WHEELCHAIR MOBILITY PERFORMANCE ONLY SUPPORTS THE USE OF TWO CLASSES IN WHEELCHAIR BASKETBALL

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The purpose of this study was to determine the effect of functional classification on wheelchair mobility performance in wheelchair basketball, measured during match play (n=29) and a standardised field test (n=47). In unconstrained field test conditions, wheelchair mobility performance outcomes only differed significantly between the low classified players compared to the adjacent higher class athletes. In match play differences between adjacent classes are less prominent, with a more even rise in performance with increase in classification. These differences in patterns were expected to be the consequence of match related factors, field position in particular. Differentiated wheelchair mobility performance measurement on and off court could corroborate classification guidelines or provide bases for a reduced number of classes.

KEY WORDS: Wheelchair basketball, Inertial Measurement Units, Mobility performance.

INTRODUCTION: In adapted sports, there is an ongoing quest to attain regulations for fair competition (Vanlandewijck et al., 1995, 2004; Altmann et al., 2015) given the heterogeneous group of athletes. In wheelchair basketball, a single competition is achieved by classifying athletes based on their impairment and its expected effect on match play. Classifications range from 1 point (most impaired) to 4.5 (no functional limitations), with a team of 5 athletes composed of maximal 14 points. But are the eight classes in the current classification system still necessary? Although game performance is clearly affected by classification level, other factors like field position are known to interact on that relationship. To provide more fundament for evidence based classification guidelines, this research describes the effect of classification on wheelchair mobility performance in an unconstrained field test versus match play.

METHODS: Wheelchair mobility performance of 47 (see Table 1) Dutch wheelchair basketball athletes was measured in a standardised field test for wheelchair basketball (de Witte et al., 2017) and 29 international athletes were measured during match play (van der Slikke et al., 2016). This study was approved by the ethical committee of the faculty of Human Movement Sciences: ECB-2014-2. All participants signed an informed consent after being informed about the experiment.

Table 1
Distribution of classification and age (years) per competition level group.

Level		Mean	SD	Classification 1.0	1.5	2.0	2.5	3.0	4.0	4.5
National Male (NM)	Class	3.3	1.2	2	1	1	1	2	7	4
	Age	23.7	10.1							
International Male (IM)	Class	3.0	1.2	2	1	1	4	3	2	4
	Age	26.4	7.8							
International Female (IF)	Class	2.8	1.2	1	2	1	2	3	1	2
	Age	32.9	8.0							
Total				5	4	3	7	8	10	10
Group total				Low = 9		Mid = 18			High = 20	

The athlete's wheelchair was equipped with 3 Inertial Measurement Units (IMUs, see Figure 1), one on each rear wheel axis and one on the rear frame bar. The frame sensor was used for measuring forward acceleration as well as rotation of the frame in the horizontal plane (heading direction). The combined signal of wheel sensor acceleration and gyroscope was used to estimate wheel rotation, which in turn provided frame displacement given the wheel circumference (van der Slikke et al., 2015).

Figure 1: Measurement setup, with IMUs on wheels and frame applied during match measurements. (Photograph by www.frankvanhollebeke.be).

Based on IMU outcomes for each measurement a wheelchair mobility performance plot was generated, showing the key outcomes of wheelchair performance (van der Slikke et al., 2016). The six outcomes included are: average speed; average best speed (of best 5 in a match and of best 2 in the field test); average acceleration in the first 2m from standstill; average rotational speed during forward movement; average best rotational speed during a turn on the spot (of best 5 / best 2) and average rotational acceleration.
To test for classification effects on wheelchair mobility performance, athletes were split into three classification groups: low (1 -1.5), mid (2 – 3) and high (4 – 4.5). A Kolmogorov-Smirnov test was applied to test for normal distribution of all 6 wheelchair mobility performance outcomes, to verify for the use of parametric statistics. A one-way ANOVA was used to test for group differences in mobility performance outcomes, in both the field test (n=47) and the match data (n=29). Subsequent T-test analyses were used to identify between which groups significant differences occurred. These differences were also expressed as a factor of the Smallest Detectable Difference.

RESULTS: Classification groups showed significant ($p<0.05$, with Holm-Bonferroni correction) differences in five out of six wheelchair mobility performance outcomes in the field test and all six in the match measurements (see Table 1). Post ANOVA T-test revealed that in the field test five wheelchair mobility performance outcomes differed significantly ($p<0.05$) between low and mid classified athletes and no outcomes differed between mid and high classified athletes. In the match measurements three out of six outcomes differed significantly between the low and mid classified athletes and only best forward speed differed between the mid and high classified group.

Table 1
Classification group statistics in the field test and match data, with ANOVA and T-test. Significant differences (<0.05 after Holm-Bonferroni correction) are marked italic.

	Match				Field Test			
	ANOVA	T-test			ANOVA	T-test		
		Low - Mid	Low - High	Mid - High		Low - Mid	Low - High	Mid - High
Forward speed avg.	*0.000*	*0.006*	*0.000*	0.101	*0.000*	*0.000*	*0.000*	0.795
Forward speed best	*0.000*	0.350	*0.000*	*0.002*	*0.000*	*0.004*	*0.001*	0.384
Forward acceleration avg.	*0.001*	0.041	*0.000*	0.057	*0.003*	*0.005*	*0.001*	0.664
Rotational acceleration avg.	*0.006*	0.033	*0.001*	0.193	*0.002*	*0.000*	*0.001*	0.991
Rotational speed turn best	*0.003*	*0.005*	*0.001*	0.524	0.068	0.062	0.075	0.695
Rotational speed curve avg.	*0.002*	*0.004*	*0.000*	0.707	*0.009*	*0.007*	*0.003*	0.943

Expressed in Smallest Detectable Difference (SDD), differences in *field test* outcomes ranged from 1.5 – 6.2 SDD between low and mid classified players, and only maximal 1.0 SDD between mid and high classified players (see Table 2).

Table 2
Smallest Detectable Difference (SDD) for classification group statistics in the field test

	SDD	Low -Mid	Low -High	Mid -High
Forward speed avg.	.038 m/s	**6.2**	**6.5**	0.3
Forward speed best	.046 m/s	**5.2**	**6.2**	**1.0**
Forward acceleration avg.	.085 m/s^2	**5.3**	**6.0**	0.6
Rotational acceleration avg.	18.7 °/s	**5.5**	**5.5**	0.0
Rotational speed turn best	12.1 °/s	**1.5**	**1.3**	-0.2
Rotational speed curve avg.	3.4 °/s^2	**2.0**	**2.0**	0.0

Classification group averages of match and field test performance are displayed in the standardized wheelchair mobility performance plot (van der Slikke, 2016), see Figure 2. These plots show the six wheelchair mobility performance outcomes in a radar plot, with outcomes of forward movement on the upper half and rotational outcomes on the lower half. Outcomes are plotted towards average match performance. Since average speed and acceleration in the field test exceed match averages (short condensed test), these outcomes show high up the scale (Figure 2, right). The differences between field test and match outcomes expressed in the statistical analysis clearly shows in these plots as well.

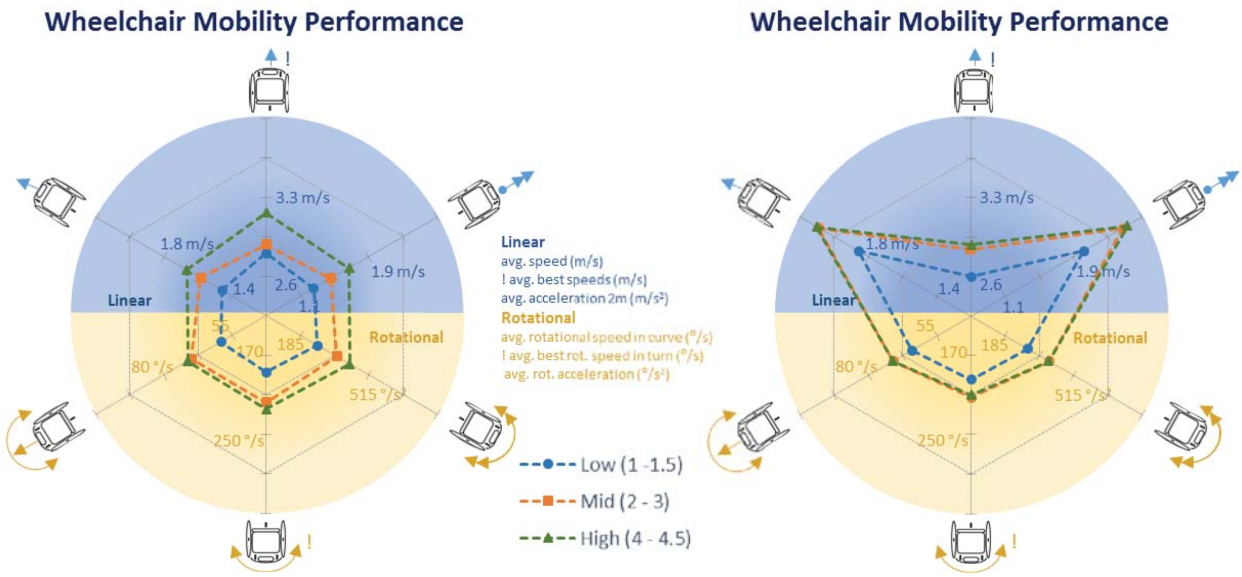

Figure 2: Wheelchair mobility performance for three classification groups, adapted from van der Slikke et al. 2016. Group averages for each of the six wheelchair mobility performance outcomes is shown. The left plot shows the *match* and the right one the *field test* performance.

DISCUSSION: Wheelchair mobility performance is clearly affected by the physical ability as expressed in the classification, but this effect is not consistent over all classes. In unrestrained field test conditions, the largest performance difference between athletes of adjacent classification groups is observed between low and mid classified athletes, with five of the wheelchair mobility performance outcomes showing significant differences. No significant differences showed between mid and high classification groups. In the match, wheelchair mobility performance also showed a relationship with classification, but more

evenly distributed over classes. The low classified athletes show lower wheelchair mobility performance values, but the differences with the mid classified athletes are less prominent. So, the effect of classification on wheelchair mobility performance is different between unconstrained field test measurements and data obtained during a match with its inherent performance limiting factors.
Given the unrestrained nature of the field test (no opponent or other obstructions), it was anticipated that wheelchair mobility performance outcomes would exceed those of match conditions, which showed in five out of six outcomes. Only average best speed appeared to score better in match conditions, which can be explained by the field test size limitations.
If mobility performance is regarded as one of the most important factors in wheelchair basketball, results of this study could be enforced to argue for a reduced number of classifications. In a more isolated field test, a typical separation revealed between the classification 1-1.5 athletes and the rest, which is not prevalent in the results of match measurements. This type of class division is in line with the conclusion of Vanlandewijck et al (1995) pinpointing the viability of a reduction in the number of classes. If *match* wheelchair mobility performance is regarded, differences between classifications are subtler, but it is unclear if this is an effect of physical capacity or an effect of typical match requirements as determined by field position. In a study of Vanlandewijck et al. (2004) it was also concluded that classification-position interaction disturbed the expected performance differences due to classification.
Based on our results, it could be argued to reduce the number of wheelchair mobility performance classes to only two (1-1.5 and 2+). Subsequently, the 2+ class athletes could be divided into two (or more) groups given the effect of their disabilities on others skills, such as ball handling. Future classification directed research could be extended with measures for these other performance aspects, like adding the comprehensive basketball grading system (Vanlandewijck et al., 2004) alongside wheelchair mobility performance measurements in match and field test.

CONCLUSION: Wheelchair mobility performance is an important aspect of wheelchair court sports and it is affected by athlete's impairment level as expressed in the classification. To eliminate match specific effects of impairment on performance, it is advisable to include performance measurements from sport specific field tests as fundament for evidence based classification guidelines. This research showed that *match* performance does not equal *best* performance, but the field test used seems a valuable tool for accurate estimation of *best* wheelchair mobility performance levels.

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