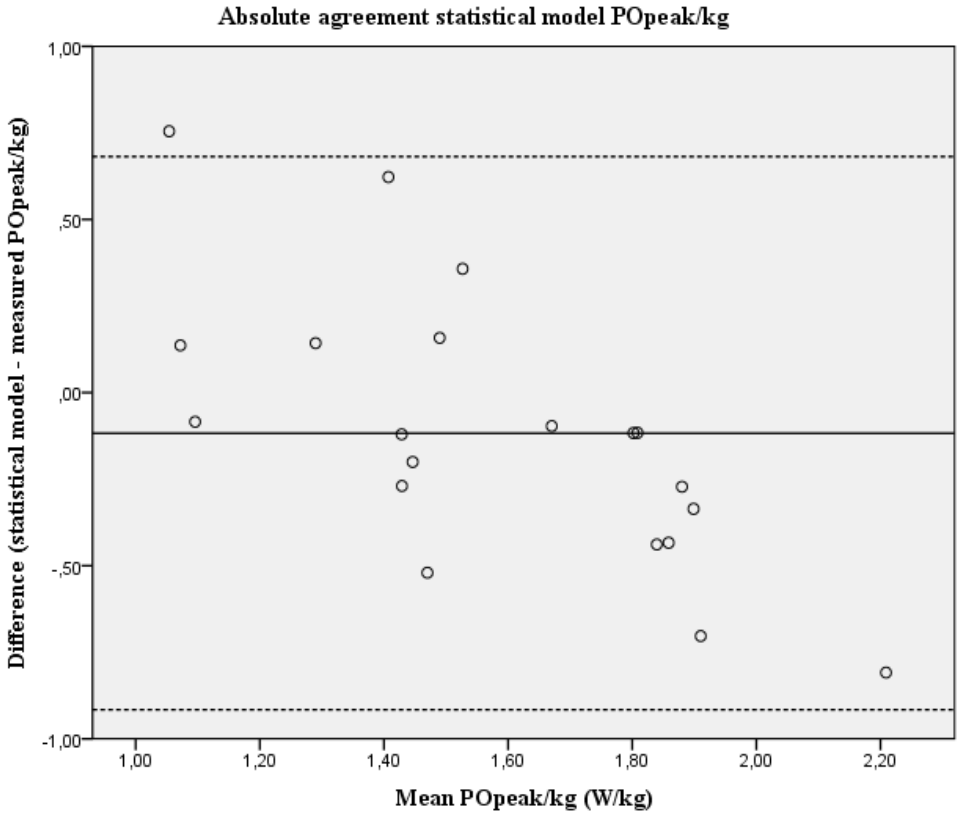
Results



ICC = 0.43 (fair)

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Discussion

- Simmons et al. 2014: functional classification, BMI, motor level of injury (R^2=57%)

- How can we make the prediction model more valid?

- Evaluate training load
- Add more determinants?
- Sport participation
- Strength test *Janssen et al. 1992 (R^2=0.66)*
- Wingate / sprint *Janssen et al. 1992 (R^2=0.81)*

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Conclusion

- A predictive theoretical and statistical model for POpeak (in W/kg) in a handcycling GXT for people with SCI

- POpeak/kg is determined by: BMI (-), lesion level (+), handcycling training (+)
- Other determinants might also be important

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Thanks for your attention

Sponsored by:

HandbikeBattle

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Results

Theoretical model POpeak	Statistical model POpeak
Age (years)	Age (years)
Sex (M/F)	Sex (M/F)
Body mass index (kg/m^2)	Body mass index (kg/m^2)
Time since injury (TSI in years)	Time since injury (TSI in years)
Lesion level (>Th6 vs ≤Th6)	Lesion level (>Th6 vs ≤Th6)
Completeness (ASIA A+B vs C+D)	Completeness (ASIA A+B vs C+D)
Handcycling weekly training (hours)	Handcycling weekly training (hours)
R^2 42%	**R^2 39%**
ICC 0.43 (fair)	**ICC 0.35 (poor)**

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Results

	Theoretical model POpeak/kg (N=84)		Statistical model POpeak/kg (N=94)	
	β (SE)	p-value	β (SE)	p-value
Intercept	2.94 (0.26)	< 0.01	2.36 (0.23)	< 0.01
Sex	-0.38 (0.11)	< 0.01	ns	NA
Lesion level	0.33 (0.08)	< 0.01	0.31 (0.09)	< 0.01
Handcycling training (h)	0.03 (0.01)	< 0.01	0.03 (0.01)	0.01
BMI (kg/m^2)	-0.06 (0.01)	< 0.01	-0.05 (0.01)	< 0.01
TSI (years)	0.01 (0.01)	0.23	ns	NA
Completeness	0.10 (0.09)	0.24	ns	NA
Age (years)	-0.01 (0.004)	< 0.01	ns	NA
R^2	**42%**		**30%**	

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Results

	Theoretical model POpeak (N=84)		Statistical model POpeak (N=95)	
	β (SE)	p-value	β (SE)	p-value
Intercept	107.05 (18.54)	< 0.01	99.97 (5.14)	< 0.01
Sex	-41.13 (7.88)	< 0.01	-41.29 (6.96)	< 0.01
Lesion level	26.67 (5.90)	< 0.01	28.88 (5.69)	< 0.01
Handcycling training (h)	1.82 (0.75)	0.017	1.77 (0.71)	0.01
BMI (kg/m^2)	0.52 (0.84)	0.54	ns	NA
TSI (years)	0.18 (0.33)	0.59	ns	NA
Completeness	10.92 (6.24)	0.08	ns	NA
Age (years)	-0.59 (0.30)	0.05	ns	NA
R^2	**42%**		**39%**	

Results

	Total group (N = 128)	Model group (N = 104)	Validation Group (N = 24)	*p*-value
	M ±SD or N	**M ±SD or N**	**M ±SD or N**	
SCI/spina bifida	118/10	96/8	22/2	1.00
Lesion level (>Th6/≤Th6)	37/86	32/68	5/18	0.45
Completeness (motor compl/incompl)	77/41	61/35	16/6	0.47
Sex (male/female)	106/22	85/19	21/3	0.76
Age (years)	39.4 ± 12.0	39.5 ± 12.1	39.3 ± 12.0	0.91
TSI (years)	10.1 ± 9.6	10.2 ± 10.0	10.0 ± 8.8	0.87
Height (m)	1.8 ± 0.1	1.8 ± 0.1	1.8 ± 0.1	0.54
Body Mass (kg)	78.1 ± 16.6	77.9 ± 16.4	79.1 ± 17.8	0.27
BMI (kg/m^2)	24.1 ± 4.1	24.0 ± 4.2	24.4 ± 3.8	0.78
Waist circumference (cm)	90.7 ± 15.4	91.3 ± 15.0	88.0 ± 17.1	0.96
Handcycling training (h)	3.4 ± 3.7	3.5 ± 3.8	2.8 ± 3.0	0.44
Handcycling classification (H1-H3/H4-H5)	67/57	55/46	12/11	1.00