



Wheelchair Mobility Performance enhancement by changing wheelchair properties; what is the effect of grip, seat height and mass?

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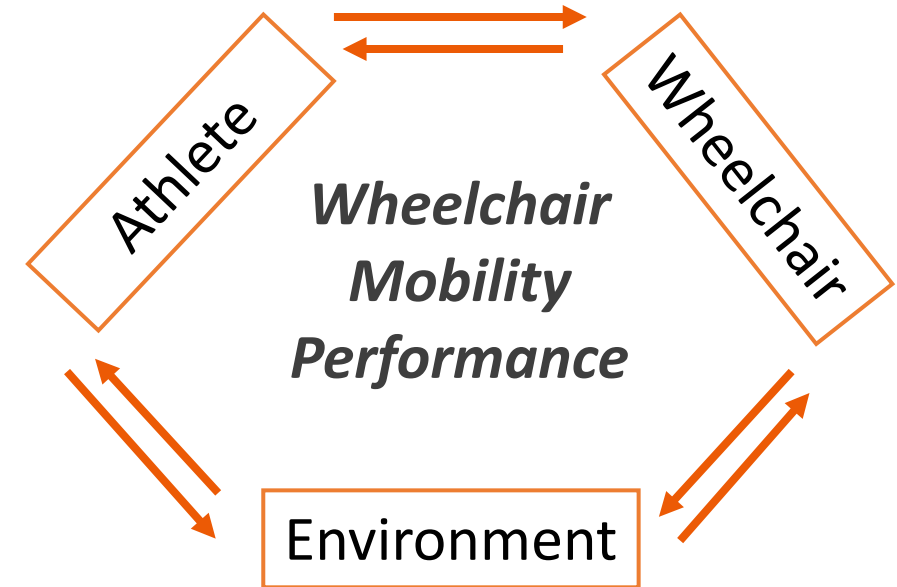


Introduction

Wheelchair configuration and performance

Performance in wheelchair sports

- Athlete – wheelchair
 - One functional unit
- Individual athletes
 - Class / athlete bound performance goals
 - Sport / field position bound performance goals
- Wheelchair mobility performance
 - Optimize wheelchair settings / configuration



Model by Kees van Breukelen



Methods

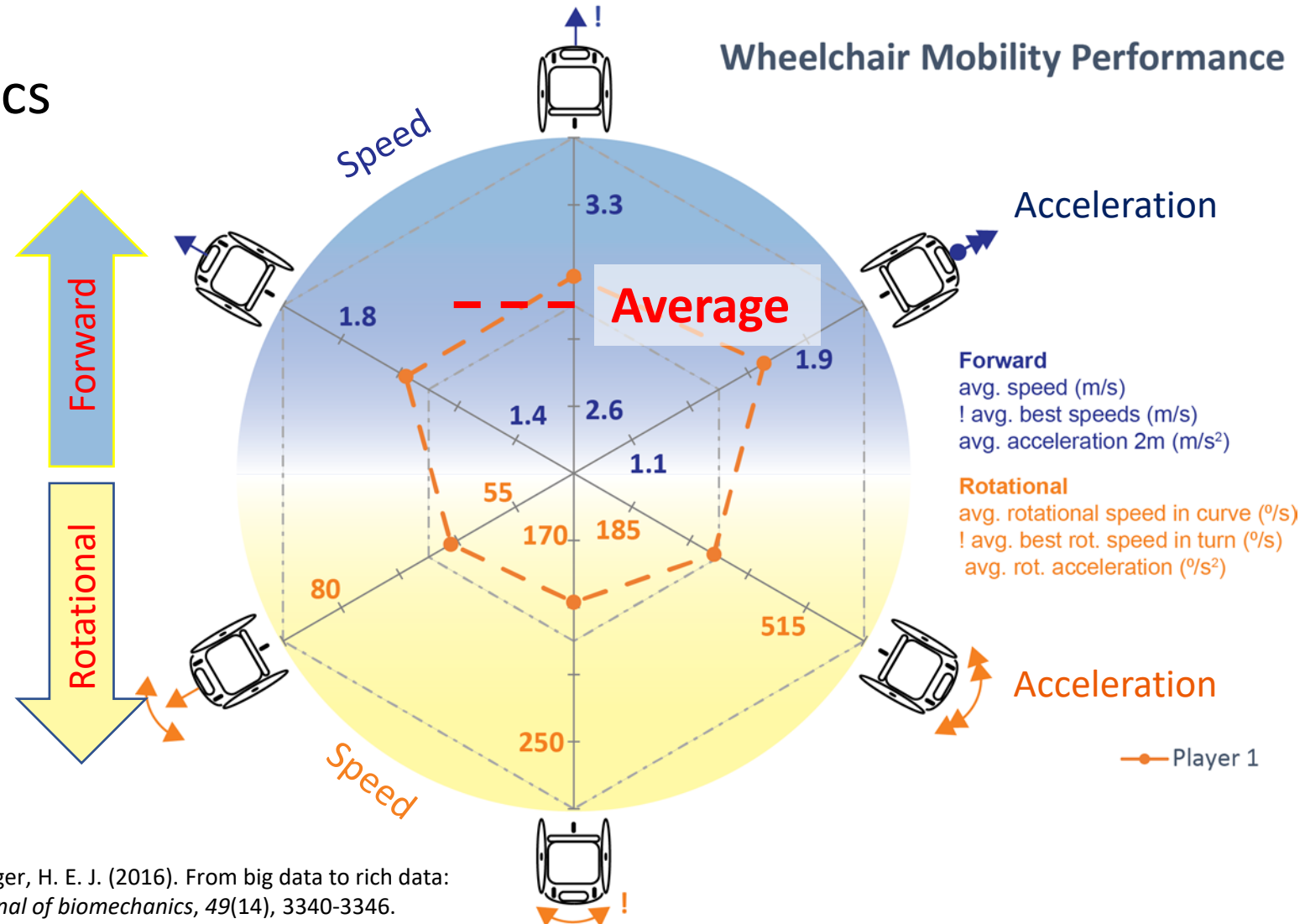
Wheelchair Mobility Performance Monitor

Wheelchair basketball field test

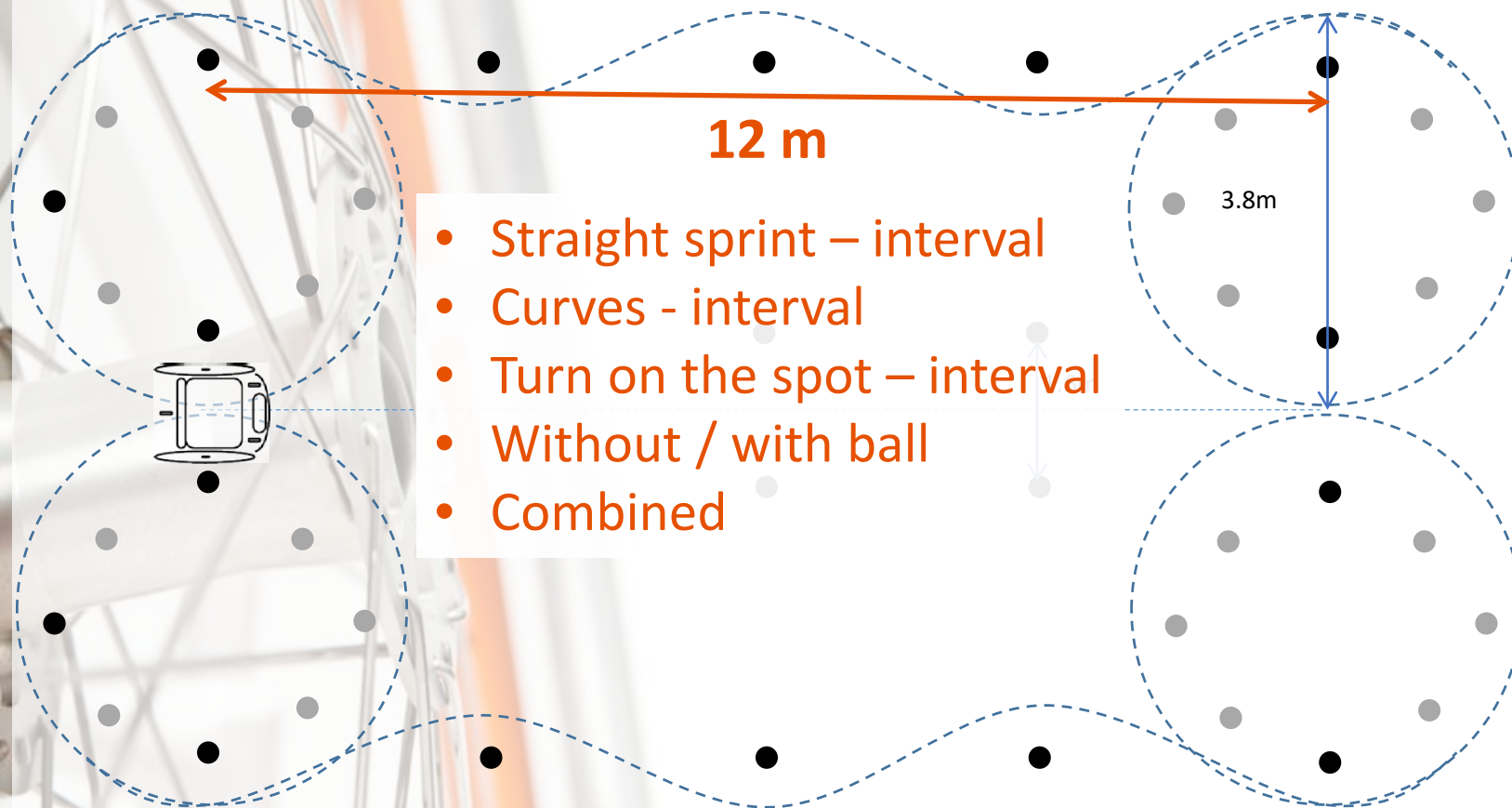
Normal wheelchair setup and five altered settings

Wheelchair Mobility Performance Monitor

- Key wheelchair kinematics measured with IMUs



Wheelchair basketball field test



van der Slikke, R. M., Bregman, D. J., Berger, M. A., De Witte, A. M., & Veeger, D. J. H. E. (2018). The future of classification in wheelchair sports: can data science and technological advancement offer an alternative point of view?. *International journal of sports physiology and performance*, 13(6), 742-749.

Test conditions: changes in wheelchair setup

Neutral (N)

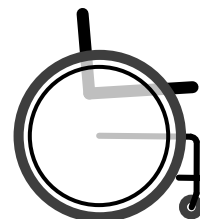


Seat height

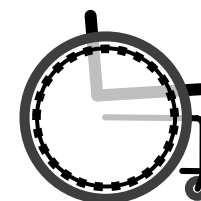
Low (L)
-7.5%



High (H)
+ 7.5%

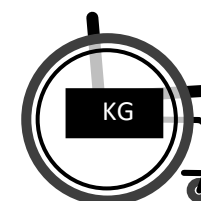


Grip (G)

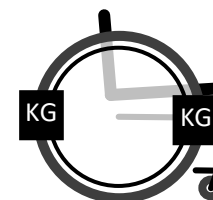


Added mass

Mass Central (MC)
+ 7.5%

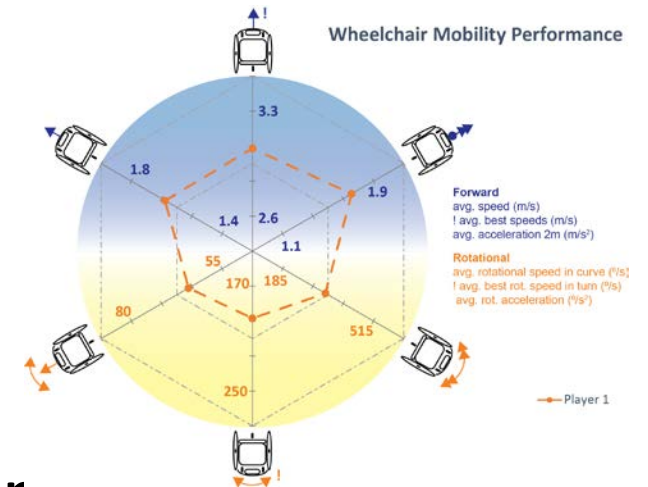


Mass Distributed (MD)
+ 3.75% & + 3.75%



Outcomes

- Number of outcomes
 - **Six** WMPM outcomes complete test **per test condition**
 - **Four** outcomes **per test part** (n=14) and **per test condition**
 - **Seven** comparisons
- Effect size (ES)
 - Differences expressed in ES
 - Small $|0.2| < |0.5|$
 - Moderate $|0.5| < |0.8|$
 - Large $> |0.8|$
 - Number of ES > 0.2





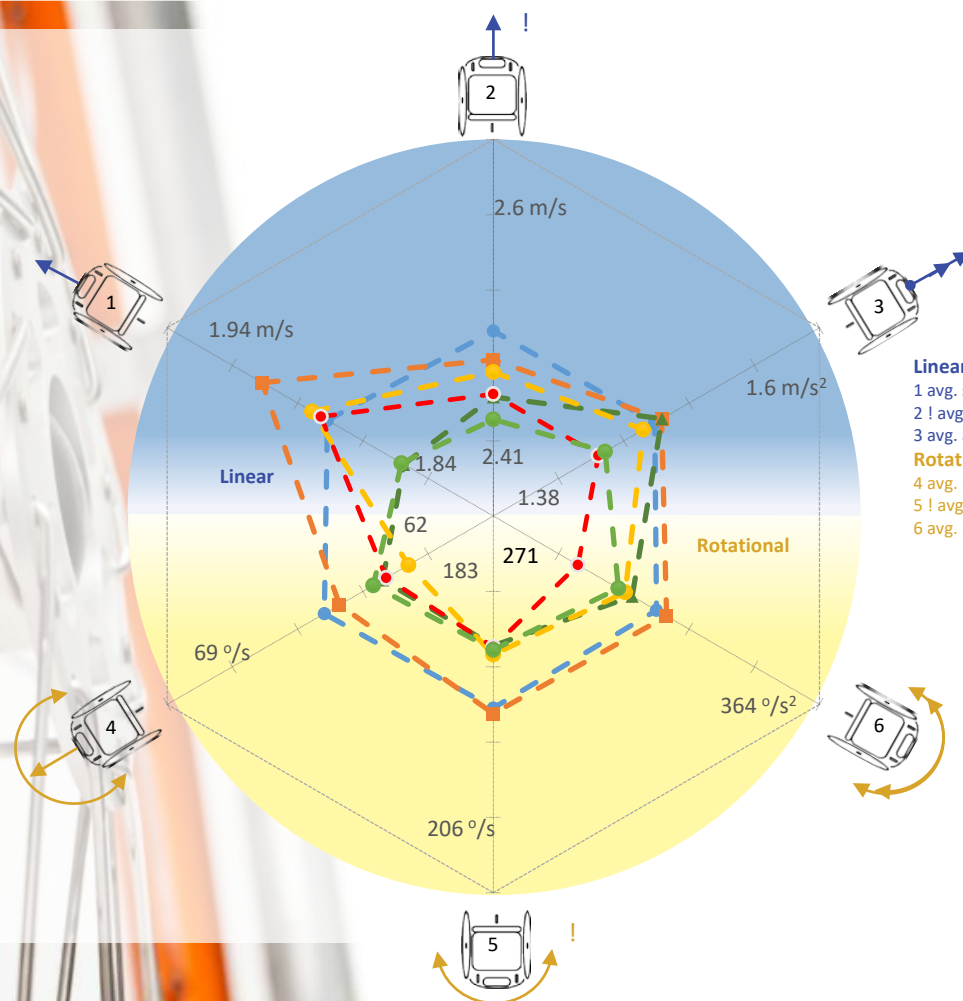
Results & conclusions

Wheelchair Mobility Performance

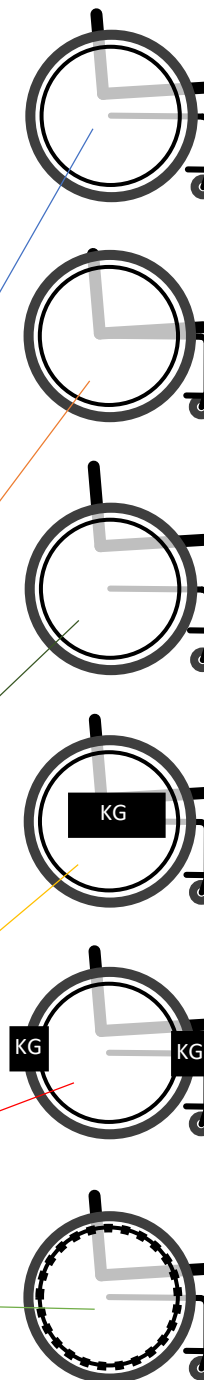
Outcome level effect sizes

Conclusions

Wheelchair settings



- Neutral
- Low
- ▲— High
- Weight Central
- Weight Distr.
- Grip



Outcome level

• Outcomes

- 4 main outcomes
- 14 test parts
- 6 WMP outcomes
- 7 comparisons
- 434 outcomes

• Effect size

- Small $|0.2| < |0.5|$
- Moderate $|0.5| < |0.8|$
- Large $> |0.8|$

			12m straight						12m curve				Turn on the spot				Comb.	
			Overall	Variable	Regular	Ball	Interval	Right	Left	R ball	L ball	R Interval	L interval	Right	Left	R interval	L interval	Regular
			WMP															
Neutral - Low	Forward	Sp Avg	0.17															
		Best 2	-0.09	Abs max	0.21	-0.05	-0.04	-0.10	0.25	0.18	0.08	-0.02	0.14	-0.04	-0.18	-0.20	0.38	0.00
		Acc 2m Avg	0.02	Abs avg	-0.07	0.13	-0.05	-0.07	0.10	-0.07	-0.13	0.07	0.08	-0.08	0.09	-0.03	-0.29	0.01
	Rotation	Sp Curve Avg	-0.07															
		Turn best 2	0.02	Abs max	-0.43	-0.57	0.26	-0.46	-0.07	-0.20	0.05	0.10	-0.20	0.18	0.03	0.05	-0.27	0.14
		Acc Avg	0.05	Abs avg	-0.33	-0.16	-0.13	-0.04	-0.01	-0.19	-0.14	0.10	-0.10	0.24	0.04	0.08	-0.10	0.09
Neutral - High	Forward	Sp Avg	-0.13															
		Best 2	-0.11	Abs max	0.17	-0.09	-0.26	-0.17	-0.02	-0.09	-0.04	-0.09	0.01	0.34	0.23	0.19	0.09	-0.10
		Acc 2m Avg	0.07	Abs avg	-0.25	0.26	-0.01	-0.29	0.11	-0.15	-0.14	0.07	0.07	-0.24	-0.16	-0.19	-0.34	-0.10
	Rotation	Sp Curve Avg	-0.27															
		Turn best 2	-0.30	Abs max	-0.15	-0.36	0.01	-0.22	-0.13	0.11	-0.06	-0.20	-0.17	-0.22	-0.11	-0.20	-0.48	-0.24
		Acc Avg	-0.13	Abs avg	-0.45	-0.17	-0.13	0.03	0.14	-0.10	-0.12	0.09	-0.11	-0.22	-0.11	-0.34	-0.29	-0.03
Low High	Forward	Sp Avg	-0.35															
		Best 2	-0.11	Abs max	-0.17	-0.03	-0.16	-0.06	-0.14	-0.27	-0.05	-0.09	0.07	0.35	0.41	-0.27	-0.09	
		Acc 2m Avg	0.00	Abs avg	-0.19	0.11	0.02	-0.25	0.03	-0.02	0.00	-0.08	-0.11	0.15	-0.10	-0.13	-0.11	
	Rotation	Sp Curve Avg	-0.25															
		Turn best 2	-0.27	Abs max	0.19	0.00	-0.12	0.20	0.00	-0.09	-0.28	0.13	-0.38	-0.14	-0.23	-0.26	-0.30	
		Acc Avg	-0.15	Abs avg	-0.05	-0.05	-0.01	0.04	0.28	-0.09	0.01	0.02	-0.03	-0.39	-0.18	-0.39	-0.19	-0.12
Neutral - Weight Central	Forward	Sp Avg	0.03															
		Best 2	-0.01	Abs max	-0.04	-0.21	-0.03	-0.17	-0.22	-0.32	0.05	0.04	-0.07	0.17	-0.36	0.14	0.30	-0.03
		Acc 2m Avg	0.02	Abs avg	-0.36	-0.13	-0.30	-0.01	-0.51	-0.42	-0.45	-0.26	-0.23	-0.49	-0.69	-0.37	-0.49	-0.45
	Rotation	Sp Curve Avg	-0.32															
		Turn best 2	-0.22	Abs max	0.00	0.63	0.25	-0.19	-0.11	0.09	-0.16	-0.24	-0.14	0.01	-0.13	0.00	-0.21	-0.39
		Acc Avg	-0.05	Abs avg	-0.04	0.14	-0.24	0.04	-0.01	-0.09	-0.06	0.03	-0.03	-0.01	-0.03	-0.10	-0.07	0.02
Neutral - Weight Distributed	Forward	Sp Avg	0.13															
		Best 2	-0.09	Abs max	0.01	0.15	-0.05	-0.03	-0.11	-0.18	0.00	0.03	0.06	0.18	0.36	0.02	0.18	-0.20
		Acc 2m Avg	0.01	Abs avg	-0.32	-0.17	-0.28	-0.52	-0.43	-0.34	-0.41	-0.15	-0.34	-0.39	-0.37	-0.39	-0.59	-0.36
	Rotation	Sp Curve Avg	-0.21															
		Turn best 2	-0.26	Abs max	-0.54	-1.12	-0.31	-0.63	-0.75	-0.52	-0.45	-0.18	-0.48	-0.27	-0.39	-0.31	-0.41	-0.43
		Acc Avg	-0.32	Abs avg	-0.40	-0.44	-0.38	-0.53	-0.36	-0.45	-0.43	-0.21	-0.59	-0.29	-0.31	-0.36	-0.35	-0.29
Weight Central - Weight Distributed	Forward	Sp Avg	0.17															
		Best 2	0.01	Abs max	0.09	0.05	0.05	0.36	0.19	0.18	0.03	0.06	0.14	0.21	0.51	0.02	-0.10	-0.21
		Acc 2m Avg	0.06	Abs avg	0.14	-0.01	0.04	-0.06	0.07	0.07	0.05	0.16	-0.07	0.18	0.41	-0.01	-0.24	0.07
	Rotation	Sp Curve Avg	0.02															
		Turn best 2	-0.04	Abs max	-0.69	-0.57	-0.25	-0.49	-0.49	-0.41	-0.24	0.04	-0.34	-0.26	-0.23	-0.35	-0.30	-0.11
		Acc Avg	-0.29	Abs avg	-0.21	-0.48	-0.23	-0.48	-0.33	-0.42	-0.40	-0.25	-0.58	-0.30	-0.22	-0.27	-0.27	-0.34
Neutral - Grip	Forward	Sp Avg	-0.10															
		Best 2	-0.16	Abs max	-0.01	-0.12	-0.13	0.30	0.31	0.16	-0.20	0.07	0.18	0.12	-0.09	-0.08	0.32	0.02
		Acc 2m Avg	-0.08	Abs avg	-0.14	0.13	0.02	-0.04	0.09	-0.07	-0.17	0.07	0.11	0.04	-0.04	-0.01	-0.08	-0.01
	Rotation	Sp Curve Avg	-0.15															
		Turn best 2	-0.28	Abs max	-0.21	-0.61	0.08	-0.13	-0.04	-0.12	-0.06	0.12	-0.12	0.01	0.05	0.00	-0.27	0.07
		Acc Avg	-0.07	Abs avg	-0.18	-0.18	-0.14	0.05	-0.06	-0.11	-0.11	0.07	-0.10	-0.04	-0.02	-0.21	-0.20	0.24

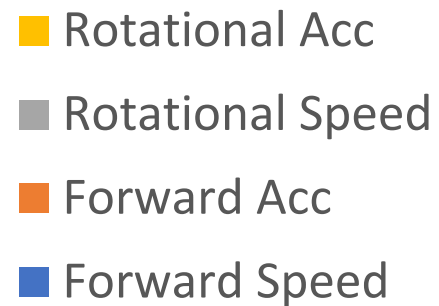
Comparisons (n=7)

Outcomes

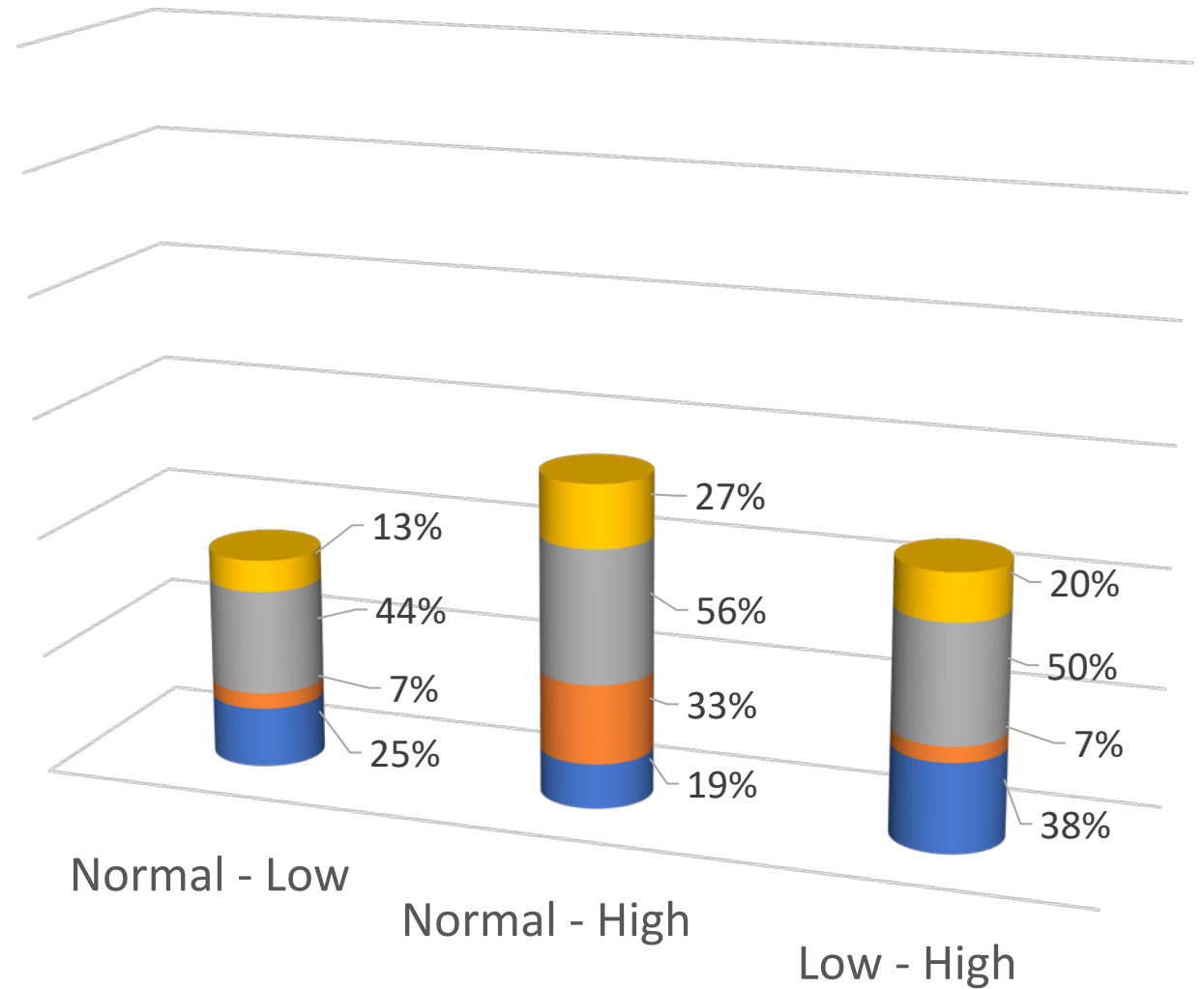
434 outcomes!

Seat height

- Minimal effect on speed
- Hardly effect on acceleration
- Most effect on rotational speed
- Minimal effect rotational acceleration

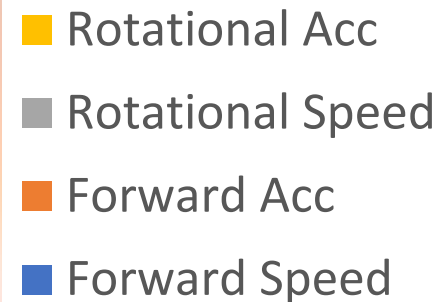


Percentage of Effect Sizes > 0.2

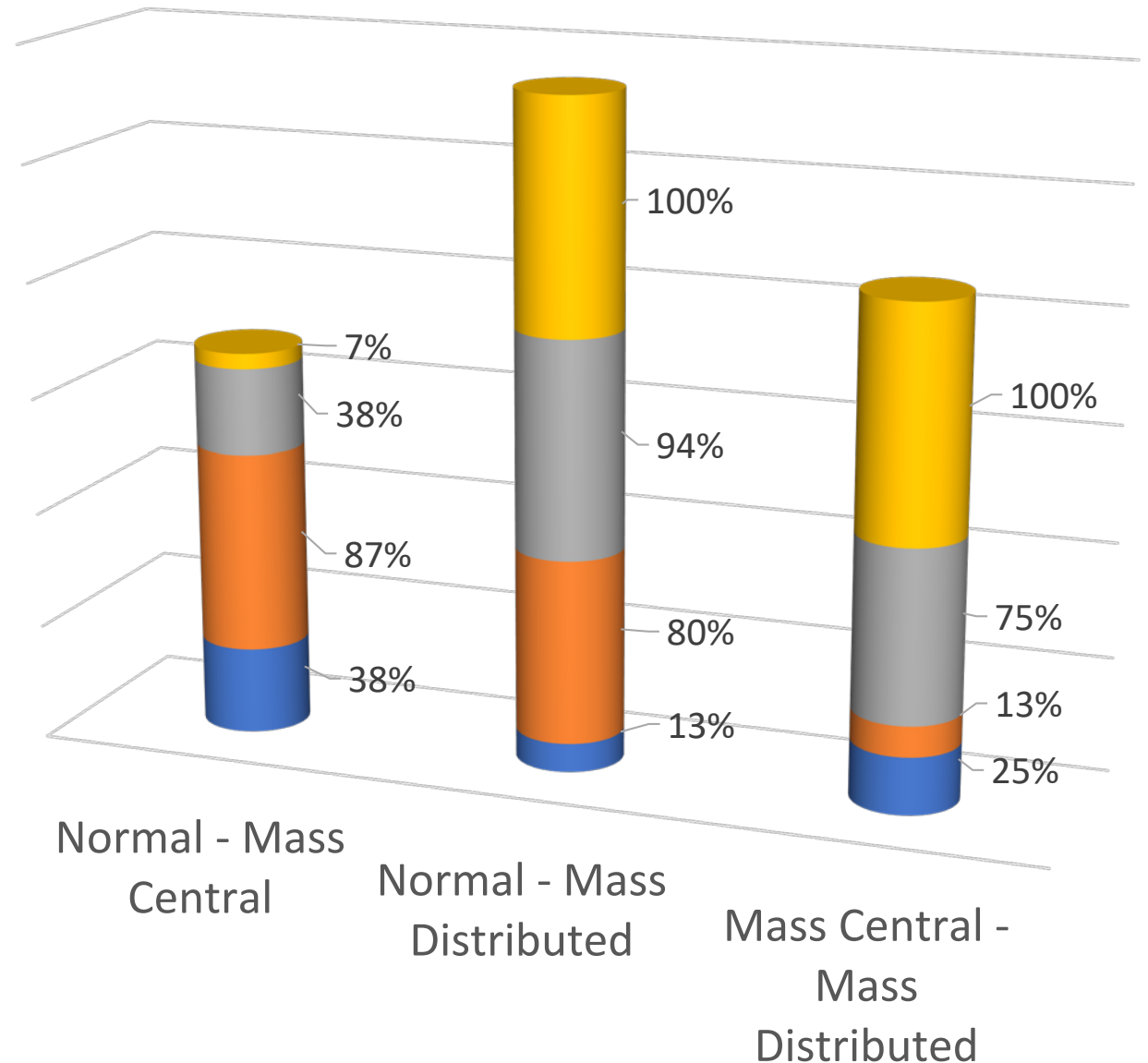


Added mass

- Minimal effect on speed
- Clear effect on acceleration
 - No difference between location
- Clear effect on rotational speed in distributed mass
- Very clear effect on rotational acceleration in distributed mass



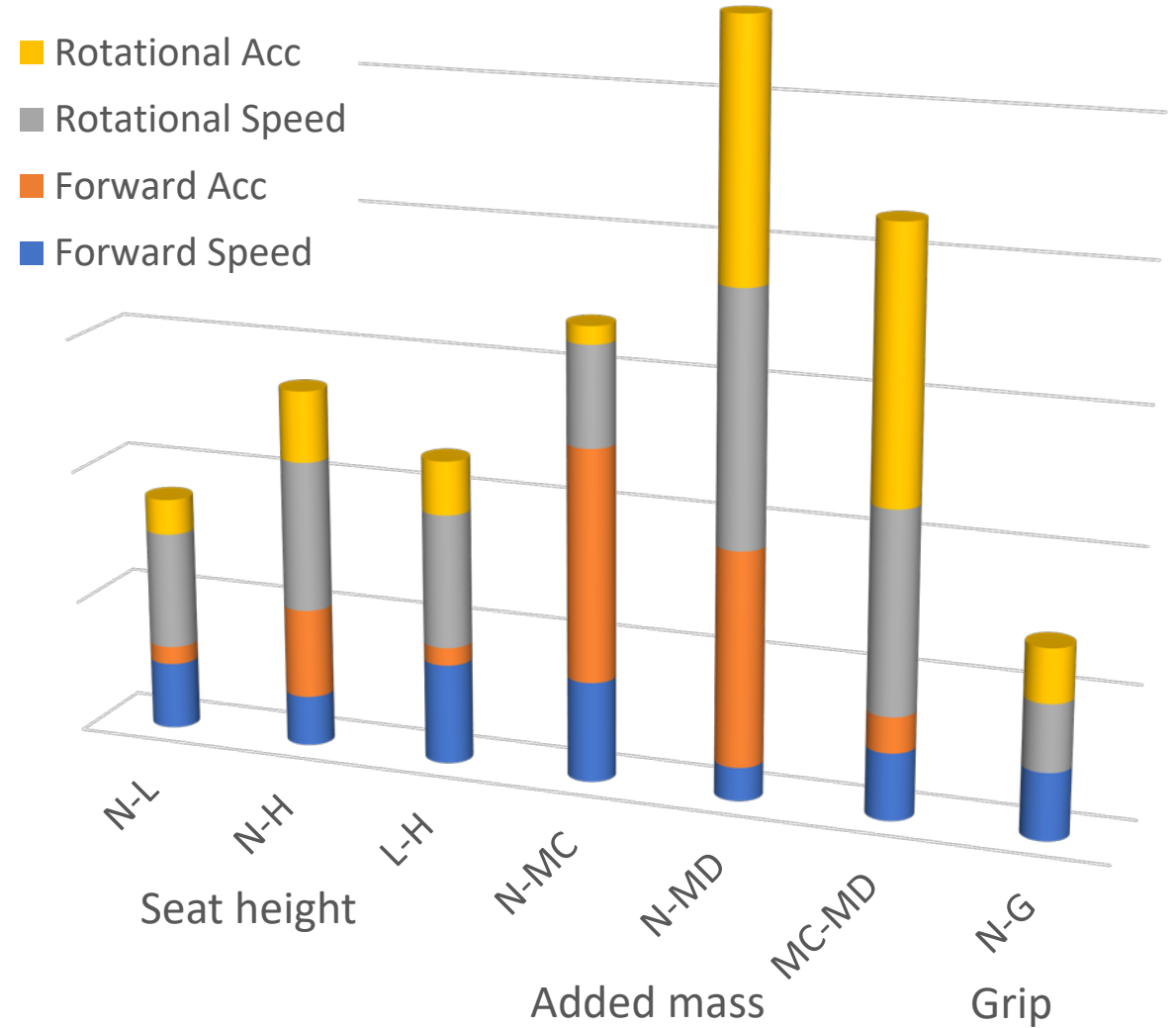
Percentage of Effect Sizes > 0.2



Conclusions settings

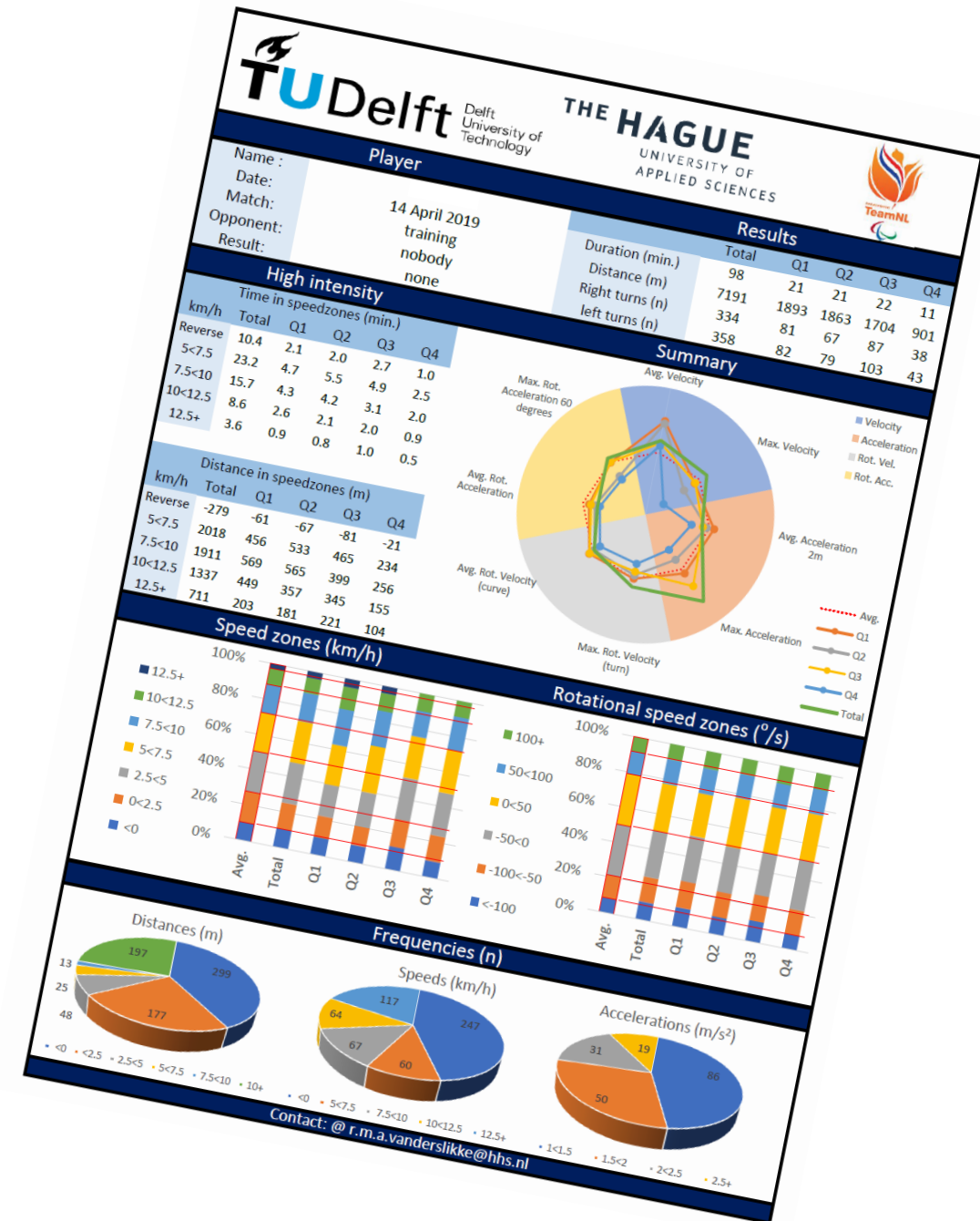
- Seat height
 - High, (rotational) performance ↓
- Mass central
 - Acceleration ↓
- Mass distributed
 - Acceleration ↓
 - Rotational speed & acceleration ↓
- Grip
 - Hardly effect

Percentage of Effect Sizes > 0.2



Perspective

- WMPM method & fieldtest
 - Sensitive to small changes in wheelchair configuration
- Structural WMPM monitoring
 - Evaluate training effect
 - Optimize wheelchair configuration





Out of the lab,
onto the court

Wheelchair Mobility
Performance quantified

Free copies
available!

