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Body composition and motor performance in wheelchair handball

Composição corporal e desempenho motor no handebol em cadeira de rodas

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Abstract – The aim of this study was to verify the relationship between body composition and motor performance in Wheelchair Handball players (WH). Overall, 21 athletes composed the sample (13 males and 8 females). To analyze motor performance, the following tests were used: ball driving, block performance, 20 m velocity and zigzag agility for individuals on wheelchair. Body mass, height, body perimeter and skinfold thickness (tricipital, subescapular, bicipital and supra-iliac) were used to establish body composition profile. Data was presented through descriptive statistics and inference was performed by Spearmans' and Kruskal-Wallis correlation coefficient (non-parametric). Therefore, strong and significant correlations between body composition and motor performance were detected within different functional class and also according to sex, whereas male athletes showed significant correlation between body fat percentage and agility ($r=0.70$, $p\leq0.01$) and, in the case of female athletes, body fat percentage is strongly related with speed ($r=0.81$, $p\leq0.01$) and agility ($r=0.74$, $p\leq0.05$). As conclusion, it was verified that apparently, increased body fat in body composition profile negatively influences motor performance in wheelchair handball players

Key words: Anthropometry; Body composition; Disabled people.

Resumo – *O objetivo deste estudo foi verificar as relações entre composição corporal e desempenho motor em atletas de Handebol em Cadeira de Rodas (HCR). A amostra foi composta por 21 atletas, sendo 13 atletas do sexo masculino e oito do sexo feminino. Para análise do desempenho motor foram utilizados os testes de condução de bola, desempenho de bloqueio, velocidade 20m e agilidade em ziguezague para indivíduos em cadeira de rodas. As variáveis massa corporal, estatura, perímetro corporal e espessuras de pregas cutâneas (tricipital, subescapular, bicipital e supra-ilíaca) foram coletadas para estabelecer o perfil da composição corporal. Os dados foram apresentados mediante estatística descritiva e a inferência foi realizada por meio do coeficiente de correlação de postos de Spearman e Kruskal-Wallis (não paramétricos). Observamos correlações entre composição corporal e desempenho motor nas diferentes classes funcionais e também de acordo com o sexo, sendo que atletas homens apresentaram correlações significativas entre percentual de gordura corporal e agilidade ($r= 0,70$, $p\leq0,01$) e em mulheres o percentual de gordura corporal está fortemente relacionado às variáveis velocidade ($r=0,81$, $p\leq0,01$) e agilidade ($r=0,74$, $p\leq0,05$). Concluímos que o aumento de gordura corporal em atletas de HCR aparentemente influencia negativamente o desempenho motor.*

Palavras-chave: *Antropometria; Composição corporal; Pessoas com deficiência.*

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INTRODUCTION

Wheelchair Handball (WH) is an adapted collective sport practiced in two distinct modalities: HCR7, which is an adaptation of court handball and is played with seven players per team and HCR4, which is an adaptation of sand handball, played with four players on the court. Developed with competitive character since 2005[1], the sport has grown significantly.

Given the current panorama of the modality, strategies have been adopted with the aim of improving the aspects of training. One of these initiatives concerns the evaluation of motor performance. This is a tool that assists in the prior planning of subsequent works[2], being a fundamental part of the training planning, checking the progress of athletes and the training effectiveness regarding the mentioned aspects.

With regard to the technical parameters of the modality, physical abilities and motor skills can be monitored. According to Brasile and Hedrick[3], motor skills must be considered in training programs, since their acquisition along with previous experiences are factors that positively influence the performance of athletes and teams. However, the evaluation of these motor abilities as well as the sports performance can be influenced by several processes and factors intrinsic and extrinsic to the individual[4].

Among the factors that interfere in the desired motor performance in non-disabled athletes is body composition. Riendeau et al.[5] reported that there is a positive correlation between high levels of fat-free mass and sports performance in activities of resistance, strength, power and speed, while increased adiposity has a negative impact on performance. This is in agreement with Cyrino et al.[6], who reported that lower body fat values can favor the maximum performance representing a lower energy consumption and favoring the process of recovery after effort.

However, although there is evidence of an important relationship between body composition and motor performance in conventional sports, in adapted sports practiced in wheelchairs, there is no evidence to identify this influence, which motivated conducting this study to verify the relation between body composition and motor performance of wheelchair handball athletes.

METHODOLOGICAL PROCEDURES

Participants

This study is characterized as descriptive with cross-sectional design. Twenty-one HCR4 athletes from two teams in the state of Paraná participated in this study. To participate in the study, athletes should have at least one year of practice and participation in at least one competitive event (state or national level). Of the 21 participating athletes, 13 were males with mean age of 34.4 ± 10.2 years and eight females with mean age of 34.6 ± 10.4 years. Participants were divided into three groups of functional classes: Low points - 1.0 and 1.5 (n = 7); Intermediate points - 2.0 and 2.5 (n = 6); and High points - 3.0, 3.5 and 4.0 (n = 9).

Anthropometry

Anthropometric variables body mass and height were measured using a Filizola® scale (São Paulo, Brazil) with reading scale in grams and a stadiometer with reading scale in millimeters. However, the body mass of individuals with amputation was determined using the equation proposed by Lee and Nieman[7], thus obtaining the corrected body mass. In cases in which the individual was unable to place himself in the orthostatic position, the supine height was evaluated.

Similarly, in cases where participants were unable to maintain orthostatic position during body mass measurement, a bench was used on the scale for athletes to sit. In this way, total mass (bank + athlete) was measured; after this measurement, the subject returned to the wheelchair and the bench weight was deducted from the total value, resulting in the body mass value. Body Mass Index (BMI) was obtained by dividing the mass (Kg) by squared height (m^2).

To measure skinfold thickness, the Harpenden® adipometer (St Albans, UK) was used to measure triceps, subscapular, bicipital and supra-iliac skinfolds according to the Guedes and Guedes protocol[8].

To estimate body density, specific equations were used by sex and age group through the Durnin and Womersley protocol[9], which uses triceps, biciptal, subscapular and suprailiac skinfolds. In order to measure body fat percentage (% body fat), the Siri[10] equation was used: % Body fat = (4.95 / Density - 4.50) * 100.

The Durnin and Womersley equation was used in the absence of specific validated protocols for this population and for prioritizing the upper limbs. It should be noted that the Bulbullian equation[11] was validated to evaluate fat percentage of athletes with SCI; however, due to the sample heterogeneity, we chose not to use it.

Abdominal circumference was measured with anthropometric tape with reading scale in millimeters. This measure was selected because it is one of the main predictors of body composition and cardiovascular risk for individuals with and without disabilities[12].

Motor Tests

Motor performance was evaluated through some of the tests proposed and validated by Costa e Silva et al.[1] to evaluate the motor skills of WH. The tests used were: ball driving; blocking performance; and 20m speed.

In the ball driving test, the athlete must drive the ball as fast as possible in accordance with WH rules within the course marked by six cones at a distance of 3 meters between cones. The athlete should be positioned before the start line of the test and, at the evaluator's signal, he / she should dribble in zigzag bypassing the cones as quickly as possible. Two valid attempts were performed and the best result computed for analysis.

The blocking performance test is delimited by four cones and a distance of 3 meters between them, in a straight line path of 9.75m in length. At the signal, the athlete moves quickly and simulates a block on the second cone. It then performs a spin and does the same with the first cone. Then, the athlete simulates a block the third cone, then rotates and performs it in the second, then goes to the fourth, then returns to the third, and after passing through the fourth cone, completes the course. In all, a 27-meter displacement is performed during the test due to changes in direction. The count for each attempt is the total time to complete the course. Two attempts are considered and the best result is computed for analysis.

The speed test consists of the athlete walking a distance of 20m, being positioned behind the starting line, demarcated by tape and at the signal of the evaluator, the athlete should move to the end line as quickly as possible. The test result is the time taken to complete the course. These are two attempts and the best will be computed for analysis.

In addition to these tests, the zigzag agility test was used for wheelchair users, validated by Gorgatti and Bohme[13], which aims to determine the subject's agility traveling a certain distance that requires changes of direction. This test has a course of 9m long by 6m wide. At the signal, the individual being evaluated starts the test behind the starting line and pushes the chair through the course as fast as possible, the test result is the time taken to travel the circuit, with accuracy of tenths of seconds. Three attempts will be made and the best result will be scored.

It is noteworthy that athletes used sports wheelchairs (Alphamix®, Aparecida de Goiana, Brazil), specific to the practice of the modality and tailored.

Statistical analysis

Data were presented through descriptive statistics, mean and standard deviation. Normality analysis was performed using the Shapiro-Wilk test. The Spearman correlation coefficient (rho, non-parametric) was used to analyze the relationship between anthropometric variables and motor performance. Comparisons between sexes were performed through Student's T (parametric) and Mann Whitney (non-parametric) tests. For the comparison of functional groups (low, intermediate and high), the non-parametric Kruskal-Wallis test for independent samples was used and multiple comparison was performed using the Dunn test. Data were analyzed using the R-Plus statistical package version 2.15.0®, 2012, for MSWindows® (Vienna, Austria), and the R-Studio® package (Boston, USA). The significance level adopted was $p \leq 0.05$.

RESULTS

The sample characteristics are presented in Table 1.

Regarding body composition profile, significant differences ($p \leq 0.05$) of % body fat were observed between sexes, and males had mean values of 22.7 (± 6.2) for this variable and females 31.5 (± 6.1). However, the analyses of functional classes did not present significant differences, even though high-point athletes presented better results in all variables.

Table 1. Sample characterization

Subject	Sex	Td	Age (years)	TP (months)	FC	Mass (kg)	Height (cm)	BMI (Kg/m²)
1	Male	Polyo	36	36	4.0	49	162	15
2	Male	Polyo	35	102	2.0	63	155	20
3	Male	Polyo	44	48	2.0	62	168	18
4	Male	Polyo	47	36	1.5	80	166	24
5	Male	Polyo	51	60	1.5	62	165	19
6	Male	Polyo	38	36	1.5	70	162	22
7	Male	Amp	40	84	3.5	88	178	28
8	Male	Amp	23	36	3.5	82	185	24
9	Male	Amp	23	72	3.0	73	174	26
10	Male	SCI	21	24	1.5	66	172	19
11	Male	SCI	19	84	1.5	72	180	20
12	Male	SCI	34	54	1.5	75	165	23
13	Male	HD	36	36	4.0	90	169	27
14	Fem	HD	34	36	4.0	66	169	20
15	Fem	HD	17	24	4.0	48	145	17
16	Fem	MD	25	36	1.0	50	150	17
17	Fem	Polyo	34	72	3.5	85	159	27
18	Fem	Polyo	54	42	2.5	60	155	19
19	Fem	Polyo	36	42	2.0	42	147	14
20	Fem	Polyo	40	60	2.0	43	138	16
21	Fem	CMF	35	60	4.0	34	133	13
	Mean		34.6	51.4		64.2	161.7	19.7
	±sd		±10.4	±21.3		±15.3	±13.6	±3.7

Male: male; Fem: female; TD: Type of disability; Age: Age; FC: Functional Classification; Mass: body mass; Height: height; BMI: body mass index; Polyo: Polyomelite; Amp: Amputation; SCI: Spinal Cord Injury; HD: Hip dislocation; MD: Muscular Dystrophy; CMF: Congenital malformation.

Regarding speed and blocking performance, males presented significantly better results than females ($p \leq 0.05$), and when considering the separation by functional class, no significant differences were observed for these variables.

Table 2. Descriptive statistics of the study variables

			Functional Class Groups		
Variable	Male (n=13)	Female (n=8)	Low points (7)	Intermediate points (5)	High points (9)
∑4SF (mm)	57.9(±24)	65.2 (±24.3)	61.6 (25.8)	68.2 (26.5)	63.1(18.7)
BMI (Kg/m²)	20.8 (±2.9)	18 (±4.4)	20.8 (2.5)	17.4 (2.4)	21.7 (5.6)
% Body Fat	22.7 (±6.2)*	31.5 (±6.1)	25.9 (6.9)	29.5 (8.3)	24.2 (7.9)
Circ. (cm)	91.7 (±11.8)	82.8 (±14.4)	92.4 (12.9)	84.6 (11.4)	87.2 (15)
Speed (sec)	5.1(±0.5)*	6.6(±2)	6.2 (2.2)	5.9 (0.9)	5.1 (0.7)
Bloc. (sec)	15.2(±2.2)*	18.6(±3.5)	17.9 (4.3)	17.2 (2.3)	15 (1.9)
Agil. (sec)	16.5 (±1.5)	18.7(±3.9)	19 (4.1)	17.3 (1.3)	16.1 (1.8)
Ball. (sec)	10 (±1.9)	10.5 (±6.5)	11.1 (1.9)	12.5 (5.8)	9.6 (1.5)

Σ4DC: Sum of skinfolds; BMI: Body Mass Index; % Body Fat: Body Fat Percentage. Circ: Abdominal Circumference; Speed: 20m Speed Test ; Bloc: Block Test; Agil: Modified Wheelchair Agility Test; Ball: Ball Driving Test. * Denotes statistical significance of $p \leq 0.05$.

In males, physical agility showed significant correlation with % body faty (r = 0.70, p = 0.00) and abdominal circumference (r = 0.65, p = 0.01). In females, body composition showed a higher correlation with motor performance, especially the strong correlations of % body Fat with physical capacity speed (r = 0.81, p = 0.05) and speed (r = 0.74, p = 0.03). In addition to variables presented in the table above, relationships between body mass and BMI with motor performance were also verified; however, no significant relationships were found between variables (Table 3).

Table 3. Correlation values between anthropometric variables and motor performance according to sex.

	Speed(sec)	Bloc.(sec)	Agil.(sec)	Ball.(sec)
		Men (n=13)		
∑4SF (mm)*	0.58	0.30	0.43	0.23
Circ.	0.34	0.48	0.65**	0.16
% Body Fat	0.32	0.51*	0.70**	0.13
		Women (n=8)		
∑4SF (mm)*	0.26	0.40	0.19*	0.54
Circ.	0.64	0.35	0.62	0.15
% Body fat	0.81**	0.59	0.74*	0.42

∑4SF: Sum of skinfolds; BMI: Body Mass Index; % Body Fat: Body Fat Percentage. Circ: Abdominal Circumference; Speed: 20m Speed Test ; Bloc: Block Test; Agil: Modified Wheelchair Agility Test; Ball: Ball Driving Test. * Denotes statistical significance of p≤0.01.

The same correlation analyses were performed according to functional classification, where the influence of body composition variables on motor performance can also be observed (Table 4). Athletes with lower functional classes and greater body fat accumulation presented worse motor performance results.

Table 4. Correlation values between anthropometric variables and motor performance according to functional class group

	Speed(sec)	Bloc.(sec)	Agil.(sec)	Ball. (sec)
		Low points (n=7)		
∑4SF (mm)*	0.60	0.78*	0.85*	-0.17
Circ	0.14	0.35	0.28	0.39
% Body fat	0.61	0.79*	0.85*	-0.17
		Intermediate points (n=5)		
∑4SF (mm)*	-0.76	-0.70	-0.70	-0.60
Circ	0.15	0.05	0.05	0.05
% Body fat	0.90*	0.80*	0.90*	0.60
		Low points (n=9)		
∑4SF (mm)*	0.58	0.30	0.43	0.40
Circ	0.04	-0.13	0.36	0.08
% Body fat	0.62	0.62	0.80**	0.65

∑4SF: Sum of skinfolds; BMI: Body Mass Index; % Body fat: Body Fat Percentage. Circ: Abdominal Circumference; Speed: 20m Speed Test ; Bloc: Block Test; Agil: Modified Wheelchair Agility Test; Ball: Ball Driving Test. * Denotes statistical significance of p≤0.01.

DISCUSSION

The aim of this investigation was to verify the relationship between body composition and motor performance in WH athletes. Thus the study showed that: 1) the body composition of WH athletes is associated with motor performance; 2) in men, body composition is strongly related to agility, indicating the tendency that the greater the abdominal circumference and % body fat, the lower the agility of athletes; 3) in women, body composition is strongly related to speed and agility, signaling that high % body fat is also detrimental to motor performance; 4) the negative influence of body composition on motor performance can be observed in the three groups of functional classes, having as indicator the greater fat accumulation.

The results observed in this study corroborate results of Neto and Cesar[14], who reported that excess body mass can cause damage to muscle endurance and speed of movement, thus increased fat is unfavorable for sports performance in collective sports.

Among the motor variables analyzed, agility is defined by Sheppard and Young[15] as "rapid body movements with changes of speed or direction in response to a stimulus". This author reported that agility is an important factor in court sports, since they usually include direction changes in response to a stimulus. For good performance of this skill, there are numerous interaction factors that must be observed, such as cognitive, physical and technical factors[16], as well as the motor repertoire and training of the individual. In addition, the results have shown that body composition can influence the agility performance, showing that the higher the % body fat, the lower the performance of athletes in this test, demonstrated by the increase in the time spent for its performance.

Strong and significant relationship of % body fat with speed was observed in females, indicating that increased fat will increase the time of travel in speed, which corroborates the study by Riendau et al.[5], who observed a negative impact of increased body fat on sports performance (strength, power and speed). It is noteworthy that this physical capacity is important for the sport performance in WH, since the modality has as characteristics accelerations, changes of direction and sprints. For Vanlandewijck et al.[17], speed in adapted sports depends on the relationship established between user and the wheelchair, and a good relationship contributes to all motor skills performed in WH, and is conditioned not only to ergometric aspects. For this reason, athletes use their tailored sports wheelchairs in the test, minimizing errors in this user-wheelchair relationship.

When variables were analyzed according to functional class groups, greater influence of body composition on the motor performance of athletes of intermediate points was observed (speed, block and agility), compared to athletes of low points (block and agility) and with those of high points (agility). This can be explained by the fact that athletes in the group of intermediate points presented greater % body fat compared to the other groups, although no significant differences were found between them.

Another factor that may have contributed are the different deficiencies of subjects of each functional class group, as it is the case of low and intermediate groups, which are mostly composed of individuals with SCI and Poliomyelitis, and tend to present increased motor impairment and increased body fat mainly in paralyzed limbs[18-20].

Regarding body composition profile, it was observed that women presented significantly higher body mass index than men, which is in agreement with Guedes and Guedes[8]. This difference in body composition justifies the need to analyze data of this study separately (by sex), since women also presented "worse" results in motor performance tests, compared to men.

Regarding the anthropometric profile expressed by BMI, this may be considered adequate for male athletes with physical disability, since the mean BMI value of men (20.8 ± 2.9 kg / m^2) in this study is not different from results obtained in the study by Keil et al.[21], in which the BMI of elite athletes in wheelchair basketball was 21.0 (± 2.0 kg / m^2). For the BMI values of women, no comparative parameters were found. However, BMI is not considered a good predictor for body composition analysis[22-25] because it does not distinguish fat mass and lean mass, which may underestimate or overestimate an individual's body fat.

Some aspects of this study deserve further comments. For example, the sample heterogeneity may have made comparisons between sexes and functional classes difficult, considering that the type of deficiency tends to influence body composition, and the relatively small sample size, which are study limitations, and may have impacted the analysis of data. The use of prediction equations by the anthropometric method using skinfolds is another limitation, since these equations are developed and validated for populations without deficiency and include assumptions about body fat distribution, which are different in individuals with deficiency, implying a greater error in the measurement of these variables. However, it is worth highlighting the need for this type of evaluation in order to generate information about the progress of training in the short and long term in order to obtain the best performance of each athlete.

CONCLUSION

The present study showed that the body composition of WH athletes is related to motor performance according to both gender and functional classification, and body fat accumulation may negatively influence motor performance.

Thus, the need to evaluate and monitor body composition is reinforced in order to minimize the negative effects of this variable on sports performance.

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