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Wheelchair basketball skill tests: differences between athletes' functional classification level and disability type

Bartosz MOLIK, Andrzej KOSMOL, James J LASKIN, Natalia MORGULEC-ADAMOWICZ, Kestas SKUCAS, Agnieszka DABROWSKA, Jan GAJEWSKI, Nevin ERGUN

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Research Article

B Molik, A Kosmol, N Morgulec-Adamowicz, J Gajewski, A Dąbrowska
Józef Piłsudski University of Physical Education,
Warsaw, Poland

JJ Laskin
University of Montana, School of Physical Therapy and Rehabilitation Science Missoula,
MT, USA

K Skucas
Lithuanian Academy of Physical Education,
Kaunas, Lithuania

N Ergun
Hacettepe University, Faculty of Health Sciences, Department of Physiotherapy and Rehabilitation,
Ankara, Türkiye

Address correspondence to:
Bartosz Molik
Katedra Teorii i Metodyki Nauczania Ruchu,
Wydział Rehabilitacji,
Akademia Wychowania Fizycznego w Warszawie
Warszawa 00-968,
ul. Marymoncka 34
E-mail: b_molik@poczta.onet.pl
bartosz.molik@awf.edu.pl

Purpose: The aim of this study was to evaluate wheelchair basketball skills in athletes representing the different functional classification levels and various types of disabilities. **Materials and methods:** One hundred nine athletes from the Polish and Lithuanian national wheelchair basketball leagues participated in the study. Six standardized skill tests were included: 20-m sprint, two-handed chest pass, slalom without the ball, slalom with the ball, modified Cooper 12-minute test, and the envelope drill. **Results:** The results demonstrated that there were observable differences between the skill tests performance and the functional classes; the higher functioning classes performed better. However, there was no significant difference between functional classes 1 and 2, as well as between classes 3 through 4.5 ($p>0.05$). **Conclusion:** Regardless of the classification level, athletes with cerebral palsy consistently performed the poorest. A reexamination of athletes with cerebral palsy and how they fit into the functional classification system should be undertaken.

Key words: Functional classification, Motor skills, Basketball; wheelchair.

Tekerlekli sandalye basketbolunda beceri testleri: sporcuların fonksiyonel sınıflandırma düzeyleri ve özür tipleri arasındaki faklılıklar

Amaç: Bu çalışmanın amacı, farklı sınıflandırma düzeyinde ve değişik özür tiplerindeki sporcularda tekerlekli basketbol becerilerini değerlendirmekti. **Gereç ve yöntem:** Polonya ve Litvanya ulusal basketbol liginden 109 sporcu çalışmaya katıldı. Altı adet standardize beceri testi kullanıldı: 20 m sürat, topu iki elle göğüsten fırlatma, topsuz slalom, topla slalom, modifiye 12-dakika Cooper testi ve zarf çalışması. **Sonuçlar:** Sonuçlar, beceri testi performansı ve fonksiyonel sınıflamalar arasında belirgin farklar olduğunu gösterdi; daha üst düzey fonksiyonel seviyedekiler daha iyi performans gösterdiler. Fonksiyonel seviye 1 ile 2 ve fonksiyonel seviye 3 ile 4 ve 4.5 arasında önemli bir fark yoktu ($p>0.05$). **Tartışma:** Sınıflandırma düzeyine bakılmaksızın, serebral palsili sporcular en zayıf performansı gösterdiler. Bu nedenle, serebral palsili sporcuların tekrar değerlendirilmeleri ve fonksiyonel sınıflandırma sistemlerinin düzenlenmesi gerekliliği sonucuna varıldı.

Anahtar kelimeler: Fonksiyonel sınıflandırma, Motor yetenekler, Basketbol; tekerlekli sandalye.

The functional classification model was formally adopted by International Wheelchair Basketball Federation (IWBF) in 1982, except in the United States.[1] Individuals with permanent locomotors disabilities are classified based on their functional abilities into five main classes 1 (1.0-1.5 points; athletes with lowest level of functional ability), 2 (2.0-2.5 points), 3 (3.0-3.5 points), 4 (4.0 points) and 4.5 (4.5 points; those with a minimal disability).[1,2] To ensure that all athletes regardless of functional abilities have equitable opportunities to participate in wheelchair basketball the sum of points (classification level) of the five players on the court cannot be higher than 14 points.

Batteries of skill tests have been created to address the specific needs of a given sport; wheelchair basketball is no exception. According to Thibouthot,[3] the analysis of skills demonstrated by wheelchair basketball athletes could be beneficial in the classification process.

Brasile and Hedrick,[4] used skill tests to evaluate of IWBF functional classification system. Their recommendation was as follows: Class I – IWBF 1.0, Class II – IWBF 1.5 and 2.0, and Class III – IWBF 2.5 through 4.5. In addition they proposed to reduce the team point limit from 14 to 12. Molik and Kosmol,[5] in a pilot study did not find any significant differences between the performances of athletes in classes 3 and 4. Other authors have also used skill test performances to examine the National Wheelchair Basketball Association (NWBA) medical classification system.[6-8] Brasile proposed a reduction in the number of classes from three to two. In addition the team point limit should be reduced to 8.[6,7] Doyle et al,[9] using the 20-m sprint test, support the proposal by Brasile.[6,7]

For the most part previous studies utilized fairly small sample sizes. Our goal for this study was to recruit a significantly larger sample size. The relationship between skill test performance and common disability types has not been evaluated. From a practical point of view this data may help develop reference values that are needed for the development of training programs. The aim of this study was to evaluate wheelchair basketball skills in athletes representing the different functional classification levels and various types of disabilities.

MATERIALS AND METHODS

One hundred nine wheelchair basketball athletes from the Polish and Lithuanian leagues volunteered for this study. These individuals were at least 17 years of age, had at least one year of experience and consistently played throughout the league's season. In addition all of the athletes actively participated in regular training sessions.

The participants were grouped into the five main classes (1, 2, 3, 4, and 4.5) according to the IWBF's functional classification system.[1,2] For purpose of this study the athletes were also divided into six disability groups: minimal disability, lower extremity amputees, high spinal cord injuries (T9 level and above), low spinal cord injuries (below T9 level), cerebral palsy and those with other locomotor disabilities (i.e. poliomyelitis, leg-length discrepancy). Athletes' characteristics are provided in Table 1.

To evaluate the skills of wheelchair basketball athletes we selected six tests based on the literature and the authors' prior experience: 20 m sprint, two handed chest pass (distance covered), slalom without the ball, slalom with the ball, modified Cooper test (line to line wheeling for a distance of 24 m each way), envelope drill.[8,10-14] The reliability for all of these tests has been documented in prior studies.[10] Moreover reliability of the 20 m sprint was reported by Vanlandewijck et al.[8,11] The two-handed chest pass is an established skill test for able-body basketball players,[12] and has been universally adopted for individuals with disabilities.[13] Vanlerberghe and Slock also introduced a test for wheelchair basketball athletes (called "pass for distance" best of 6 trials).[14] Slalom without the ball was a modification made by the current authors of similar test established by Bolach.[15] The Cooper test was modified for wheelchair basketball athletes by the test being completed in a gymnasium.

The envelope drill is another universal able-bodied basketball skill test and was adapted for wheelchair users.[16] The test was adapted for wheelchair basketball from the traditional three loops to two loops but changing directions for the second loop. This adaptation requires the wheelchair athlete to have to turn their chair to the right and left – a potential discerning factor in classification.

Athletes performed each of the skill tests in their own competitive wheelchair using whatever stabilization and strapping used in competition. All the adaptations to the wheelchairs were in accordance with IWBF regulations. Some of athletes did not choose to participate in of the all tests, therefore there are varying sample sizes for each of the six skill tests.

Statistical analysis:

Data were analyzed using SPSS 14.1 program. One-way analysis of variance (ANOVA) was used to compare groups across functional classification levels and for the type of disability for each of the skill tests. Tukey's analysis was used when indicated for post-hoc comparisons. An alpha level of $p<0.05$ in both parametric and non parametric analysis was the criterion for statistically significant difference among groups.

References values were created for athletes in category A (no pelvic stability) and category B (active pelvic stability) for each test. Those values were based on average values, and standard deviations values (±1SD, and ±2SD).

Table 1. Characteristics of wheelchair basketball athletes.

Groups (Classes)	N	Age (years)	Sport exp. (years)	Weight (kg)	Height (cm)	Rich of arm (cm)	Function
1	26	30.2±8.2	4.9±3.9	70.7±9.9	173.3±20.5	175.7±8.0	wc = 25 wc/l = 1 l = 0
2	25	28.8±7.7	4.5±2.6	74.5±11.9	175.3±6.9	175.7±10.1	wc = 23 wc/l = 0 l = 2
3	24	30.7±7.8	7.7±5.4	72.7±14.6	178.7±5.6	186.4±8.9	wc = 6 wc/l = 10 l = 8
4	16	27.6±6.5	6.4±6.5	75.2±9.9	179.6±5.6	201.4±9.2	wc = 0 wc/l = 1 l = 15
4.5	18	26.1±5.9	4.4±2.3	78.0±11.8	180.8±7.6	197.2±12.3	wc = 0 wc/l = 0 l = 18
Total	109	28.9±7.5	5.6±4.5	73.9±11.9	177.1±11.7	185.7±13.8	wc = 54 wc/l = 12 l = 43

wc: full-time wheelchair users, l: athletes with walking function during the day, wc/l: athletes use wheelchair or walking depend on the daily activity and distance.

RESULTS

Statistical analysis did not reveal any significant differences in performance between functional classes 1 and 2 as well as classes 3 through 4.5 ($p>0.05$, Table 2). Of these skill tests the two-handed chest pass test, and 20-m sprint test showed greatest differences between the functional classes ($p<0.05$).

Significant differences between six disability groups were observed ($p<0.05$, Table 3). Significant differences were found between those with cerebral palsy and high-level lesion paraplegia as compared to all others locomotor disabilities. Those with cerebral palsy and high-level lesion spinal cord injuries consistently demonstrated the lowest levels of performance. A difference was found in the performance of the 20-m sprint test between low-level lesion spinal cord injuries and lower extremity amputees ($p<0.05$). No other statistical differences were found between athletes with low-level lesion spinal cord injuries, lower extremity amputees, minimal disability, and other locomotors disabilities ($p>0.05$).

The observed similarities in performance across the six skill tests between athletes in functional classification category A (1-2.5 points) and category B (3-4.5 points) provided us the opportunity to establish group specific typical values for each test (Table 4).

DISCUSSION

The results showed that individuals assigned to higher classes consistently performed best. However, our analysis did not demonstrate significant differences between all functional classes. There were no significant differences found between functional classes 3, 4 and 4.5. The results were reporting similarities of those three classes representing functional category B (active pelvic stability). The observation that the best performances were not obtained by those in class 4.5 suggest that their technique of wheeling, and fitness may be less than those in classes 4 and 3. Players representing class from 3 to 4.5 are primarily differentiated by trunk stabilization in frontal plane. This stability and control is critical differences for ball rebounding during the basketball game. However, this movement was not included in any of the six tests utilized in this study. Differences between these category B athletes could be demonstrated in a future study and/or looking at game efficiency analysis.

Our data demonstrated similarities in skill performance between those in category A (class 1 and 2). From a functional point of view, any differences in trunk stabilization between classes would be the main factor influencing the results of skill tests.

Brasile and Hedrick proposed a recombination of athletes into a three class system: class I for 1 players, class II for players from 1.5 and 2 and class III for individuals from higher levels.[4] The current study supports the finding of a similarity in skill performance between athletes' in classes from 3 to 4.5. We are unsure of the proposed separation of 1 players from 1.5 due to the small number of athletes used in Brasile and Hedrick study (only five athletes included into group 1 and 3 included into group 1.5).[4] This sample size may not provide sufficient evidence to demonstrate significant differences between these low point athletes. Due to the small number of 1.5 players recruited into this study we were also unable to divide class 1 athletes into two groups, 1 and 1.5. Future research should focus on the recruitment of lower class athlete's in order to determine if there are any differences in performance between those in functional classification 1.0 and 1.5. On the other hand our data did not reveal any differences in skill test performance between class 1 and 2 players.

Molik and Kosmol also proposed a three-functional class classification system.[5] Class 1 and 2 for those with the least functional ability, and amalgamation of IWBF classes 3 and 4 to create class which would combine IWBF classes from 3 to 4.5. However, our data does not support the amalgamation of IWBF classes 2 and 3.

Analysis of skill tests performance using the athlete's type of disability was a novel component to this study. Results of this disability-oriented analysis confirm that the performance of the skill tests is indeed related to their athletes' level of function, which corresponds to their disability diagnosis. Those with high lesion level paraplegia demonstrated the lowest levels of performance and were all classified as class 1. The results confirm suitable classification level athletes with higher level of physical disability. Athletes with cerebral palsy also tended to have the poorest performances across all the skill tests in spite of them being classified as high as 4 (ranged from 1 to 4). This finding suggests at least for athletes with cerebral palsy some consideration should be made for their medical diagnosis. However, due a small sample size further study is needed. In practice athletes with cerebral palsy athletes are an exception in high level wheelchair basketball, primarily due to their low performance in a comparison to others in their classification level. A modification in the classification of athlete's with cerebral palsy might increase their chances for success and participation in wheelchair basketball.

Our data has suggested that the reexamination of the functional classification system in wheelchair basketball should be considered. Our investigation supports previous research that the combination of the current classes may simplify the classification system and make it more effective and equitable. However, skill performance results cannot be the only criterion used to determine a new classification distribution. Besides the use of skill testing, other authors have used a variety of criteria to evaluate the current functional classification system. Vanlandewijck et al,[17] Molik and Kosmol,[18] and Vanlandewijck et al,[19,20] have been used game efficiency to evaluate the classification system. Vanlandewijck et al,[21] Nyland et al,[22] and Malone et al,[23] used biomechanical analysis (wheelchair propulsion, shoulder rotator torque, shooting mechanics) to determine if any differences exist between classification levels. Hutzler,[24] Hutzler et al,[25] and Vanlandewijck et al,[17,21] have used aerobic and anaerobic performance for comparison wheelchair basketball athletes across the range of functional classifications. The majority of these studies have

Table 2. Comparison results of skill tests between athletes represent different functional classes.

	Functional classes					*Differences between the classes*									
	1	2	3	4	4.5	1 vs. 2	1 vs. 3	1 vs. 4	1 vs. 4.5	2 vs. 3	2 vs. 4	2 vs. 4.5	3 vs. 4	3 vs. 4.5	4 vs. 4.5
Sprint 20 m (s)	6.54 ±0.74 n=24	6.24 ±0.85 n=24	5.68 ±0.66 n=24	5.49 ±0.44 n=16	5.63 ±0.44 n=15	0.54	0.01*	0.01*	0.01*	0.04*	0.01*	0.06	0.91	0.99	0.98
Two-handed chest pass (m)	8,89 ±1.75 n=26	9.52 ±1.37 n=25	10.49 ±1.81 n=24	11.81 ±1.59 n=16	11.09 ±1.97 n=18	0.68	0.01*	0.01*	0.01*	0.27	0.01*	0.03*	0.12	0.79	0.73
Slalom without the ball (s)	10.98 ±1.93 n =25	10.18 ±1.67 n=24	9.22 ±1.07 n=24	9.05 ±0.77 n=16	9.92 ±0.84 n=18	0.28	0.01*	0.01*	0.11	0.13	0.10	0.98	0.99	0.49	0.37
Slalom with the ball (s)	14.40 ±3.50 n =25	12.79 ±2.68 n=24	10.92 ±2.23 n=24	10.47 ±1.25 n=16	11.93 ±1.43 n=18	0.16	0.01*	0.01*	0.01*	0.08	0.04*	0.80	0.98	0.70	0.44
Modified Cooper test (m)	1748 ±246 n=19	1803 ±242 n=17	1971 ±227 n=18	2070 ±116 n=11	2002 ±141 n=13	0.94	0.02*	0.01*	0.01*	0.14	0.01*	0.09	0.74	0.99	0.93
Envelope drill (s)	26.22 ±3.27 n=16	26.19 ±2.90 n=14	23.18 ±1.45 n=19	22.69 ±1.28 n=9	24.94 ±2.19 n=11	0.99	0.01*	0.01*	0.65	0.01*	0.01*	0.70	0.98	0.31	0.23

* p<0.05 (Post Hoc Tukey's test).

Table 3. Comparison results of physical ability tests between athletes represent different disability groups.

	Type of disability: classification range					
	HP	LP	A	CP	O	MD
	1-1.5	1-3	3-4.5	1-4	1-4.5	4,5
20 m sprint (s)	6.75 ±0.81 n=13	6.05 ±0.61 n=33	5.51 ±0.48 n=30	6.96 ±1.22 n=7	5.67 ±0.39 n=13	5.71 ±0.49 n=7
Two-handed chest pass (m)	8.49 ±1.53 n=14	9.89 ±1.36 n=34	11.07 ±1.83 n=30	8.49 ±2.07 n=8	10.94 ±2.14 n=14	11.23 ±1.87 n=9
Slalom without the ball (s)	11.44 ±2.29 n=14	9.86 ±0.96 n=32	9.11 ±0.80 n=30	11.59 ±2.51 n=8	9.56 ±1.09 n=14	9.78 ±0.70 n=9
Slalom with the ball (s)	14.90 ±3.97 n=14	12.32 ±2.12 n=32	10.61 ±1.24 n=30	15.54 ±4.35 n=8	11.27 ±1.48 n=14	12.02 ±1.56 n=9
Modified Cooper test (m)	1620 ±193 n=10	1886 ±209 n=24	2039 ±176 n=22	1500 ±75 n=4	2013 ±164 n=11	1949 ±152 n=7
Envelope drill (s)	27.41 ±4.12 n=8	24.78 ±1.75 n=21	23.17 ±1.50 n=21	27.12 ±4.67 n=5	24.09 ±1.88 n=9	25.34 ±2.94 n=5

A: lower extremity amputees, CP: cerebral palsy, HP: high spinal cord injuries (T9 level and above), LP: low spinal cord injuries (below T9 level), MD: minimal disability, O: other locomotors disabilities.* p<0.05 (Post Hoc Tukey's test).

Table 3. Comparison results of physical ability tests between athletes represent different disability groups ***(continued)*****.**

	Differences between the disability groups														
	HP vs. LP	HP vs. A	HP vs. CP	HP vs. O	HP vs. MD	LP vs. A	LP vs. CP	LP vs. O	LP vs. MD	A vs. CP	A vs. O	A vs. MD	CP vs. O	CP vs. MD	O vs. MD
20 m sprint (s)	0.01*	0.01*	0.98	0.01*	0.01*	0.01*	0.01*	0.43	0.79	0.01*	0.98	0.97	0.01*	0.01*	0.99
Two-handed chest pass (m)	0.12	0.01*	0.99	0.01*	0.01*	0.08	0.31	0.39	0.31	0.01*	0.99	0.99	0.02*	0.02*	0.99
Slalom without the ball (s)	0.01*	0.01*	0.99	0.01*	0.04*	0.25	0.02*	0.98	0.99	0.01*	0.90	0.78	0.01*	0.07	0.99
Slalom with the ball (s)	0.01*	0.01*	0.99	0.01*	0.06	0.06	0.01*	0.74	0.99	0.01*	0.95	0.62	0.01*	0.03*	0.98
Modified Cooper test (m)	0.01*	0.01*	0.88	0.01*	0.01*	0.06	0.01*	0.40	0.97	0.01*	0.99	0.87	0.01*	0.01*	0.98
Envelope drill (s)	0.11	0.01*	0.99	0.07	0.67	0.28	0.40	0.98	0.99	0.02*	0.93	0.48	0.24	0.86	0.94

A: lower extremity amputees, CP: cerebral palsy, HP: high spinal cord injuries (T9 level and above), LP: low spinal cord injuries (below T9 level), MD: minimal disability, O: other locomotors disabilities.* p<0.05 (Post Hoc Tukey's test).

Table 4. Typical skill test values (references) for wheelchair basketball athletes.

	Values	Category A (1-2.5)	Category B (3-4.5)
20 m sprint (s)	Very good	<5.6	<5.1
	Good	6.4-5.6	5.6-5.1
	Below average	7.2-6.4	6.2-5.6
	Poor	>7.2	>6.2
Two-handed chest pass (m)	Very good	>10.8	>12.9
	Good	9.2-10.8	11.0-12.9
	Below average	7.6-9.2	9.2-11.0
	Poor	<7.6	<9.2
Slalom without the ball (s)	Very good	<8.8	<8.4
	Good	10.6-8.8	9.4-8.4
	Below average	12.4-10.6	10.4-9.4
	Poor	>12.4	>10.4
Slalom with the ball (s)	Very good	<10.4	<9.3
	Good	13.6-10.4	11.1-9.3
	Below average	16.8-13.6	12.9-11.1
	Poor	>16.8	>12.9
Modified Cooper test (m)	Very good	>2016	>2185
	Good	1774-2016	2006-2185
	Below average	1531-1774	1827-2006
	Poor	<1531	<1827
Envelope drill (s)	Very good	<23.2	<21.7
	Good	26.2-23.2	23.6-21.7
	Below average	29.3-26.2	25.4-21.7
	Poor	>29.3	>25.4

found similarities between some classes and many have proposed changes to the classification system. Ultimately only a combination of research methods and designs should be used in the development of a revised classification model.

Continued research is needed to demonstrate any differences between types of disabilities. Unfortunately in this study there was not a sufficient a sample size of athletes with minimal disability and cerebral palsy to make anything other then recommendations. Future studies could add in their analysis yet another factor; player position (i.e. guard, center, and playmaker).

CONCLUSION

The results of this study showed the similarities and differences between athletes across classification level and disability type. Significant similarities were found between functional classes 1 and 2, as well as between classes 3 through 4.5.

The argument for a separate classification level for those currently in class 1 was not supported by this study's data. The literature demonstrated a preponderance of evidence that supports a modification of the current IWBF functional classification system. However, this process should take into account more then just one methodology. Our results support the notion that athletes with high lesion level paraplegia are classified correctly. However, a reexamination of athletes with cerebral palsy is warranted, as it appears from our data that although many may have the functional ability of a higher class their actual performance is very low.

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