Functional classification and performance in wheelchair basketball

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Abstract

Wheelchair basketball players are classified into four classes based on the International Wheelchair Basketball Federation competition system. The aim of this study was to investigate whether the IWBF functional classification for wheelchair basketball was related to different performance field-based tests. Forty wheelchair basketball athletes took part in the study. The players carried out five field tests, three of which were quantitative, related to the three conditional skills (strength, endurance and speed test) and two of the qualitative type (accuracy and shooting ability tests). Pearson's correlation was performed to analyse the correlation between the score obtained from functional classification and the results of the wheelchair performance tests. The IWBF class was not correlated (p <0.05) with any of the tests performed. Players with even major injuries, in their best wheelchair set-up, even achieved better times than upper-class players; therefore, the disability factor in these tests is not an index that determines performance disadvantage. The study shows that the functional classification does not affect the qualitative-quantitative performance, so the disabled athlete with a lower score is not disadvantaged in basketball.

***Keywords*:** Functional classification, Wheelchair basketball, Disability, Inclusive education

INTRODUCTION

Wheelchair basketball is a sport characterised by the complexity of individual and team technical-tactical choices, which reproduce in all respects of a basketball match for non-disabled people (Altavilla & Raiola, 2015). It is a situational sport, where players must be able to immediately predict what will happen in a particular area of the pitch (spatial anticipation of the movement) and when the event will occur (time anticipation) (Altavilla & Raiola, 2019). In this way, the action can be organised in advance and carried out at the right time (Altavilla & Raiola, 2014). It is also a team sport, so communication can be a fundamental component to understanding one's teammates (D'Elia et al., 2020; Raiola et al., 2015). Non-verbal communication is essential because it allows athletes to communicate without the opponent listening to their strategies (Raiola, 2015; Raiola & D'Isanto, 2016).

Regarding the quantitative aspects in wheelchair sports (fencing, basketball, tennis, athletics), high average values of VO2max were detected on athletes, corresponding to average intensities equal to 70% of VO2max (Boccia et al., 2019). The maximum values of VO2max and heart rate recorded on the court in wheelchair basketball are similar to the values measured in the laboratory (Yanci et al., 2015). In the high-level disabled athlete, to ensure an adequate evaluation, clinical and functional, it would be advisable to perform an integrated cardiopulmonary exercise test (Coutts & Mackenzie, 1995). The standard reference values of VO2max in people with paraplegia are around 20–25 ml/ kg/ min for sedentary and 30–40 ml/kg/min or higher for trained athletes (Castagna et al., 2008; Hutzler, 1993). The metabolic commitment is mixed due to the succession of actions that can last even minutes, given the immediate succession of a defensive action after the offensive one (Gaetano et al., 2016). As for the conditional skills used in wheelchair basketball, the athlete needs a level of strength that allows them to develop agility and speed adequately (Di Domenico et al., 2019). The qualitative aspects are very similar to basketball for the non-disabled, except for some variations in the execution of technical gestures and the regulation (Altavilla et al., 2020). Wheelchair basketball players show differences in the movement of the trunk and arms in the execution of technical gestures due to the residual motor possibilities that differentiate the players of the various classes (Cascone et al., 2020).

For each level of disability, particular biomechanical situations are created: some muscles are indispensable for a given movement, and many others are useful [20]. Wheelchair basketball was the first Paralympic sport to use functional classification (Boccia et al., 2019; Pivik et al., 2002). The classification system of the International Wheelchair Basketball Federation (IWBF) was introduced in 1984. For the first time, the classification strictly linked to medical diagnosis and assessment on the couch was abandoned, introducing technical assessment of the sporting gesture directly on the competition field (Cassese & Raiola, 2017). Currently, the classification criteria derive from a summary that considers both the evaluation of a physician and a technician (Morgulec-Adamowicz et al., 2011; Vanlandewijck et al., 1995). This summary of the judge determines the functional evaluation. The classification system of the IWBF is constantly evolving and is based on the observation of the residual functional abilities demonstrated by the players on the field. The number of classes currently in use for wheelchair basketball is 4, from 1 to 4 and 4 other intermediate classes: 1.5–2.5–3.5–4.5 (when it is difficult to place the player in the four classes or when special situations arise). The lowest classes are assigned to players with greater disabilities and reduced physical abilities (Vanlandewijck et al., 1995). Higher classes are assigned to players with minimal loss of functional skills. In the major competitions established by IWBF, the limit that a team must respect is the score of 14, or 14.5, the sum derived from the total score of the five players on the field (Gil et al., 2015; Vanlandewijck et al., 1995). Consequently, it is interesting to know if the classification as mentioned above also reflects the functional performance of wheelchair athletes while they are practising their sport. In this respect, to our knowledge, only a few studies have attempted to identify the relationship between the functional IWBF classification and performance. We hypothesised that there would be a correlation between the different levels of the classification and the performance in a wide range of field-based tests.

The aim of this study was to investigate whether the IWBF functional classification for wheelchair basketball was related to performance in short- (strength, speed and technical skills) and long-duration (endurance) field tests.

MATERIALS AND METHODS

Participants

Forty male wheelchair basketball players (Age=33.30 ± 8.01 years) from teams competing in Serie B participated in this study. All of them conducted three training sessions and played one match every week. Written informed consent was received from all players after submission of the experimental design and potential risks of the study. They were classified according to the Classification Committee of the IWBF as: class 2 (n=10), class 3 (n=10), class 4 (n=10) and class 4.5 (n=10). Thus, players were grouped into categories (classes) from 2.0 (being the player with the least physical functions) to 4.5 (being the player with the most physical functions). This classification was the players' "playing points", and at any given time in a game, the five players on the court must not exceed a total of 14 playing points. Each player had to pass a medical examination to determine his class to play. The classifiers carried out this examination.

Study Design

The authors declare that the procedures were followed according to the regulations established by the Clinical Research and Ethics Committee and to the Helsinki Declaration of the World Medical Association. The study was carried out over two weeks, where different tests were carried out in different sessions. These tests are easier to execute and interpret, and they also mimic more closely the actions and the movements of the training sessions and games, representing the performance of the athletes in a more exact way. They are the most used to evaluate the qualitative and quantitative performance of wheelchair basketball (Gil et al., 2015). The first quantitative test used was that of strength, where participants had to throw a 5 kg medicine ball as far as possible (De Groot et al., 2012) (Figure 1). The distance was measured in meters. Each participant made three attempts, and the best was used for further analysis.

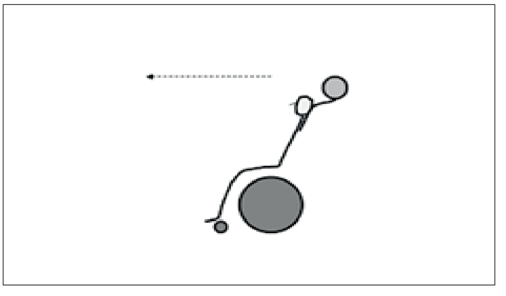

Figure 1. Strength test

The workouts performed before the execution of the test to improve strength were:

- Multiple workout stations with constant load and number of repetitions. For example, 3 series of 10 repetitions at 70% of the maximum load, with a variation of the load level and a constant number of repetitions; or 10 repetitions at 50% of the load, with constant intensity and variation in the number of repetitions.
- Pyramid training: progressive decrease or increase in the load level and inversely proportional relationship between the number of repetitions and the intensity of the load. Load intensity between 60% and 100%; repetitions between 1 and 8; sets of 5 to 10 per exercise.
- Circuit Training: technical-conditional circuits with and without tools, with or without the ball.

The second quantitative test performed was that of speed. It consisted of sprinting over 20 meters starting from the baseline. Performance was measured using electronic timing lights positioned at 5 m and 20 m and placed 0.4 m above the ground with an accuracy of ±0.001 s. The starting position of the players was 0.5 m before the first timing light. The test was performed three times with 2 min of recovery in between. The best result was used for further analysis.

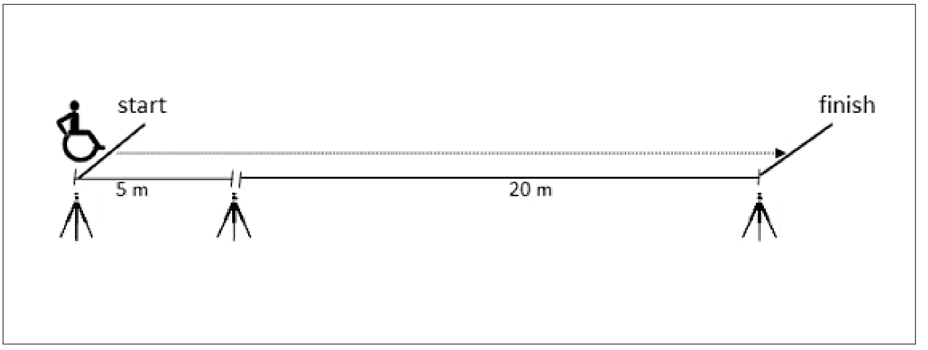

Figure 2. Speed test

The workouts were aimed at improving the speed of action with and without the ball, the reaction speed, deciding in the shortest possible time the most effective action among all possible. The last test used to analyse the quantitative aspects was the endurance test. Level 1 version of the Yo-Yo test was completed according to previously described methods (Invernizzi et al., 2020). Due to the differences between running and propelling the wheelchair, the distance covered in the shuttle run was reduced to 10 m (Figure 3). The number of laps completed for 2 minutes were counted for the set time.

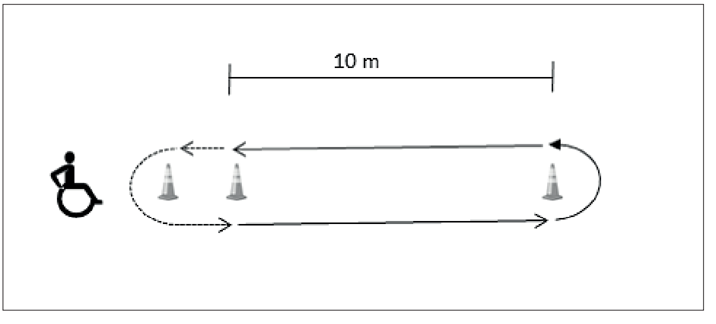

Figure 3. Endurance test

Circuits characterised by situational exercises were used to train endurance, with high demands on speed and precision of movement. There were two main objectives:

– perform the motor task even in case of fatigue. In 60 seconds of work, perform 30–40 repetitions. Recovery time: 30–45".
– work at a fast pace for 1 minute with 15 seconds of rest.

On the other hand, the accuracy-test and the shooting ability test were carried out among the qualitative tests. In the accuracy test, the player was required to shoot from an initial distance of 8m towards a target (30x30cm square) placed 1.20 m above the ground. The player could gradually advance until he was able to shoot from a maximum distance of 4 m. The overall score was added by assigning 1 point for each basket made from 4 m and 2 points from 8 m. The test lasted 2 minutes. The second qualitative test performed was the shooting skill test. Starting from the free-throw line, all successful throws have been added up for a time of 2 minutes.

Statistical Analysis

The normality of data was tested using the Shapiro–Wilk test. As the data followed a normal distribution, parametric tests were used for further analysis. To analyse the correlation between different variables the Pearson's correlation was performed. Statistical analyses of the data were performed using the Statistical Package for Social Sciences software (IBM SPSS Statistics for Windows, version 25.0. Armonk, NY).

RESULTS

Concerning the athletes with a functional classification of 2.0, the best result obtained in the strength test, i.e., throwing the ball weight by 3kg, was 5.4 m; the worst throw was 3.3 m. In the speed test, the fastest player was the one who covered the 20 meters in 2.89 seconds; the slowest was the one who covered 20 meters in 5.01 seconds. In the endurance test, the best result was 21 laps; the worst was 7 laps. The best result of accuracy was 69, while the worse was 23. The best result in the shooting ability test was 26 baskets; the worst was 11. A detailed description is shown in Table 1.

Table 1. Results of the tests performed by the athletes with the functional classification of 2.0.

Athletes	Functional classification	Strength test [m]	Speed test [s]	Endurance test [laps]	Accuracy test	Shooting ability test
1	2	4.3	3.75	8	36	16
2	2	3.3	3.60	11	23	18
3	2	5.0	4.25	10	27	15
4	2	3.8	4.83	12	30	11
5	2	4.7	3.21	8	32	26
6	2	4.5	4.59	21	23	25
7	2	5.4	3.63	20	69	18
8	2	4.9	2.89	7	23	16
9	2	5.3	3.23	8	41	18
10	2	4.9	5.01	20	47	21
Mean ± SD		4.6 ± 0.6	3.8 ± 0.7	12.5 ± 5.6	35.1 ± 14.4	18.4 ± 4.5

Regarding the athletes with a functional classification of 3.0, the best result obtained in the strength test was 6.9 m; the worst throw was 2.9 m. In the speed test, the fastest player was the one who covered the 20 meters in 2.98 seconds; the slowest was the one who covered 20 meters in 6.01 seconds. In the endurance test, the best result was 26 laps; the worst was 14 laps. The best result of accuracy was 57, while the worse was 28. The best result in the shooting ability test was 27 baskets; the worst was 11. A detailed description is shown in Table 2.

Table 2. Results of tests performed by athletes with the functional classification of 3.0

Athletes	Functional classification	Strength test [m]	Speed test [s]	Endurance test [laps]	Accuracy test	Shooting ability test
1	3	4.3	3.75	18	49	13
2	3	4.3	4.73	19	46	17
3	3	6.9	3.53	26	28	15
4	3	5.5	5.19	19	30	24
5	3	4.0	4.01	20	57	16
6	3	5.7	5.23	22	36	27
7	3	2.9	6.01	14	37	11
8	3	4.3	4.73	19	48	17
9	3	7.0	2.98	22	48	28
10	3	6.1	5.27	18	40	25
Mean ± SD		5.1 ± 1.3	4.5 ± 0.9	19.7 ± 3.1	41.9 ± 9.2	19.3 ± 6.1

In the athletes with a functional classification of 4 (Table 3), the best result obtained in the strength test was 9.3 m; the worst throw was 4 m. In the speed test, the fastest player was the one who covered the 20 meters in 2.98 seconds; the slowest was the one who covered 20 meters in 5.27 seconds. In the endurance test, the best result was 26 laps; the worst was 15 laps. The best result of accuracy was 61, while the worse was 33. The best result in the shooting ability test was 28 baskets; the worst was 15. A detailed description is shown in Table 3.

Table 3. Results of tests performed by athletes with the functional classification of 4.0

Athletes	Functional classification	Strength test [m]	Speed test [s]	Endurance test [laps]	Accuracy test	Shooting ability test
1	4	6.1	5.27	18	37	25
2	4	9.3	3.60	23	33	27
3	4	4.3	4.73	19	33	17
4	4	6.9	3.53	26	37	15
5	4	5.5	5.19	19	50	24
6	4	4.0	4.01	20	22	26
7	4	5.7	5.23	22	43	17
8	4	4.7	3.52	16	61	19
9	4	4.0	2.98	15	33	28
10	4	4.1	5.27	18	47	15
Mean ± SD		5.4 ± 1.6	4.3 ± 0.8	19.6 ± 3.3	39.6 ± 10.9	21.3 ± 5.1

Finally, regarding the athletes with a functional classification of 4.5, the best result obtained in the strength test was 6.9 m; the worst throw was 3.9 m. In the speed test, the fastest player was the one who covered the 20 meters in 2.89 seconds; the slowest was the one who covered 20 meters in 5.27 seconds. In the endurance test, the best result was 26 laps; the worst was 8 laps. The best result of accuracy was 67, while the worse was 27. The best result in the shooting ability test was 27 baskets; the worst was 15. A detailed description is shown in Table 4.

Table 4. Results of tests performed by athletes with functional classification of 4.5

Athletes	Functional classification	Strength test [m]	Speed test [s]	Endurance test [laps]	Accuracy test	Shooting ability test
1	4,5	3,9	2,89	9	64	25
2	4,5	6,1	5,27	18	47	25
3	4,5	4,3	3,23	8	67	27
4	4,5	4,9	5,01	26	39	23
5	4,5	4,3	4,73	19	53	17
6	4,5	6,9	3,53	12	27	15
7	4,5	5,5	5,19	19	50	24
8	4,5	4,0	4,01	11	32	26
9	4,5	5,0	4,25	19	38	21
10	4,5	6,8	4,83	18	56	15
Mean ± SD		5.17 ± 1.1	4.2 ± 0.8	15.9 ± 5.6	47.3 ± 13.2	21.8 ± 4.5

Pearson's test found no significant correlation between IWBF and wheelchair performance tests. A detailed description is shown in Table 5.

Table 5. Correlations amongst IWBF and wheelchair performance tests.

	Functional Classification	Strength test	Speed test	Endurance test	Accuracy test	Shooting ability test
Pearson Correlation	1	0.207	0.146	0.274	0.295	0.272
Sig. (2-tailed)		0.200	0.370	0.087	0.064	0.090
N	40	40	40	40	40	40
Mean ± SD		5.08 ±1.2	4.2±0.8	16.9±5.3	40.9±12.4	20.2±5.1

DISCUSSION

From the results obtained, we can summarise by stating that there are no significant correlations between the score obtained from functional classification and the results of the wheelchair performance tests in basketball. In the present study, we analysed the relationship among the IWBF classification with various field-based tests designed to measure speed, accuracy, technique, strength, power and endurance performance in a team of wheelchair male basketball players. From Table 5, no significant correlation was found between IWBF and wheelchair performance tests. Players with a high rating (≥3.0 points) were expected to perform better than players with a low rating (≤2.5 points), but this didn't happen. More precisely, amputee players were expected to benefit from a privileged state of muscle function over athletes with spinal paralysis (Molik et al., 2010), but this did not happen. Players with even severe injuries, in their wheelchair performance, even scored better times than upper-class players; therefore, the disability factor in this test is not an index determining the performance disadvantage. Regarding the correlation between the results of the strength test carried out and the score class of the players, we note a small increase in strength from athletes with ratings 2 to 4. At the same time, between 4 and 4.5, there is a slight decrease (not significant from a statistical point of view). We justify this result because the pelvic stability on the wheelchair allows ample executive possibilities of throwing from the two-handed / head position. For this reason, each player has reached high levels of strength training in the specific muscles of the upper limbs, chest, upper back and abdominals, specifically for each scoring class (D'Elia et al., 2020; D'Elia et al., 2020). For the data obtained in the speed test, the correlation is not significantly relevant, i.e., there is no correlation between "the shortest time" and the various "score classes". We would have expected that amputee players would benefit from a privileged state of muscle function over those with spinal paralysis, but this did not happen. Players with even major injuries, in their best wheelchair set-up, even achieved better times than upper-class players; therefore, the "disability factor" in this test is not an index that determines performance disadvantage. From the data obtained from the endurance test, we observe that although slight, there is a small correlation between a player's score class and technical ability. Those with a mild physical disability express better ability to drive the wheelchair. The data obtained in the accuracy test indicate that the correlation from a statistical point of view is not extremely relevant even if we observe that the trend line describes an improvement in performance as the player's classification score progresses. We expected players with higher class scores to benefit from privileged muscle function status over those with spinal paralysis; this is partly the case. According to statistics, the disability factor in this test was not an index that caused performance disadvantage. Still, again the best position on the wheelchair, which determines pelvic stability in the various scoring classes, promotes good technical execution. Finally, from the data obtained in the shooting skill test, there is no significant correlation; this underlined that in the execution of the test, the player with the least motor disability did not express a lesser technical ability in the shooting. The results of this study dispel the myth that those with a higher functional classification have an advantage in the quantitative aspects of performance. As can also be seen from the qualitative tests, there is a tendency to direct correlation for the accuracy test and shooting test. To our knowledge, only a few studies have aimed to determine the relationship between the functional classification level and sport-specific skill tests. Previous research has shown that trunk impairment impacted wheelchair propulsion, especially in acceleration from a standstill (Montella et al., 2019; Tafuri et al., 2017). Similar to our study, De Groot et al. (2012) did not find any differences between the players of a low (<4) and high (>4) IWBF classification level in short-term performance field-based tests. They observed that the participants with a higher classification class performed better; these differences were particularly significant amongst the participants of both classification ends. On the other hand, Hutzler (1993) observed a moderate correlation ($r= -0.64$, $p=0.031$) between the class and 428 m racing trails (lasting for about 2–3 min), but not the 6 min test nor the slalom test.

CONCLUSION

The study shows that the functional classification does not affect the qualitative-quantitative performance, so the disabled athlete with a lower score is not disadvantaged in sports practice. Players with even major injuries, in their best wheelchair set-up, even achieved better times than upper-class players; therefore, the disability factor in these tests is not an index that determines performance disadvantage.

Conflict of Interests
The authors declare no conflict of interest.

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