Test–retest reliability of the newly developed field-based tests focuses on short time efforts with maximal intensity for wheelchair basketball players

A – preparing concepts
B – formulating methods
C – conducting research
D – processing results
E – interpretation and conclusions
F – editing the final version

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Abstract

Introduction: There are some studies concern special field-based tests for wheelchair basketball players however, there were not a lot of studies confirmed reliability and/or validity of wheelchair basketball field-based tests. The aim of the present study was to assess test-retest reliability of the newly developed field-based tests focused on short time efforts with maximal intensity for wheelchair basketball players.

Material and methods: Nine elite male wheelchair basketball players (mean age 29.7 ± 5.9 years) performed two times 11 field-based tests focused on short time efforts with the maximal intensity: 3 m sprint, 5 m sprint, 10 m sprint, 20 m sprint, pass basketball ball by both hands from the chest, pass medicine ball (3 kg) by both hands from the chest, bilateral handgrip, 3-6-9 m drill test, 30-seconds sprint test, agility drill test, and 10x5 m sprint test. All sprint tests' time were measured by Microgate® photocells (Bolzano, Italy). Differences between field-based tests repetitions were compared by the t-test for dependent samples, relationship between repetitions was calculated by the Pearson correlation coefficient, and the ICCs were calculated (test-retest reliability).

Results: The ICCs were 'very good', correlations were strong for each field-based test ($r > 0.7$). Only for the agility drill test the first repetition is statistically different compare to the second repetition ($p = .015$).

Conclusions: The main application of our research is a confirmation of reliability of 10 field-based tests related to short time efforts with maximum intensity: 3 m sprint, 5 m sprint, 10 m sprint, 20 m sprint, pass basketball ball by both hands from the chest, pass medicine ball (3 kg) by both hands from the chest, bilateral handgrip, 3-6-9 m drill test, 30-seconds sprint test, and 10x5 m sprint test.

Key words: **anaerobic performance, athlete, assessment, evaluation**

Introduction

The evaluation of wheelchair mobility performance of wheelchair basketball players is an important requirement for coaches and players. Wheelchair mobility performance is understood as players' abilities and skills with a wheelchair on the basketball court [1]. de Witte et al. [1] and Mason et al. [2] indicated that key determinants of wheelchair mobility performance are related to acceleration, sprints, braking and turning with a wheelchair [1, 2]. Assessing of wheelchair mobility performance

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can be done during game observation, in a real situation on the basketball court, as well as using standardized field-based tests [1, 3, 4].

In the literature, there are some studies concern special field-based tests for wheelchair basketball players [5, 3, 6]. All developed and introduced tests were specially selected due to specificity of wheelchair basketball game. Authors focused on tests related to short time efforts with maximal intensity (anaerobic performance), aerobic capacity, and/or tests included technique or mobility performance (drill tests with the ball and without the ball, shooting tests) [3, 6].

However, there were not a lot of studies confirmed reliability and/or validity of wheelchair basketball field-based tests. Players' anaerobic performance and aerobic capacity assessed by standardized, reliable and valid field-based tests were presented in some studies [5, 1, 4, 7]. Vanlandewijck et al. [4] confirmed reliability of seven tests related to aerobic capacity and anaerobic performance, and wheelchair basketball skills on the basketball court. The authors did not confirm reliability of shooting test (test - retest, r = .65) [4]. De Groot et al. [5] showed six reliable field-based tests. However, the pass-for-accuracy test and shooting tasks were not reliable [5]. Yanci et al. [7] confirmed reliability of Yo-Yo 10 m recovery test (aerobic capacity) and agility T-test (anaerobic performance) [7]. De Witte et al. [1] analyzed 15 different wheelchair mobility performance tests (activities) and received the interclass correlation values of the separate activities ranged between 0.25 and 0.95. Five out of 15 outcome measurements showed low reliability (<0.70). Nonetheless, the value for the overall performance time was excellent (ICC = 0.95) [1].

Goosey-Tolfrey & Leicht [3] underlined that further analysis of field-based tests testing key parameters for each wheelchair sport separately are desirable [3]. The previous studies have indicated important role of short time efforts with maximal intensity [8-10]. Coutts et al. [8] suggested that wheelchair basketball players required more anaerobic performance during a game, e.g. during attack, in defensive game and playing with the ball, than aerobic capacity [8]. Hutzler et al. [10] concluded that an anaerobic performance depended on efficiency of wheelchair basketball players in the game [10]. Goosey-Tolfrey [9] underlined that short-time efforts are fundamental for wheelchair basketball players and improvement of anaerobic performance could affected on players' ability on the field [9]. Unanimously, all cited above authors underlined that there is a need to looking for new different tests, related to the specificity of wheelchair basketball game abilities and skills, and wheelchair mobility performance, which will be reliable, valid and standardized.

In this context, the aim of the present study was to assess test-retest reliability of the newly developed field-based tests focused on short time efforts with maximal intensity for wheelchair basketball players.

Materials and methods

Participants

Nine elite male wheelchair basketball players (mean age 29.7 ± 5.9 years) with minimum 2 years of training experience representing wheelchair basketball team from the first league, volunteered to participated in this study. They were informed about the purpose and all testing procedures, and were asked to sign the consent form. All procedures were approved by the Local Bioethics Committees (KEIB - 10/2016, SKE 01-16/2017) and were completed in accordance with the ethical standards as described in the Declaration of Helsinki.

Participants were evaluated by international classifiers and were divided into functional categories according to International Wheelchair Basketball Federation (IWBF) rules [11]. The characteristic of wheelchair basketball players was presented in table 1.

Table 1. The characteristic of wheelchair basketball athletes participated in test-retest

No.	Age [years]	Sport experience [years]	Functional class	Type of impairment
1	36	11	1.5	Paraplegia
2	35	6	2.0	Paraplegia
3	24	2	1.0	Paraplegia
4	21	6	3.0	Spina bifida
5	22	4	3.0	Other
6	32	16	3.0	Cerebral palsy
7	29	5	3.5	Amputation
8	35	8	1.5	Paraplegia
9	33	9	1.0	Paraplegia
Total	29.7 ± 5.9	7.4 ± 4.2		

Procedure

The reliability of 11 field-based tests focused on short time efforts with the maximal intensity: 3 m sprint, 5 m sprint, 10 m sprint, 20 m sprint, pass

basketball ball by both hands from the chest, pass medicine ball (3 kg) by both hands from the chest, bilateral handgrip, 3-6-9 m drill test, 30-seconds sprint test, agility drill test, and 10x5 m sprint test, was investigated. The idea of these newly developed field-based tests was come from coaches and our experience. We tried to develop tests which will be measured specificity of wheelchair basketball game skills like pushing, dynamic turning, passing, turnovers, acceleration, playing one-on-one. All procedures and descriptions of field-based tests were explained and checked in terms of validity by Marszałek et al. [12]. All participants had had warm up and after it they had opportunity to familiarized themselves with all tests, especially these tests which consisted maneuverability elements.

All sprint tests' time were measured by Microgate® photocells (electronic time measurement system with accuracy of up to .01 s; Bolzano, Italy) and Witty Manager software (version 1.4.1). The participant was with the large wheel axle lined up with the start line and the timer was activated automatically and began when the participant felt ready.

Test-retest of all 11 tests was used to examine if field-based tests are reliable. The first repetition in each test was performed during a morning training session. The second repetition was performed 8 hours later, during an evening training session.

Statistical analysis

All analyses were calculated using the SPSS IBM Statistics 25 for Windows (IBM Corp., Armonk, NY, USA). The analysis of the quantitative data was based on arithmetic means and standard deviations (SD). The Kolmogorov-Smirnov test was applied in order to examine the distribution of results.

To assess the reliability of the measurements, the first and the second repetition in each field-based test were compared with the use of the t-test for dependent samples. The level of significance was set at $p < .05$. Moreover, we calculated also relationship between the first and the second repetition in each field-based test (the Pearson correlation coefficient was applied). The level of significance was set at $p < .05$ and strong correlation was set at $r > .7$ [13].

Additionally, the interclass correlation coefficients (ICCs) were calculated to determine the relative test-retest reliability of the results the first and the second repetition in each field-based test. The ICCs values were defined as 'poor' for values below .20, 'fair' for values between .21 and .40, 'moderate' for values between .41 and .60, 'good' for values between .61 and .80, and 'very good' for values between .81 and 1.0 [14].

Results

Table 2 shows results of the first and the second repetition in each field-based test, correlation between these two results, the ICCs as well as differences between repetitions.

The ICCs were 'very good' for each field-based test. Correlation was strong for each field-based test ($r > 0.7$). There are not statistically significant differences between the first and the second repetition in 10 out of 11 field-based tests ($p > .05$) what it means that these 10 tests are reliable. Only for agility drill test the first repetition is statistically different compare to the second repetition ($p = .015$).

Table 2. Results and reliability of field-based tests for wheelchair basketball players

Field-based tests	mean	SD	SE	Min	Max	Correlation	p	ICC
3 m sprint 1 [sec.]	1.32	.18	.06	1.16	1.74	.895***	.870	.942
3 m sprint 2 [sec.]	1.32	.16	.05	1.15	1.58			
5 m sprint 1 [sec.]	1.97	.26	.09	1.67	2.46	.910***	.729	.940
5 m sprint 2 [sec.]	1.95	.21	.07	1.67	2.25			
10 m sprint 1 [sec.]	3.22	.27	.09	2.91	3.74	.927***	.643	.962
10 m sprint 2 [sec.]	3.20	.27	.09	2.91	3.59			
20 m sprint 1 [sec.]	5.50	.42	.14	4.98	6.26	.940***	.931	.969
20 m sprint 2 [sec.]	5.50	.43	.14	4.94	6.08			
pass basketball ball both hands from the chest 1 [m]	11.24	1.45	.48	10.00	13.40	.905***	.757	.942
pass basketball ball both hands from the chest 2 [m]	11.18	1.21	.40	9.80	13.20			
pass medicine ball both hands from the chest 1 [m]	6.24	.50	.17	5.50	6.90	.950***	.738	.968
pass medicine ball both hands from the chest 2 [m]	6.22	.59	.20	5.30	7.00			

bilateral handgrip 1 [N]	102.13	26.68	9.43	69.00	150.00	.989***	.056	.995
bilateral handgrip 2 [N]	105.25	26.10	9.23	74.00	154.00			
30-seconds sprint test 1 [m]	98.44	6.36	2.12	86.50	107.50	.982***	.312	.990
30-seconds sprint test 2 [m]	98.89	6.00	2.00	89.00	107.50			
10x5 m sprint test 1 [sec.]	23.72	1.67	.56	20.76	25.57	.941***	.053	.966
10x5 m sprint test 2 [sec.]	23.29	1.48	.49	20.54	24.80			
3-6-9 m drill test 1 [sec.]	15.81	1.06	.35	14.27	17.29	.806**	.205	.854
3-6-9 m drill test 2 [sec.]	15.52	.71	.24	14.09	16.33			
agility drill test 1 [sec.]	28.61	1.64	.55	26.68	31.24	.971***	.015*	.985
agility drill test 2 [sec.]	29.03	1.68	.56	26.60	31.36			

* p < .05; **p < .01; ***p < .001; 1 – the first repetition; 2 - the second repetition
SD – standard deviation; SE – Standard error of measurement; Min – minimum; Max – maximum; p – p-value (statistical difference); ICC – Intraclass Correlation Coefficient

Discussion

The aim of the present study was to assess test-retest reliability of the newly developed field-based tests focused on short time efforts with maximal intensity for wheelchair basketball players. To assess reliability of all tests three criteria were used. The first criterion was to analyze the interclass correlation coefficient (ICC > 0.8). The second criterion was to find correlations between two repetitions, were r > 0.7 means high correlation between results. The third criterion was to check differences between repetitions (p > 0.05). It is important to underline, that most authors checking reliability of tests use only correlation between results and establish the interclass correlation coefficient. We think that our approach, i.e. find also differences between the first and the second results repetition in a test is important to enhance the global assessment of test reliability.

The current study indicated that 10 out of 11 field-based tests for wheelchair basketball players are reliable except the agility drill test. There was significant difference between the first and the second repetition of this test. It is debatable why the agility drill test was not reliable. It seems that the agility drill test had the biggest number of technical components out of all test, i.e. slaloms, wheelchair turning, which could influence on the final results in this test. It means that probably wheelchair maneuvering is a differentiating factor. We suggest that in the future study all participants should have more time to familiarized with this type of tests, e.g. practice these tests during the training sessions. In our study, all participants had around 10 minutes to practice wheelchair maneuverability movements before the main repetition. On the other hand, maybe experience of participants had influence of results, and that is why the first and the second repetitions were different. We would recommend to add some exercises of wheelchair maneuvering as a regular part of the training practice in wheelchair basketball, because it seems that this is a part of specificity of wheelchair basketball game. It can be also an individual indication for an athlete who had significant difference between the first and the second repetition in the agility drill test that he should focus more time in their everyday wheelchair basketball practice into wheelchair skills like turning, pushing, changing directions, playing on-on-one, etc. Additionally, we would advise to check reliability of this test in elite wheelchair basketball players, to exclude the factor of wheelchair maneuverability on final results, because potentially these group of athletes is very good trained in terms of all wheelchair skills, and their repetitions of this type of tests, like the agility drill test, could be similar.

In the literature, it was noticed that it is difficult to establish reliability of tests where technical and shooting components are a main part testing. Vanlandewijck et al. [4] did not confirm reliability of the shooting test. De Groot et al. [5] showed that the pass-for-accuracy test and shooting tasks were not reliable. Also, De Witte et al. [1] confirmed that more complex activities in terms of wheelchair maneuverability were not reliable. All authors strongly underlined that further studies are needed to find technical and reliable tests for wheelchair basketball players.

On the other hand, all ten tests in the current study are closely related to short time effort with maximal intensity. Short time efforts with maximal intensity types of exercises are typical for wheelchair basketball game, and could be effective methods for players' training control. We would distinguish two groups of tests based of time of exercises and specificity of wheelchair basketball game. One

group is associated with explosive power like 3 m sprint, 5 m sprint, bilateral handgrip and pass basketball ball by both hands from the chest, pass medicine ball (3 kg) by both hands from the chest. The other group is connected to short time efforts with maximal intensity which take from 3 to 30 seconds: 10 m sprint, 20 m sprint, 3-6-9 m drill test, 30-seconds sprint test, and 10x5 m sprint test. It can be an indication for coaches that they can choose different types of tests and create their own batteries of tests to examine their players in terms of short time efforts.

Limitations and recommendations to the future studies

We recommend to check reliability of selected tests introduced in the current study in bigger groups of participants and divide players into two functional categories (based on IWBF classification rules). The reliability of proposed tests was checked by test-retest calculations in a one day. Short time efforts tests are easy to carry out test. We did not expect that the second repetition in the end of the day had influence on the final results, because players had long breaks, and they started after full rest. However, in the future studies, the second repetition of tests (retest) could be performed after some days, to avoid potential players' fatigue. We strongly enhance authors in the future studies to looking for different types of tests like shooting, wheeling and aerobic capacity tests specific for wheelchair basketball. It would be a base to create a complex battery of tests using by coaches in wheelchair basketball players' examination and selection.

Conclusions

In conclusion, we would recommend that verifying reliability of tests is necessary to check if there are significant differences between repetitions in the test-retest. The main application of our research is a confirmation of reliability of 10 field-based tests related to short time efforts with maximum intensity: 3 m sprint, 5 m sprint, 10 m sprint, 20 m sprint, pass basketball ball by both hands from the chest, pass medicine ball (3 kg) by both hands from the chest, bilateral handgrip, 3-6-9 m drill test, 30-seconds sprint test, and 10x5 m sprint test.

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