Emek Gök [1]
Yücel Makaracı [2,*]

THE INFLUENCE OF COMPETITIVE LEVEL ON THE SPORTS-SPECIFIC PERFORMANCES OF WHEELCHAIR BASKETBALL PLAYERS

VPLIV TEKMOVALNE RAVNI NA ŠPORTNO SPECIFIČNE PREDSTAVE KOŠARKARJEV NA VOZIČKIH

ABSTRACT

The main purpose of the present study is to evaluate the physical characteristics and field test performances of wheelchair basketball (WB) players according to the competitive level (CL). The second goal was to compare the results of physical characteristics and field test performances of WB athletes with different functional classification (FC) scores. Seventy-five (70 males- 5 females) proffesional WB athletes took part in this study. The athletes were divided into two CL: Elite (Super and First League)- Sub-elite (Second and Third League) categories. Players are also grouped into two FC categories: Category A (classes from 1.0 to 2.5)- Category B (classes from 3.0 to 4.5). Players underwent anthropometric measurements, bilateral grip strenght and took field tests in separated sessions. Field tests were evaluated with 20-meter sprint, slalom without the ball, slalom with the ball, zone shot, lay up, passing accuracy, and shuttle run test. Between group differences and correlations were computed to assess the study hypotheses. Statistical differences were observed when the bilateral grip strength and field test performances of WB athletes were examined according to the CL and FC categories. The sitting height and FC score were found to be the indicators that best expressed the field test performances. It has been determined that the field performance in WB differs according to the CL. Besides; since the hand wrist area is intensively used in many movements in WB, a common measurement such as grip strength should be evaluated as a performance criterion in WB athletes.

Keywords: athletic performance, disability, field test, functional classification, wheelchair basketball

[1]Institute of Health Sciences, Karamanoğlu Mehmetbey University, Karaman, Turkey
[2]Faculty of Sports Sciences, Karamanoğlu Mehmetbey University, Karaman, Turkey

IZVLEČEK

Glavni namen študije je oceniti telesne značilnosti in uspešnost terenskih testov košarkarjev na vozičkih (WB) glede na tekmovalno raven (CL). Drugi cilj je bil primerjati rezultate telesnih značilnosti in zmogljivosti terenskih testov športnikov WB z različnimi ocenami funkcionalne klasifikacije (FC). V tej študiji je sodelovalo petinsedemdeset (70 moških in 5 žensk) profesionalnih športnikov na vozičkih. Športniki so bili razdeljeni v dve kategoriji: elitno (super in prva liga) in pol elitno (druga in tretja liga) kategorijo. Športniki so bili prav tako razvrščeni v dve kategoriji FC: kategorija A (razredi od 1,0 do 2,5) in kategorija B (razredi od 3,0 do 4,5). Športniki so opravili antropometrične meritve, meritve stiska pesti in terenske teste. Terenski testi so bili ocenjeni s šprintom na 20 metrov, slalomom brez žoge, slalomom z žogo, metom v coni, polaganjem, natančnostjo podaj in prilagojeno stopnjevalno vožnjo na vozičku. Za oceno hipotez študije so bile izračunane razlike med skupinami in korelacije. Med skupinama košarkarjev, ki so nastopali na različnih tekmovalni ravnih in FC, so bile opažene statistične razlike pri moči stiska pesti in pri terenskih testih. Ugotovljeno je bilo, da sta višina sedenja in rezultat FC najboljša kazalnika uspešnosti terenskih testov. Ugotovljeno je bilo tudi, da se uspešnost na terenu pri WB razlikuje glede na tekmovalno raven. Ker se zapestje roke intenzivno uporablja pri številnih gibih v WB, bi bilo treba kot merilo uspešnosti pri športnikih WB oceniti skupno meritev moči stiska pesti.

Ključne besede: telesna zmogljivost, invalidnost, terenske meritve, funkcionalna klasifikacija, košarka na vozičku

Corresponding author:* Yücel Makaracı,
Karamanoğlu Mehmetbey University, Faculty of Sport Sciences, 70200 Karaman/TURKEY
E-mail: yucelmkrc@gmail.com

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INTRODUCTION

More than one billion people worldwide maintain their lives with a different form of disability (Pineda and Corburn, 2020). Regular physical activity functions as physical, psychological, and social support for individuals with disabilities (Jaarsma and Smith, 2018). Owing to the sports that have been specially designed and/or modified for individuals with disabilities in recent years, individuals with disabilities have participated in many sports. In parallel, there has been a considerable increase in the number of athletes (McLoughlin, Fecske, Castaneda, Gwin and Graber, 2017). Wheelchair basketball (WB) has been designed for individuals with permanent disabilities of upper and lower extremities that restrict movements such as running, jumping, and pivoting due to different physical disabilities (e.g., spinal cord, amputation, poliomyelitis, joint-musculoskeletal, athetosis, ataxia) (Seron et al., 2019). It is one of the most popular sports for the individuals with physical disabilities, and its popularity increases every year (Yanci et al., 2015). The number of active players worldwide is known to be above 100,000 in WB, in which men and women from all ages and different levels (recreational, national, international, Olympic) participate (Cavedon, Zancanaro and Milanese, 2018). The game rules in WB are determined, and the functional classification (FC) of athletes according to the level of disability is made by the International Wheelchair Basketball Federation (IWBF) (Marszalek et al., 2019a).

WB, which is a team sport, requires a high level of talent and technical capacity in addition to acting together and team spirit. Handling both the wheelchair and the ball simultaneously is a key feature specific to WB (Marszalek et al., 2019b). The athlete's ability to move comfortably is not only characterized by strength, power, and aerobic performance but also depends on the interaction between the athlete and the wheelchair (Veeger et al., 2019). Therefore, the contribution of anthropometric and physical characteristics to the interaction of the athlete with the wheelchair is an expected situation. Some studies have emphasized that sportive performance in WB is associated with anthropometric characteristics (especially upper extremity) (Cavedon, Zancanaro and Milanese, 2015; Granados et al., 2015). The creation of WB with the inspiration of classical basketball dynamics turns speed, agility, and advanced physical capacity into key factors for success (Goosey-Tolfrey, 2010). In addition to these factors, rapid wheel rotation, acceleration/deceleration, speed, sudden directional changes, and turns are the priority characteristics expected from a WB athlete (Van der Slikke, Berger, Bregman and Veeger, 2016). The monitoring and evaluation of WB-specific performance, which is realized in a short time and intensively, are extremely important, particularly for athletes competing at the elite level. In this context, it is expected that athletes perform at elite and sub-elite levels will have different profiles in terms of technical and sport-specific performance. Because the content of training programs varies according to the competition level (CL) (Dehghansai et al., 2017). Physical and/or physiological analyses will help evaluate the key performance components of WB, such as shooting, long-distance passing, throwing the ball at the hoop quickly, rebounds, and ball/no ball movements against defense (Soylu, Yıldırım, Akalan, Akınoğlu and Kocahan, 2021). However, the FC status should also be considered when evaluating the performance analysis of WB athletes (Gil et al., 2015).

Although WB and classical basketball are similar to each other in terms of game rules (Cavedon et al., 2018), there are differences in terms of determining the players to be on the court considering ball and no ball movements, foul types, and especially FC. To ensure that the two teams that will participate in the game have a balanced profile, a FC score is determined for each player (considering the level of disability). According to the rule set by the IWBF, the sum of the FC score of the five players who are eligible to be on the court at any time of the game cannot be higher than 14.0 (e.g., 4.5, 4.0, 3.0, 1.5, and 1.0) (Marszalek et al., 2019a). In this sense, WB has a different position among sports organized for individuals with disabilities in terms of having not only technical and tactical elements in the game but also sports-specific rules because the limitation level of the athletes directly affects the game performance on the court. Thus, a low FC score (e.g., 1.0) indicates a higher level of limitation. A level of limitation close to the maximum performance is expressed with 4.5 (Van der Slikke, Bregman, Berger and De Witte, 2018).

Usually, laboratory tests are used to evaluate physical fitness and athletic performance (Goosey-Tolfrey and Leicht, 2013). Such an approach is much more valid in circumstances under which healthy athletes participate, but it poses different challenges with regard to high cost, environmental factors, insufficient time, and the number of participants for studies in which individuals with physical limitations take part (Granados et al., 2015). Accordingly, the determination of performance components based on field testing is assumed to be a more appropriate method to reveal the athletic levels of athletes with special needs (Molik, Laskin, Kosmol, Skucas and Bida, 2010). Although there are some studies in the literature that reveal the sports-specific performance analysis of WB athletes, the number of studies focusing on the importance of CL is quite limited. It is expexted that a study with a large sample size will be important in terms of determining the effect of CL WB specific performance. The main purpose of the present study is to evaluate the physical characteristics and field test performances of

WB players according to the CL. The second goal was to compare the results of physical characteristics and field test performances of WB athletes with different FC scores.

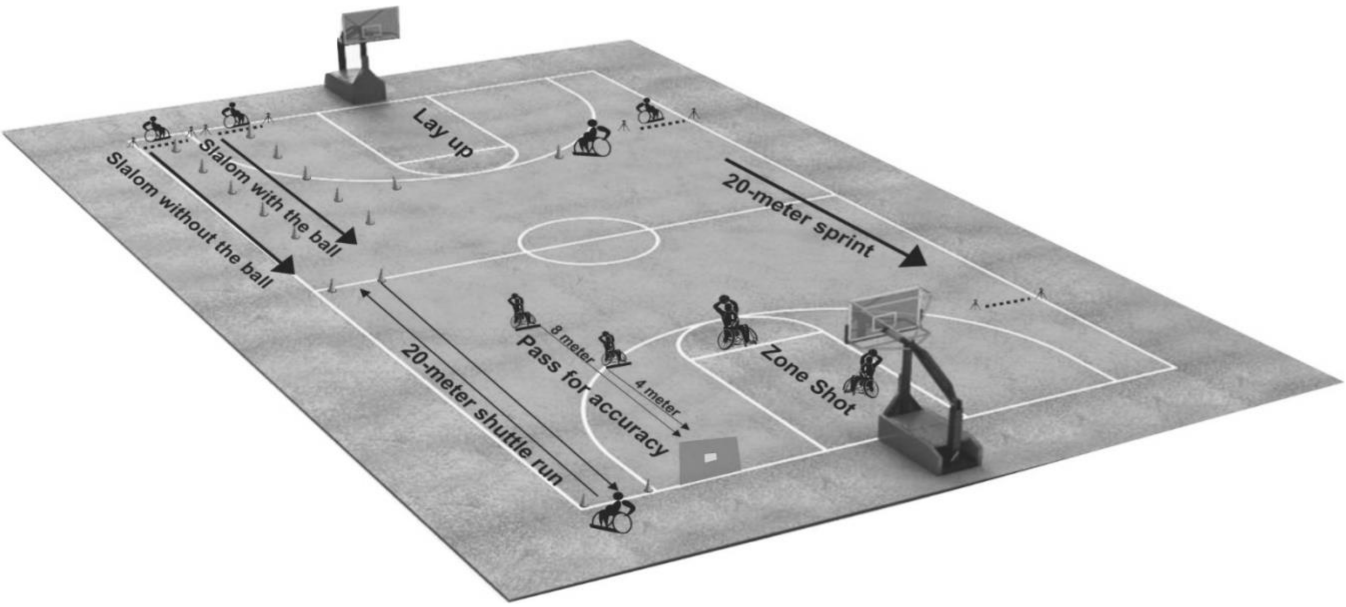
METHODS

Procedure

In this cross-sectional study, all measurements were conducted before the 2021-2022 Turkish Wheelchair Basketball Leagues. The study measurements were taken during pre-season period and at the same time of day (i.e., mid-day) by the same researcher to control the effects of the circadian rhythm. All measurements were carried out at the training facilities of the athletes.

The athletes underwent physical/anthropometric measurements, and field tests in three sessions in the following order: Session 1- Anthropometric measurements and grip strength (dominant and non-dominant arm), 20-meter sprint, Slalom without the ball, and Slalom with the ball; Session 2- Zone shot, Lay up, and Passing accuracy; Session 3- Shuttle run test (Figure 1). All test sessions were separated by at least 24 h to standardize recovery. Testing was conducted with each player using his/her personal wheelchair (standard tyre pressure) which used in the official games (Cavedon et al., 2015). Thus, the test protocols were standardized for all participants. Before the measurements, athletes were verbally introduced to the procedures and field-tests were demonstrated with a video. The athletes did not perform any kind of exercise and/or training sessions during the study period. The temperature was 20–23°C for the field tests, and relative humidity was no more than 50% (Soylu et al., 2021). To reduce the interference of uncontrolled variables, all athletes were instructed to maintain their usual way of life and routine diet program intake before and during the study. During the testing, only water was allowed as a drink (Makaracı, Soslu, Özer, and Uysal, 2021).

Figure 1. The field tests used in the study.



Participants

Seventy-five (70 males-5 females; 68 with the dominant arm right-7 with the dominant arm left) profesional WB athletes from Turkish Wheelchair Basketball Leagues (TWBL) within the Turkish Sports Federation of Physically Disabled voluntarily participated in this study. We enrolled male and female athletes in the same study design (Vanlandewijck et al., 2011; Yanci et al., 2015; Soylu et al., 2021) since both genders can play in the same team in WB. The general characteristics of the athletes are shown in Table 1.

Table 1. The general characteristics of the athletes by competitive level.

Parameters	Competitive level	n	$\bar{X}$	SD
Age (year)	Elite	40	32.85	9.04
	Sub-elite	35	33.51	12.49
Training age (year)	Elite	40	13.55	7.66
	Sub-elite	35	11.09	9.49
Height (cm)	Elite	40	175.09	11.19
	Sub-elite	35	166.17	34.86
Sitting height (cm)	Elite	40	91.83	8.61
	Sub-elite	35	90.37	8.55
Body mass (kg)	Elite	40	73.75	16.53
	Sub-elite	35	72.46	16.50
Body mass index (kg/m^2)	Elite	40	24.81	14.28
	Sub-elite	35	24.12	15.34
Stroke length (cm)	Elite	40	179.70	9.33
	Sub-elite	35	174.19	16.31

Participation criteria for the athletes were as follows: having been playing WB at least for three years in TWBL, being older than 16 years old, providing a participation approval either by himself/herself, ability to apply study instructions, and having no other medical problems apart from his/her own disability. Exclusion criteria of the athletes from the study were as follows: having been undergone to the upper extremity and/or upper body surgery, having acute shoulder pain, give at least 5 months break to team training, partial or complete finger losses on the upper extremity that can prevent measurements, and having any neurological or cardiovascular diseases. (Soylu et al., 2021).

The athletes were divided into two CL categories: Elite (Turkish Wheelchair Basketball Super League and First League; n = 40) and Sub-elite (Turkish Wheelchair Basketball Second and Third League; n = 35). The athletes also were grouped into two FC categories: A (classes from 1.0 to 2.5; n = 32) and B (classes from 3.0 to 4.5; n = 43) according to the IWBF rules (International Wheelchair Basketball Federation, 2014). All the players were evaluated by official national classifiers. The number of WB athletes in the elite and sub-elite groups by FC score are presented in Table 2. All individuals were asked about their age and wheelchair basketball training experience. Informed consent was obtained from the athletes (as all players were over 16 years old) through the teams' coaches/managers who were informed about the aims and methods of all the test protocols. Ethical approval was obtained from the Clinical Research Ethics Committee of Karamanoğlu Mehmetbey University (KMU), in accordance with the Declaration of Helsinki (Document No: 03-2021/03).

Table 2. The number of wheelchair basketball players in the elite and sub-elite groups by FC score.

FC (point)	**1.0**	**1.5**	**2.0**	**2.5**	**3.0**	**3.5**	**4.0**	**4.5**
Elite	4	7	3	4	2	7	12	1
Sub-elite	3	5	3	3	4	3	13	1
Total (n=75)	7	12	6	7	6	10	25	2

Data Collection

Anthropometric variables

Height (cm) and body mass (kg) were measured using a stadiometer/electronic scale (SECA-Mod.220, Seca GmbH & Co. KG., Hamburg, Germany). Sitting height and stroke length was measured with a flexible anthropometric tape (RossCraft, Canada). Anthropometric variables were measured as described by Vanlandewijck et al. (2011). The formula used to calculate the body mass index (BMI) is weight in kilograms (kg) divided by height in meters (m) squared.

Grip strength

A hand dynamometer (Baseline Electronic Smedley, NY, USA) was used to measure bilateral (dominant and nondominant arm) grip strength of the athletes. Grip strength measurement were conducted while the athlete was sitting on his/her own normal wheelchair position. During the measurements, the hand wrist was fit at 30º extension and 10º ulnar deviation. The athletes were asked to hold the dynamometer as tight as possible for 3 s, and free it afterward. Three trials were performed, and the average of the three trials was used to calculate the test results. A 30 s passive recovery was given in between the three trials. Measurement was done on both the dominant and nondominant hand.

Field-test performance tests

Field-test performance tests were conducted in the second visit of the study measurements (Session 2). The athletes performed a individual warm-up process before starting the tests using their regular pre-game warm-up. Sport-specific field test were conducted adhering to the IWBF rules (De Groot, Balvers, Kouwenhoven and Janssen, 2012). An official basket ball (size 7, Spalding) was used during the test measurements. All sport-specific tests are detailed below.

20-meter sprint: 20 m sprint test was conducted in order to evaluate the wheelchair ball handling and speed of the athletes. Players were placed at 0.5 m from the starting point (photocell gate) and began when they felt ready. Electronic photocells (Witty, Microgate, ITALY) placed 0.4 m above the ground were used for the test time. The test recording was in seconds. The test was performed three times with 2 min of passive recovery in between which was enough time to return to the start (Vanlandewijck, Daly and Theisen, 1999). The best result of three trials was used for further analysis (Molik et al., 2010; Soylu et al., 2021).

Slalom without the ball / Slalom with the ball: The slalom test was conducted in order to measure the wheelchair riding skills of the athletes. Five cones were placed on the court (with a 1.5 m distance between each). The athletes were asked to move forward among the cones with slaloms, and to finish the court after turning back behind the last cone and moving back among the cones with slaloms. Time was recorded using photocell gates placed 0.4 m above the ground. The test recording was in seconds. The test was performed three times with 2 min of recovery in between which was enough time to return to the start (Vanlandewijck et al., 1999). The best result of this test was used for further analysis (Molik et al., 2010; Soylu et al., 2021). The slalom with the ball test was performed using the same protocol and materials with the slalom without the ball test.

Zone shot: The zone shot test was conducted to evaluate the shooting skills of the athletes. The athletes were asked to take the start position behind the foul (free throw) line. Following the "start" signal, the athletes were asked to shoot during two minutes as many shoots as possible from outside the foul line, and to rebound their shoots each time. The athletes were asked to shoot again from the rebound position and return to the foul line after taking the rebound. At the end of the test, total scores were recorded. Scoring shots were considered as 2 points while the missed shots as considered 1 point of the athletes (Vanlandewijck et al., 1999). The test time was recorded using a standart chronometer.

Lay up: The lay up test was conducted to evaluate the acceleration, ball control, and shooting accuracy of the athletes. Two cones are positioned on the 3-point line, perpendicular to the hoop, of the side lines of the foul line and the baseline. The athlete takes position out of the 3-point line and starts with the signal to make as many lay-ups as possible within two minutes. After each lay-up, athlete takes his/her own rebound, dribbles the ball around the opposite cone, getting ready for the next lay up. the Total number of the lay up attempts, and the successful lay ups were recorded as lay up test score (Zacharakis, Apostolidis, Kostopoulos and Bolatoglou, 2012). The test time was recorded using a standart chronometer.

Pass for accuracy: The pass for accuracy test was conducted to evaluate the passing skills of the athletes. A 30 cm square (centre point is at 1.2 m above the ground) is marked on the wall of the sports hall. After the start signal the player has to pass the ball towards the marked area during two minutes. Every kind of pass is accepted without any restriction unless the ball bounce before hitting the target. The player has to pass both from behind the 4 and 8 m distance line. Hitting the target behind the 4 m line were considered as 1 point while behind the 8 m line as considered 2 points (Vanlandewijck et al., 1999). The test time was recorded using a standart chronometer.

20-meter shuttle run: The shuttle run test was conducted in the last visit of the study measurements (Session 3). The test was used to evaluate the endurance performance of the athletes (Paradisis et al., 2014). The athletes performed a 10-minute general warm-up phase and a set of five dynamic stretches prior to the shuttle run test. The test included running between two lines set 20 m apart at a pace managed by a recording emitting tones at suitable intervals. The running velocity was 8.5 km·h−1 for the first minute, which increased by 0.5 km·h−1 every minute thereafter. The test score achieved by the athlete was the number of 20 m shuttles completed before the subject either withdrew voluntarily from the test, or failed to be within 3 m of the end lines on two consecutive warning tones. During the test the athletes were instructed to complete as many shuttles (stage) as possible.

Statistical analysis

Before starting this study, a power analysis was performed to determine the number of athletes required, and a sample size of 30 athletes per group (CL and FC) was estimated to have a power of 0.95 at $\alpha=0.05$. The statistics of descriptive variables were reported using mean and standard deviation (Mean±SD). The normality of distribution was tested by the Kolmogorov-Smirnov test. Since our data were found to be normally distributed, Independent Samples t test was used to compare differences in physical characteristic and field-test performances of professional wheelchair basketball players according to CL and FC. Pearson's correlation was also used to establish relationships between the physical characteristic and field-test performances of the athletes. For all analyses, the threshold for statistical significance was set at $P<0.05$. Threshold values for effect size (ES) statistics were 0.2–0.49 is a small effect, 0.5–0.79 is a moderate effect, and ≥0.8 is a large effect (Gil et al., 2015).

RESULTS

Statistical differences were observed between the groups organized for CL (elite/sub-elite) and FC (Category A and B) in the bilateral grip strength and field test performances of WB athletes ($p<0.05$). A significant correlation was identified between the physical characteristics and FC scores and field test performances of the athletes ($p<0.05$). The sitting height and FC score were found to be the indicators that best expressed the field test performances of WB athletes. The study findings are presented in the tables below. Comparison of physical characteristic and bilateral grip strength parameters in CL and FC score are shown in Table 3.

Table 3. Comparison of physical characteristic and bilateral grip strength parameters in CL and FC score.

Parameters	CL	X̄	SD	t	*P*	ES	FC	X̄	SD	t	*P*	ES
Height (cm)	Elite	175.09	34.85	-1.449	0.152	0.34	Category A	166.84	28.93	0.972	0.334	0.23
	Sub-Elite	166.17	11.19				Category B	172.93	23.61			
Sitting height (cm)	Elite	91.83	8.61	0.732	0.467	0.17	Category A	86.22	5.79	4.934	**0.000*****	1.11
	Sub-Elite	90.87	8.55				Category B	94.81	9.26			
Body mass (kg)	Elite	73.25	16.53	0.338	0.736	0.08	Category A	67.66	14.72	2.593	**0.011***	0.60
	Sub-Elite	72.46	16.50				Category B	77.23	17.19			
Stroke length (cm)	Elite	179.70	9.33	1.044	0.300	0.23	Category A	171.14	8.85	1.998	**0.049***	0.43
	Sub-Elite	174.19	31.91				Category B	181.58	32.77			
Grip strength-D (kg)	Elite	50.73	7.74	2.071	**0.042***	0.48	Category A	44.69	7.98	3.022	**0.003****	0.69
	Sub-Elite	46.10	11.31				Category B	51.31	10.89			
Grip strength-ND (kg)	Elite	49.28	6.62	1.987	**0.050***	0.45	Category A	43.66	8.02	2.935	**0.004****	0.67
	Sub-Elite	44.94	11.85				Category B	49.63	10.50			

Notes. D: Dominant hand, ND: Non-Dominant hand, CL: Competitive-level, FC: functional classification, ES: Effect size (Cohen's d) ES where 0.2–0.49 is a small effect, 0.5–0.79 is a moderate effect, and ≥ 0.8 is a large effect. *P < 0.05, ** P < 0.01, ***P < 0.001.

Table 4. Comparison of field-test performance parameters in CL and FC score.

Parameters	CL	X̄	SD	t	*P*	ES	FC	X̄	SD	t	*P*	ES
20 m sprint (s)	Elite	5.25	0.65	-3.172	**0.000*****	0.72	Category A	5.77	1.05	-2.478	**0.016***	0.55
	Sub-Elite	5.81	0.88				Category B	5.32	0.50			
Slalom without the ball (s)	Elite	11.96	1.64	-3.921	**0.002****	0.90	Category A	13.30	2.37	-1.871	0.065	0.43
	Sub-Elite	13.71	2.22				Category B	12.39	1.83			
Slalom with the ball (s)	Elite	13.52	3.02	-3.367	**0.000*****	0.77	Category A	16.59	5.10	-2.996	**0.004****	0.67
	Sub-Elite	16.62	4.85				Category B	13.76	3.02			
Zone shot (point)	Elite	29.70	7.00	4.497	**0.001****	1.04	Category A	24.53	8.06	1.776	0.080	0.41
	Sub-Elite	22.51	6.79				Category B	27.70	7.31			
Lay up (point)	Elite	24.08	4.65	5.292	**0.000*****	1.22	Category A	19.38	6.12	2.757	**0.007****	0.63
	Sub-Elite	18.23	4.91				Category B	22.81	4.69			
Pass for accuracy (point)	Elite	24.65	8.94	5.086	**0.000*****	1.18	Category A	15.53	8.70	3.692	**0.000*****	0.87
	Sub-Elite	14.69	7.88				Category B	23.33	9.29			
Shuttle run (n)	Elite	35.58	20.93	5.352	**0.000*****	1.27	Category A	22.81	19.71	1.295	0.199	0.30
	Sub-Elite	15.31	8.49				Category B	28.58	18.61			

Notes. CL: Competitive-level; FC: functional classification; ES: Effect size (Cohen's d). ES where 0.2–0.49 is a small effect, 0.5–0.79 is amoderate effect, and ≥ 0.8 is a large effect. *P < 0.05, ** P < 0.01, ***P < 0.001.

Table 4, statistical differences were determined in all field tests performances of WB athletes according to the CL (p<0.05). The difference in the slalom without the ball, zone shot, lay up, pass for accuracy and shıttle run parameters was found to be a "large effect (ES=0.90, 1.04, 1.22, 1.18, and 1.27 respectively)" and the difference in the 20 m sprint and slalom with the ball was found to be a "moderate effect (ES=0.72 and 0.77). All the differences were in favor of the elite group. Statistical differences were observed in 20 m sprint, slalom with the ball, lay up, and pass for accuracy performances according to the FC category (p<0.05). The difference in the pass for accuracy parameter was found to be a "large effect (ES=0.87) and the difference in the 20 m sprint, slalom with the ball and lay up parameters was found to be a "moderate effect (ES=0.55, 0.67, and 0.63 respectively)". The differences were in favor of Category B. In slalom without the ball, zone shot, and shuttle run test performances, there was a tendency in favor of Category B according to the FC category, but no statistical difference was observed (p>0.05). Correlation between physical characteristics, age/training age, FC points and field-test performance parameters of the athletes are shown in Table 5.

Table 5. Correlation between physical characteristics. age/training age, FC score and field-test performance parameters of the athletes.

Parameters		Age (year)	TA (year)	Height (cm)	SH (cm)	BM (kg)	BMI (kg/m^2)	SL (cm)	FC (point)
20 m sprint (s)	**r**	0.156	0.062	-0.071	-0.477	-0.003	-0.097	-0.041	-0.370
	r^2	0.024	0.004	0.005	0.228	0.000	0.009	0.002	0.137
	P	0.182	0.599	0.543	**0.000***	0.981	0.408	0.726	**0.001**
Slalom without the ball (s)	**r**	-0.059	-0.182	0.031	-0.328	0.039	-0.130	0.000	-0.336
	r^2	0.003	0.033	0.001	0.108	0.001	0.017	0.000	0.113
	P	0.616	0.119	0.792	**0.004**	0.742	0.266	0.999	**0.003**
Slalom with the ball (s)	**r**	-0.033	-0.160	-0.035	-0.439	-0.068	-0.094	-0.060	-0.431
	r^2	0.001	0.026	0.001	0.193	0.005	0.009	0.004	0.186
	P	0.777	0.171	0.768	**0.000***	0.564	0.422	0.612	**0.000***
Zone shot (point)	**r**	0.075	0.229	0.061	0.363	0.143	0.089	0.156	0.317
	r^2	0.006	0.052	0.004	0.132	0.021	0.008	0.024	0.100
	P	0.523	**0.048***	0.602	**0.001**	0.220	0.448	0.181	**0.006**
Lay up (point)	**r**	0.029	0.207	-0.048	0.393	0.123	0.173	0.185	0.417
	r^2	0.001	0.043	0.002	0.154	0.015	0.030	0.034	0.174
	P	0.807	0.074	0.685	**0.000***	0.293	0.138	0.111	**0.000***
Pass for accuracy (point)	**r**	-0.002	0.143	0.140	0.363	0.198	-0.005	0.218	0.454
	r^2	0.000	0.020	0.020	0.132	0.039	0.000	0.048	0.206
	P	0.987	0.221	0.231	**0.001**	0.088	0.967	0.060	**0.000***
Shuttle run (n)	**r**	-0.126	0.031	-0.023	0.347	-0.070	0.100	0.035	0.271
	r^2	0.016	0.001	0.001	0.120	0.005	0.010	0.001	0.073
	P	0.281	0.792	0.845	**0.002**	0.548	0.391	0.763	**0.019***

Notes. TA: Training age, SH: Sitting height, BM: Body mass, BMI: Body mass index, SL: Stroke length, FC: Functional classification. *P < 0.05. ** P< 0.01. ***P< 0.001.

A negative correlation was identified between 20 m sprint, slalom without the ball and slalom with the ball test performances and sitting height and FC score (r=-0.477, -0.370, -0.431 respectively; p<0.05) (Table 5). There was a positive correlation between zone shot, lay up, pass for accuracy and shuttle run test performances and sitting height and FC score (r= 0.317, 0.174, 0.454, 0.271 respectively; p<0.05). Furthermore, a positive correlation was observed between zone shot performance and training age (p<0.05). These results show that the sitting height and FC score are the indicators that best express the field test performances of WB athletes (Figure 2a and 2b). No statistical correlation was found between age, height, body mass, BMI and stroke length variables and field test performances (p>0.05). The correlation graphs of both the sitting height and FC score parameters are presented in Figure 2a and 2b.

Figure 2. a) Correlation of 20 m sprint and slalom with the ball performances with the sitting height, b) Correlation of slalom with the ball and lay up performances with functional classification point.

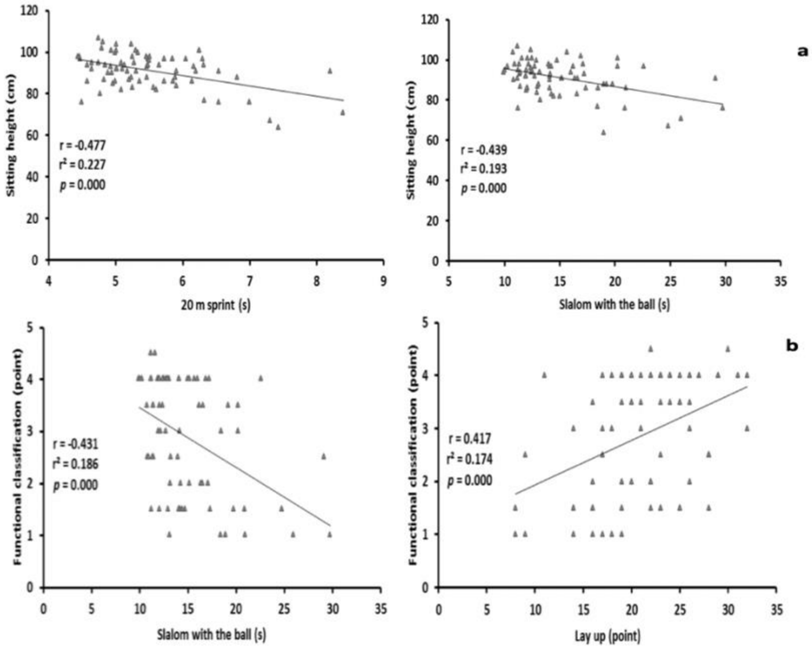


Figure 2a shows a medium-level negative correlation of 20 m sprint and slalom with the ball performances with sitting height (p <.001; r=-0.477,-0.439 respectively). Figure 2b shows a medium-level negative correlation of slalom with the ball performance with FC score (p <.001; r=-0.431), and a medium-level positive correlation of lay up with the FC score (p <.001; r=0.417).

DISCUSSION

Previous studies have emphasized that anthropometric characteristics are a performance indicator in WB athletes (Chapman, Fulton and Gough, 2010; Molik et al., 2010; Granados et al., 2015). Moreover, it is thought that the data obtained as a result of WB-specific field tests and the analyses performed according to the FC scores will be useful in determining and evaluating the athletic levels of athletes. This study primarily aimed to evaluate the physical characteristics and field test performances of WB players according to the CL. The secondary purpose of the study was to compare the results of physical characteristics and field test performances of WB athletes with different FC scores. The study findings will be discussed below.

Vanlandewijck, Spaepen and Lysens (1994) stated that sportive performance was a concept related to functional potential and competency; therefore, athletes competing at the recreational and sub-elite levels could not reach the elite level. In the literature, it is observed that the performance outputs of WB athletes are rather interpreted with field tests and physiological data. The number of studies examining the difference in physical or anthropometric characteristics of WB athletes according to the CL is highly limited. In our study, no statistical difference was observed between the elite and sub-elite groups in the comparison of WB athletes' physical characteristic parameters according to the CL ($p>0.05$) (Table 3). However, the mean values of the elite group were higher than those of the sub-elite group in all parameters. A statistical difference was identified in favor of the elite group in the Grip strength-D and Grip strength-ND values ($p<0.05$). In their study investigating the anthropometric characteristics and sportive performance in WB athletes, Granados et al. (2015) stated that there was a difference in physical characteristics (e.g., body mass, sitting height) of the athletes in different leagues (First and Second) in favor of the higher league, but this difference was not statistically significant. In Grip strength-D, there was a statistical difference in the values of the First and Second League athletes in favor of the higher league. Although the current findings indicate that anthropometric or physical characteristics differ according to the CL, it is clear that there is a need for more research to make a definitive comment on this issue.

Change in physical characteristics according to the athlete's level suggests that the CL may be a factor in test performances characterized by sprint, agility, change of direction and sportive ability, which are the fundamentals of field performance in WB. Our study findings revealed that the elite group had statistically better results than the sub-elite group in all tests (20 m sprint, slalom without the ball, slalom with the ball, zone shot, lay up, pass for accuracy, and shuttle run) performed for WB-specific field performances (Table 4). According to the other finding in the study conducted by Granados et al. (2015), the First League players performed better than the players in the Second League in terms of speed, agility, strength, and endurance. Marszałek et al. (2019a) examined heart rate (HR) values associated with passing, shooting, pushing, etc., which are the components of the game form in WB, according to the CL. The authors emphasized the effect of the athlete's level by reporting that HRpeak and HRR% values were statistically better in the group with the higher CL in the analyses conducted in two groups according to FC. Hence, the change in performance in athletic and sport-specific tests according to the athlete's level can be considered a valid finding for WB athletes. Considering that the number of studies evaluating field test performance and technical abilities in WB athletes according to the CL is highly limited, the importance of the findings of the current study increases.

According to another finding obtained from our study, the physical characteristics and hand grip strength values of WB athletes differed statistically according to the FC category of the athletes (in favor of Category B) ($p<0.05$) (Table 3). In their study on WB athletes, Cavedon et al. (2015) revealed a correlation between the sitting height and the FC score. Likewise, Gil et al. (2015) also found a correlation between body weight, height and hand grip strength values and FC scores in their study. Crespo-Ruiz and Del Ama-Espinosa (2011) reported that elbow flexion-extension-pronation-supination and wrist flexion-extension strengths increased as the FC score increased in WB athletes. In their study, Yanci et al. (2015) stated that sitting height and body weight values were higher in Category B athletes. Considering the effect of anthropometric characteristics on sportive performance, a positive correlation between WB athletes' physical characteristics and FC score is an expected result because an increase in the FC score indicates a lower level of functional limitation for the athlete. In this sense, the findings of our study and similar studies are parallel. Furthermore, among the field tests, 20 m sprint, slalom with the ball, lay up and pass for accuracy performances of WB athletes differed according to the FC score (in favor of Category B) ($p<0.05$) (Table 4). Despite a tendency in favor of Category B in slalom without the ball, zone shot and shuttle run performances, no statistical difference was found ($p>0.05$). In their study analyzing the 1998 WB World Championship, Vanlandewijck et al. (2004) expressed that athletes with high FC scores had better values in parameters reflecting field performance (rebound, shot, assist, etc.). Soylu et al. (2021) revealed that the athletes in Category B performed better in the tests associated with aerobic and anaerobic performance applied in their study. Similarly, Marszalek et al. (2019b) stated that athletes with high FC scores had statistically better values in anaerobic power output as well as field and sport-specific test performances. De Lira et al. (2010) confirmed that athletes with higher FC scores had a better athletic performance. These results indicate the need for evaluating the athletic performances of WB athletes together with upper extremity coordination and functions. The interaction between the tests applied and the functional disorder and disability status of the athletes seems normal.

When the relationship between the physical characteristics, age/sports background and FC scores of the athletes and their field tests performances, which is another hypothesis in our study, was examined, a negative correlation was observed between sitting height and FC score and 20 m sprint, slalom without the ball and slalom with the ball test performances ($p<0.05$) (Table 5). A positive correlation with zone shot, lay up, pass for accuracy and shuttle run test performances was determined ($p<0.05$) (Table 5). These results confirm a relationship between the physical characteristics and sportive performances of WB athletes, as supported by the aforementioned different studies. In the present study, sitting height and FC score were observed to be the indicators that best expressed the field test performances of WB athletes (Figure 2a and 2b). Cavedon et al. (2015) stated sitting height and FC score as parameters related to statistical data on sport-specific tests and competition in young WB athletes. Gil et al. (2015) reported a correlation between FC scores and field test performance. According to the other finding in Table 5, a positive correlation was observed between zone shot performance and training age ($p<0.05$). It is known that long-term repetitions on certain movement mechanics will enable performing the relevant movement automatically. In this regard, Gil-Agudo, Del Ama-Espinosa and Crespo-Ruiz (2010) stated that more training and sports background were the determining factors for success in WB. The effect of the sitting height parameter, which specifically refers to the upper extremity length, on sportive performance can be considered a guiding finding for athlete selection.

Limitations of the study

The number of studies examining performance differences according to the CL in WB is quite limited. Moreover, the number of samples (n=75) in our study was highly sufficient for a study to be conducted on athletes with physical disabilities. Therefore, the results of the physical characteristics and field test performance analyses performed based on the CL in this study are noteworthy. The numbers of athletes who participated in our study with different FC scores were close to each other, which is important for the validity of the finding that FC is considered a determinant of field performance.

The fact that the female athlete profile could not be examined can be shown among the limitations of the present study. It is known that men and women play in the same team in WB. However, the lack of a sufficient number of female athletes prevents clearer results for female WB athletes. Since all the athletes in our study were actively involved in professional teams, the low number of sports-specific tests applied to the athletes and the inability to apply physiologically more comprehensive test protocols can be mentioned as another limitation.

CONCLUSION

As a result, the findings of our study revealed that Grip strength-D and Grip strength-ND along with the field test and sport-specific test performances differed according to the CL (in favor of the elite group). Furthermore, physical characteristics and field test performances differed according to the FC category of WB athletes. A correlation was identified between the physical characteristics and FC scores of the athletes and their field performances. In this correlation, the sitting height and FC score were found to be the indicators that best expressed the field test performances of WB athletes. Thus, sitting height, which is an indicator of physical characteristics, can be considered a reflection of sportive performance in WB. Since the hand/wrist area is intensively used in many movements such as passing, dribbling, turning the wheelchair, and shooting, a common measurement such as grip strength should be evaluated as a performance criterion in WB athletes.

The current study showed that CL and FC are the distinguishing factors for dominant and non-dominant grip strength, field and sport-specific test performances of WB athletes. Also, the sitting height and FC score were determined as the best indicators of the field test performances. From this aspect, it can be proposed to include wrist and forearm enhancing exercise protocols in addition to routine training programs of the WB athletes. Besides, we recommend that especially upper extremity-specific anthropometric measurements should be used to determine WB-specific performance.

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Declaration of Conflicting Interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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