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Morphological characteristics, muscle strength, and anaerobic power performance of wheelchair basketball players

Características morfológicas, desempenho de força e de potência anaeróbia em jogadores de basquetebol em cadeira de rodas

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Abstract – The aim of this study was to provide a descriptive analysis of the morphological structure, muscle strength, and anaerobic power performance of the upper limbs of wheelchair basketball athletes. Eleven male players (33.2 ± 10.6 years, 71.8 ± 15.8 kg) were submitted to anthropometric measurements and dynamometry (kg), medicine ball throwing (m) and wingate arm tests (W). The results showed sitting height (79.7 ± 4.6 cm), relative body fat (20.7 ± 7.6%), handgrip strength and explosive muscle strength (50.1 ± 10.6 kg and 3.9 ± 1.1 m, respectively), as well as peak power (316.8 ± 126.2 W), mean power (160.5 ± 76.5 W) and fatigue index (50.4%) lower than the performance of other wheelchair basketball athletes. The morphological characteristics and performance of athletes in the present study suggest disadvantages when compared to other wheelchair basketball athletes.

Key words: Basketball; People with Disabilities; Exercise; Physical activity; Power.

Resumo – *O objetivo do estudo foi o de fornecer uma análise descritiva da estrutura morfológica, do desempenho de força e de potência anaeróbica de membros superiores de atletas de basquetebol em cadeira de rodas. Onze jogadores do sexo masculino (33,2 ± 10,6 anos; 71,8 ± 15,8 kg) foram submetidos a medidas antropométricas e a testes de dinamometria (kg), lançamento de medicine ball (m) e de wingate de braços (W). Os resultados revelaram altura tronco-cefálica (79,7 ± 4,6 cm), percentual de gordura (20,7 ± 7,6%), força de preensão manual e de lançamento (50,1 ± 10,6 kg e 3,9 ± 1,1 m, respectivamente), além de potência pico (316,8 ± 126,2 W), potência média (160,5 ± 76,5 W) e índice de fadiga (50,4%) inferiores ao desempenho de outros atletas de basquetebol em cadeira de rodas. As características morfológicas e desempenho dos atletas do presente estudo sugerem desvantagens quando são comparados a outros atletas de basquetebol em cadeira de rodas.*

Palavras-chave: *Atividade Física; Basquetebol; Exercício físico; Pessoas com deficiência; Potência.*

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INTRODUCTION

The great wars of the last century and diseases such as polio, automobile and labor accidents have exponentially contributed to the increase in the number of people (military and civilian) affected by trauma and motor sequelae. The inclusion of people with physical disabilities in the productive society has become a priority for the governments of several countries, based on incentives for the discovery of methods of social reintegration. One of the strategies adopted was the involvement of people with physical disabilities in physical rehabilitation programs. Among existing therapeutic methods, the practice of sports has shown to be a prominent strategy to minimize the physical and psychological sequelae of these individuals. The definition of people with disabilities included a significant number of physical, motor and cognitive limitations that allowed the participant to be categorized for sports practice[1]. One of the sport modality that stands out in this population is wheelchair basketball. The modality was used as a method for the rehabilitation of World War II soldiers, who were injured in combat[2].

Wheelchairs used by athletes are adapted and standardized by the rules of the International Wheelchair Basketball Federation (IWBF)[1]. As a general rule, the player must bounce, throw or pass the ball every two touches given in the chair. In turn, the dimensions of the court and the height of the basket follow the standard of Olympic basketball. The practice of wheelchair basketball requires a lot of technique and physical conditioning, reasoning and quick reflexes as well high ability to control the chair and handle the ball. Physical effort is characterized by intermittent actions, which suggests a significant contribution of anaerobic metabolism[3]. Although protocols have been proposed for assessing anaerobic performance in wheelchair users[4,5], the adaptation of the Wingate test to assess the power of the upper limbs has become the most frequently used resource[5].

Considering that wheelchair basketball is a very popular and popular modality in parasports, studies that seek to investigate the power of upper limbs as well as the physical characteristics of practitioners[6] are rare. In this sense, the aim of this study was to provide a descriptive analysis of the morphological structure, muscle strength, and anaerobic power performance of the upper limbs of wheelchair basketball athletes.

METHODOLOGICAL PROCEDURES

Participants

The study sample was composed of eleven male wheelchair basketball athletes who compete for regional and state competitions by the Lobos team of Guarapuava-PR-BR. Table 1 presents the characteristics of athletes evaluated.

All participants were previously informed about the procedures to which they would be submitted and also about the risks and benefits and then signed a free and informed consent form. The project was approved by the Ethics Research Committee of the University where the study was developed, under protocol No. 035055/2012.

Table 1. Characteristics of wheelchair basketball athletes.

Athlete	Age (years)	Disability / Injury	Functional Classification (IWBF*)	Experience (years)
1	17.4	Myelomeningocele	1	2
2	47.2	Poliomyelitis	2.5	6
3	41.4	Poliomyelitis	1.5	5
4	21.0	Medullary	1	2
5	41.7	Medullary	1	2
6	37.3	Muscle Atrophy	1.5	5
7	42.8	Medullary	1	8
8	25.4	Poliomyelitis	3	1
9	23.7	Medular	1	2
10	22.5	Right lower limb amputation	4	1.5
11	44.4	Medullary	1	6

* International Wheelchair Basketball Federation[1]

Experimental design

The study lasted two weeks, in which participants were asked to attend the laboratory individually or in groups of two or three in the morning (08:30 am -11:30 am), in the absence of alcoholic and caffeinated beverages, as well as not having practiced intense physical activity in the last 24 hours, not using metal objects and urinating 30 min before the evaluation procedures.

The instruments used for the accomplishment of body mass, height and anaerobic power measures were adapted for the measurement of participants.

Anthropometric measurements

Body mass was measured using an anthropometric scale (Welmy®, model 110FF, São Paulo, Brazil), with precision of 100 g. For the evaluation of athletes in the sitting position, a wooden bench placed on the scale platform was used. With the adjustment, the scale was regulated and checked with each new measure. All participants were evaluated barefoot and wearing shorts and T-shirt. Body weight (BW) values were determined by the simple subtraction between total body weight and bench weight.

The participant was then transferred to another wooden bench (50 cm) placed on the platform of a stadiometer in order to verify the measurement of the seated height (trunk-cephalic height). The measure obtained was deduced from the bench height. In this position, the measurements of length and perimeters of the right and left arms and forearms, right and left humerus and styloid diameters and the biacromial diameter were verified. The circumference measurements were collected with an inextensible measure tape (Mabis®, model Gulik, Japan) and bone diameters with a brass tipped caliper with accuracy of 0.1 cm (Cardiomed®, Brazil).

The height measurement was performed with participant in the lying position. For this, a wooden stadiometer with scale of 0.1 cm was horizontally fixed on a wall and a stretcher was used to position the participant beside the instrument. The athlete was placed in a lying position, with at least one of the legs extended to the base of the stadiometer. Then, a wooden square was used to indicate the measurement of the vertex of the plantar region according to the Frankfurt plan. All measurements were taken in accordance with guidelines contained in the Anthropometric Standardization Reference Manual[7]. Body mass index (BMI) was determined by the relationship between body weight (kg) and squared height (m^2).

Body composition

Body composition was determined based on the use of electrical bioimpedance with Maltron® BF-900 full-body tetra polar equipment. The instrument operates with disposable adhesive electrodes applied to the hand, wrist, foot and ankle on the right side of the body. Before the fixation of electrodes on the participants' skin, the contact points were cleaned with cotton wool soaked in alcohol. Two emitting electrodes were attached, one near the metacarpal-phalangeal joint on the dorsal surface of the hand and the other distal of the transverse arch on the upper surface of the foot (black electrodes). Two other sensing electrodes were attached, one between the distal prominences of the radius and ulna of the wrist and the other between medial and lateral malleoli of the ankle (red electrodes). Participants were placed in dorsal decubitus on a stretcher and remained in rest for five minutes. After this period, the instrument was turned on and immediately provided information on body composition such as fat, lean body mass and body water in relative (%) and absolute (kg) values, using equations already programmed by the instrument's manufacturer[8].

Muscle strength

The right and left handgrip muscle strength was determined using a manual dynamometer (Crown®, Filizola, São Paulo, Brazil) with capacity of 100 kgf, shortly after checking anthropometric and body composition measurements. Prior to tests, all participants were advised on the operation of the equipment and the procedures for carrying out the measurement protocol. Two attempts were performed with application of manual contraction force for familiarization. For each test, two maximal attempts (approximately two seconds each attempt) were standardized, with a recovery interval of 1 min between each attempt. As a procedure, the participant, in the wheelchair, held the dynamometer with one hand and extended the arm along the body[9]. The grip adjustment was individualized in such a way that only the last four distal phalanges exerted force on the drawbar. From this position, the subject was instructed to perform a maximum contraction. The dynamometer was transferred to the other hand, in which the same procedure was performed. The recorded measure comprised the best performance obtained for each hand in kg.

For the 3kg medicine ball throw test (performed after handgrip test), the athlete sat in his own chair with the back firmly resting on the backrest.

After guidance on the procedures for performing the test, athletes held the ball with both hands against the chest and just below the chin, with elbows the closest as possible to the trunk without removing the back from the backrest. To maintain this position, an assessor remained throughout the test period by holding a fabric strip (10 cm) that surrounded the athlete's chest area to eliminate the bending action of the trunk during the throw. In addition to a familiarization throw, three attempts were made with interval of approximate one minute. The recorded measure comprised the best throw, in meters, between the starting point and the point where the medicine ball touched the ground.

Anaerobic power

In order to measure the anaerobic power of the upper limbs, the Wingate arm test was used. The test was carried out on a cycle ergometer model MAXX®, (Hidrofit, Belo Horizonte, Brazil) Monark® standard connected to the MCE® Software (Staniak, Poland) to record and analyze the mechanical parameters obtained during the test. In this sense, a series of data were obtained concerning the anaerobic power of the participant, such as peak power (PP) and mean power (MP) as well as fatigue index (FI%), which corresponds to the mechanical power that can be developed by the recruited muscular group in addition to the drop in performance during the test, respectively[11]. The cycle ergometer was specially adapted for this purpose. For this, a table with sufficient height to fit the participant's wheelchair was used and to place the cycle ergometer. The traditional pedal was replaced by a hand crank; the wheelchair was locked by two evaluators so as not to move and adjusted to allow the trunk to remain on the same line as the center of pedals.

Before starting the test, participants performed a 10-minute warm-up, which consisted of 3 to 4 sprints of approximately 5 seconds each, increasing the intensity until reaching the test load. Sprints were accompanied by two-minute intervals in which participants pedaled with arms without resistance. After warming up, instructions for the test were given, such as not lifting the trunk from the chair, performing maximum effort and reducing the effort when informed[6].

The test consisted of a maximum effort for 30 seconds, with individualized load corresponding to 5% of body weight, regardless of functional classification. The athlete was instructed to initiate the pedal movements at maximum speed immediately after the cycloergometer cage with load being released until then sustained by a researcher[11]. Throughout the test, the athlete received verbal encouragement and, upon completion, was instructed to continue pedaling for approximately one minute without resistance. The participant was then removed from the site for follow-up with the post-test evaluations, which corresponded to heart rate (HR) measurements and blood collection for analysis of lactate concentration.

HR was continuously recorded by means of a Polar® frequencymeter model RS800CX. The ear lobe was sterilized and punctured once with a sterile microlance (Embramed) and, after puncture, one to two drops of blood (25 µL) were directly deposited onto a reagent strip (BM-lactate Cobas® - Roche) for analysis of lactate concentration (Cobas® Acactrend Plus®). Blood collection was performed at 10 min before (rest) and at 4 and 8 min after (post-test). The anaerobic power results in the adapted Wingate thesis were presented in absolute units (W) and relative to body weight (W / kg^{-1}).

Statistical analysis

The Shapiro-Wilk test was used to verify data normality and the results were presented as mean and standard deviation, minimum and maximum values. Considering the need to use both limbs (upper) to perform the fundamentals of basketball (dribble, throw), the t-test for paired samples was used to compare measures of arm length, arm and forearm perimeters, bisthioid and humerus diameters and handgrip test on the right and left side of the body. This analysis had the purpose of identifying possible differences between the right and left side that could help in the description and identification of the sample used in this study. Data were processed in the SPSS statistical software version 17 (IBM SPSS®) and the significance level was set at $p < 0.05$.

RESULTS

Table 2 shows information about age, experience and training time as well as the anthropometric characteristics of wheelchair basketball athletes. There were no differences between the right and left sides for the anthropometric measurements of arm length, arm and forearm perimeter, humeral diameter and bisostyleid diameter.

Table 3 presents the results of handgrip strength, upper limb explosive strength and anaerobic power performance indicators obtained in dynamometry, medicine ball throw and Wingate arm tests, respectively. The mean handgrip strength (right and left hand) was 50.1 ± 10.6 kg; however, there was a significantly greater force in the right hand when compared to the left hand. The average lactate concentration after the interruption of the Wingate test reached the peak value corresponding to the eight-minute collection (7.3 ± 1.4 mmol L^{-1}). Additionally, one of the participants obtained peak lactate value of 10 mmol L^{-1} at 4 minutes, and 9.4 mmol L^{-1} at 8 minutes. All other athletes showed lactate peak value at 8 minutes (Table 3).

Table 2. Demographic, anthropometric and body composition characteristics of wheelchair basketball athletes (n = 11)

Variables	Min-Max	Mean ± SD	p*
Age (years)	17.4-47.2	33.2 ± 10.6	-
Experiment time (years)	1.0-8.0	3.7 ± 2.3	-
Training (h / wk)	2.0-6.0	4.5 ± 1.3	-
Body weight (kg)	50.7-99.0	71.8 ± 15.8	-
Height (cm)	152.3-182.8	168.2 ± 9.4	-
BMI (kg/m^2)	18.5-37.9	25.4 ± 5.6	-

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Variables	Min-Max	Mean ± SD	p*
trunk-cephalic height (cm)	68.8-84.5	79.7 ± 4.6	-
Length of right arm (cm)	74.0-83.0	77.7 ± 3.1	0.210
Length of left arm (cm)	72.0-81.4	77.1 ± 3.1	
Perimeter of right arm (cm)	27.6-38.2	33.3 ± 4.0	0.148
Perimeter of left arm (cm)	26.7-37.0	32.7 ± 3.4	
Perimeter of right forearm (cm)	24.0-33.3	29.2 ± 2.9	0.059
Perimeter of left forearm (cm)	24.5-32.2	28.8 ± 2.9	
Diameter of right humerus (cm)	5.1-6.7	5.8 ± 0.6	0.324
Diameter of left humerus (cm)	5.1-6.7	5.7 ± 0.6	
Diameter of right styloid (cm)	4.5-6.0	5.2 ± 0.4	0.307
Diameter of left styloid (cm)	4.1-6.0	5.2 ± 0.5	
Biacromial diameter (cm)	35.2-42.5	38.8 ± 2.5	-
Relative fat (%)	9.3-37.0	20.7 ± 7.6	-
Absolute fat (kg)	4.7-35.0	15.7 ± 8.9	-
Relative lean mass (%)	32.0-90.7	76.4 ± 15.7	-
Absolute lean mass (kg)	37.0-71.0	53.8 ± 10.1	-
Relative body water (%)	36.5-66.5	57.1 ± 7.9	-
Absolute body water (L)	30.5-52.0	40.2 ± 6.3	-

*Paired test: comparison between right and left side measurements of the body; BMI: body mass index

Table 3. Strength and anaerobic capacity performance of wheelchair basketball athletes (n = 11)

Variables	Min-Max	Mean±SD	p
Right hand grip (kg)	37.0-69.5	52.5 ± 10.7	0.037
Left hand grip (kg)	25.0-63.5	47.6 ± 11.5	
Mean hand grip (kg)	25.0-69.5	50.1 ± 10.6	
Power of upper limbs (m)	1.2-5.1	3.9 ± 1.1	-
Lactate pre 10 min (mmol L^{-1})	1.1-1.9	1.7 ± 0.3	-
Lactate post 4 min (mmol L^{-1})	2.8-10.0	5.6 ± 2.1	-
Lactate post 8 min (mmol L^{-1})	5.1-9.4	7.3 ± 1.4	-
Peak power (W)	133.2-536.9	327.1 ± 115.4	-
Peak power (W/kg)	1.4-7.0	4.8 ± 1.5	-
Mean power (W)	73.0-287.4	164.1 ± 68.8	-
Mean power (W/kg)	0.8-3.8	2.4 ± 0.9	-
Fatigue rate (%)	37.8-65.1	50.7 ± 8.5	-

W: watts; W / kg: watts corrected for body weight. *Paired test: comparison between right and left handgrip strength.

DISCUSSION

The aim of this study was to provide a descriptive analysis of the morphological structure (structure and body composition) and anaerobic power and strength performance of upper limbs of wheelchair basketball athletes. Although the average age of athletes in the present study is relatively high (33.2 ± 11.1 years), the training time (3.7 ± 2.4 years) suggests that it is a team with little experience with the effective practice of the sports when compared to male athletes of other teams such as Brazilians (9.7 ± 3.7 years)[12], Spanish (5.9 ± 3.9 years)[13], (12.8 ± 10.2 years)[14] and Italians (6.1 ± 3.4 years)[3]. The time in weekly hours devoted to basketball training in the present sample (4.5 ± 1.3 h / wk) was lower than that of other basketball players, who trained around 10.6 ± 5.5 h / wk[15]. Conversely, shorter weekly training time has been described in young Italian athletes with mean time of 2.9 ± 0.9 h / wk[3].

Anthropometric measures, such as arm length, arm and forearm perimeter, humeral diameter and bisostyleid diameter did not differ in relation to the right and left side, suggesting symmetry between these segments. Regarding right arm and forearm circumference, it was observed that athletes of the present study presented measures (33.3 ± 4.0 cm, 29.2 ± 2.9 cm, respectively) higher than Italian athletes (27.5 ± 4.4 cm, 25.0 ± 3.1 cm, respectively). However, the lower values for arm and forearm perimeters observed in Italian athletes are probably a consequence of the lower age range (18.1 ± 4.1 years). Right arm perimeter similar to that verified in the present study was observed in Spanish wheelchair basketball athletes in the first (34.7 ± 2.8 cm) and third divisions (32.1 ± 3.3 cm)[14].

Seated height is considered an important morphological variable in wheelchair basketball performance, since it can increase the chances of success in specific game actions such as blocking, rebounding and throwing. In this sense, the athletes of the present study presented an important disadvantage in the trunk-cephalic height (79.7 ± 4.6 cm) when compared to Spanish athletes of the first (91.4 ± 4.2 cm) and third divisions (85.6 ± 6.5 cm)[14].

As for the humerus diameter, Italian (6.3 ± 0.6 cm)[3] and Spanish basketball players of the first (7.6 ± 0.4 cm) and third division (7.1 ± 0.5) cm)[14] demonstrated higher values than athletes of the present sample (5.8 ± 0.6 cm). The lower values observed for trunk-cephalic height and humerus diameter suggest that athletes of the present study have lower bone constitution.

Considering the inherent difficulties in highlighting skinfold thicknesses of participants of this study, relative fat was determined by electrical bioimpedance using the Maltron® device, model BF-900. This instrument demonstrated validity for the estimation of body fat with the hydrostatic weighing method[8,16]. The results of measurements revealed that the relative body fat (20.7 ± 7.6%) demonstrated by athletes in this study is above values desired for men (13 to 15%), but compatible with samples of wheelchair basketball players investigated by Gorla et al.[17] (19.3 ± 8.4%, lower spinal cord injury, 23.4 ± 7.4%, upper spinal cord injury). However, participants in the present study had higher relative body fat value compared to wheelchair basketball athletes investigated by Rotstein et al.[18] (16.1 ± 10.0%). Regardless of comparisons, the fat percentage demonstrated by athletes in the present study should compromise the performance in the modality. This result finds support on the inverse relationship between body fat and physical performance[19].

The explosive strength performance and anaerobic capacity of wheelchair basketball athletes are partially in agreement with literature. The result of the manual pressure force test in the present sample revealed that the dominant hand is significantly larger than the non-dominant hand (around 5%). Corroborating this information, there are reports suggesting that the handgrip strength values of the dominant hand are approximately 10% higher than the non-dominant hand[20]. The mean handgrip force and the medicine ball throw values of the evaluated group were 50.1 ± 10.6 kg and 3.9 ± 1.1 m, respectively. Compared to Spanish third-division athletes, participants in the present study demonstrated better performance for handgrip strength (45.0 ± 10.0 kg); however, similar values for explosive strength of the upper limbs (3.8 ± 0.7 m in medicine ball throwing)[21]. In turn, Spanish athletes competing in the first division showed handgrip strength performance (53.8 ± 7.0 kg) and upper limb explosive strength values (4.9 ± 0.7 m) significantly higher than those of athletes in the present study[14]. Additionally, the explosive force performance in medicine ball throw of athletes in the present study was lower than that of Brazilian wheelchair basketball athletes who played games in the first division of São Paulo (5.2 ± 0.7 m)[12]; but equivalent to sedentary ones (3.8 ± 0.2 m)[22]. This information reveals that the technical level (Spanish and Brazilian first-division athletes) determined the best of manual grip strength and explosive force performances in the medicine ball throwing.

Regarding the anaerobic power indicators of arms, athletes in the present study demonstrated PP (316.8 ± 126.2 W) 20% lower than Brazilian (396.5 ± 128.2 W)[12] and Israelis athletes of the same modality (393.2 ± 68.8 W)[6]. Concomitant with the lower PP, the indicator that represents the capacity to maintain high energy demand for short periods, that is, MP, was approximately 50% lower (160.5 ± 76.5 W vs. 304.4 ± 94.3 W and 324.0 ± 55.9 W) when compared to athletes in the state of São Paulo[12] and in Israel[6], respectively. The FI% obtained for athletes of the present study (50.4 ± 9.6%) translated a marked reduction in the power maintenance capacity during the test, results similar to the study performed in Brazil (50 ± 11%)[12], but higher than the Israeli sample (39.4 ± 9%)[6]. The physiological requirements of competitive basketball practice suggest that the athlete should have high explosive strength and anaerobic power rates[23,24]. The relative contribution of the energy systems for the performance of the Wingate test was determined as 16% of aerobic, 56% glycolytic and 28% ATP-CP[25] contribution. In this sense, considering that the anaerobic power parameters (PP and MP) are indicators of specific training level for actions in the basketball game, the athletes of the present study showed a significant physical disadvantage related to anaerobic metabolism.

Although PP and MP of athletes in the present sample showed lower work sustained by anaerobic metabolism in relation to other athletes[6,12], the lactate concentration determined before and after the test suggests considerable anaerobic activation. Since Hutzler[6] and Lira et al.[12] did not control lactate concentration after the tests administered in their experiments, other studies should be used for comparisons. It was observed that in athletes of the present study, the peak lactate concentration (7.3 ± 1.4 mmol L^{-1}), after eight minutes of interruption of the Wingate test, was higher than the peak lactate concentration obtained in wheelchair basketball athletes (6.9 ± 2.0 mmol L^{-1}) [15,] wheelchair rugby athletes (5.7 ± 2.3 mmol L^{-1}) and in sedentary wheelchair users (4.2 ± 1.9 mmol L^{-1}) after 3 to 7 min of interruption of the Wingate test [26]. However, peak lactate concentration higher than that reported in the present study was found in the study by Weissland et al.[27]. The researchers submitted 16 wheelchair basketball athletes (14 men and 2 women) to two multiple-stage field tests, one classic and other modified, and demonstrated that lactate concentration at three minutes after effort was 8.6 ± 3.2 and 8.8 ± 3.0 mmol L^{-1}, respectively.

Regarding the study limitations, it is important to note that the ergometer used was adapted for evaluations, whereas, currently, there are ergometers specially designed for this purpose. However, it was observed that ergometers with hand crank adapted for arms are, in general, reliable and valid for the clinical evolution of the patient. In this sense, arm ergometers are used for the training of wheelchair patients with spinal injuries and other physical disabilities, such as hemiplegia and cardiac rehabilitation to increase physical capacity[28]. However, it is important to note that devices of this type do not simulate the actual working condition of a wheelchair, that is, the movement of propelling the chair using the side guides. This movement requires effort different from that provided in conventional arm ergometers. However, there is evidence showing that arm-ergometer training increases wheelchair propulsion and cardiorespiratory function in men with quadriplegia[28]. Another limitation refers to references for measures of arm length, styloid and biacromial diameters that were not found in literature, which impaired comparisons.

The results obtained showed that some anthropometric variables, as well as power performance indicators of athletes in the present study, are incompatible with similar characteristics of wheelchair basketball athletes present in literature, especially those competing with a higher technical level.

CONCLUSIONS

Morphological characteristics with fat percentage and sitting height, as well as explosive strength and anaerobic power performance indicators of the upper limbs of athletes in the present study suggest disadvantages when compared with similar characteristics of other wheelchair basketball athletes.

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