

Analysis of Anaerobic Performance between Futsal and Handball through the Wingate Test

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Objectives: The purpose of this study was to compare the anaerobic power of amateur futsal and handball players utilizing the Wingate Test. **Material and Methods:** Twenty-two athletes between the ages of 18 to 21, who agreed to participate in the research after reading and signing the Terms of Free and Clarified Consent, took part in the Wingate Test using 7.5% of their total body mass. The relative and absolute Maximum Power (MP); relative and absolute Average Power (Ap) and Fatigue Rate (FR) were compared. The statistical method used was the non-paired t-student test with a significance level of $P < 5\%$. **Results:** Handball players presented higher values of absolute MP (879.45 ± 182.22 W) and Ap (671.91 ± 109.37) when compared to the values of MP (749.00 ± 71.94) and Ap (600.42 ± 52.72) of futsal players. However, there was no significant difference when the variables studied were relative to the MP and Ap and Fatigue Rate. **Conclusions:** Based on these results, it can be concluded that handball presents greater alactic anaerobic power compared to futsal where, most likely, the importance of certain characteristics and specific training contributes to the determination of the predominant metabolic medium during sport practice.

Keywords: Anaerobic Capacity; Wingate; Fatigue; Sports; Anaerobic Power

Introduction

The activity patterns of many sports such as basketball, soccer, futsal and handball are intermittent, they consist of repeated bouts of brief (≤ 6 -second) maximal/near-maximal work interspersed with relatively short (≤ 60 -second) moderate/low-intensity recovery periods. This sport involves several sprints, which provoke high mechanical stress on lower body to high reaction forces during sprinting (Arjmandi, et al., 2010). If the recovery period is insufficient to restore the metabolism to its resting conditions, fatigue will occur and performance will be compromised (Glaister, 2005). During handball participation, for example a great number of rapid directional changes, starts, stops, jumps and landing occur (Arjmandi, et al., 2010). The ability to attain high performance recovery from high intensity training is a prerequisite for success in many sporting situations, but it is limited by what we call muscle fatigue, which can be defined as any exercise-induced decrease in maximal voluntary force or power produced by a muscle or muscle group (Lericollais et al., 2010).

During anaerobic metabolism, characterized by the ATP-CP and glycolytic systems predominant in anaerobic activity, it is

common that muscular fatigue occurs. During frequent periods of high intensity exercise in futsal and handball matches, muscular energy is generated by anaerobic glycolysis (Gastin, 2001).

Since handball and futsal are known as sports with, typically, short high intensity exercise periods alternated with moments of rest; the anaerobic metabolism would appear to be highly relevant to its performance (Rannou et al., 2001; Lima et al., 2005). Therefore, the anaerobic power and capacity are important variables in the performance of these sports (Lima et al., 2005).

Indoor soccer (futsal) is a sport that has had a significant increase of practitioners throughout the world, and its popularity is rising due to the huge availability of practicing spaced available (Ribeiro et al., 2003). According to the Brazilian Federation of football, this sport is currently played by over 12 million Brazilians (Ribeiro et al., 2003). However, despite its popularity in Brazil and other countries, futsal still appears as a modality that is lacking in more scientific approaches to various aspects of the sport; including physiologic conditions.

Conversely, handball has been drawing more attention in the last few years and has merited more studies that characterize the physiological profile of its players. Rannou et al. (2001) determined the physiological profile of handball players com-

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pared to sprinters, both enduring trained and untrained subjects. They performed a Wingate anaerobic test to determine maximal power (W_{max}). The authors disclosed that the values for W_{max} were similar in the international and national handball player groups and were also very similar to the values of the sprinters. When normalized for body mass or lean body mass, W_{max} was greater in handball players when compared to untrained or endurance trained subjects (Rannou et al., 2001).

For Molina, et al. 2009, the Creatine Phosphate mobilization rate is influenced by intensity and volume of exercise, CP concentration and type of muscle involved in that exercise which is used for a ATP synthesis. In their studies the fatigue rate decreased after a supplementation with creatine, this result shows us that type of exercise low CP amount is improved by use of creatine.

Another study evaluated the degree of neuromuscular fatigue and recovery from fatigue, following handball training and handball matches at the elite level. Neuromuscular fatigue was measured as changes in voluntary isokinetic knee extensions, jump height in counter-movement jumps, and 20 m sprint time. The results showed a significant reduction by 2% - 6% in all three performance tests during the training camp and by 4% - 7% during the tournament (sprint and jump test) ($P < .05$). Slow recovery was indicated by incomplete restoration of performance between matches and training sessions (Ronglan, 2006).

Therefore, it is important to study and determine the physiological profile of indoor soccer players and handball players based on their anaerobic power and capacity in order to evaluate their respective performances. There are various tests that evaluate anaerobic power and capacity; among them is the Wingate Test, which is considered an easy test to apply, valid and highly reproducible. Besides this, it has a meaningful correlation with anaerobic index such as lactate maximum concentration and oxygen deficit (Fernandez-del-Olmo et al., 2011; Okano et al., 2001; Bar-Or, 1987; Colantonio et al., 2003). These characteristics make this test very suitable for the analysis of anaerobic performance of individuals in the majority of sport modalities (Rannou et al., 2001; Ribeiro et al., 2003; Ronglan, 2006).

The objective of this study was to compare the anaerobic power and capacity, and fatigue rate of amateur futsal and handball players, during a 30-second Wingate anaerobic test.

Materials and Methods

Subjects: The sample of the present study was composed of 22 male athletes between the ages of 18 and 21, who agreed to participate in the research after reading and signing a Term of Free and Clarified Consent, explaining the objectives and risks of the research. The players were divided into 2 groups: futsal and handball.

All of the individuals were submitted to the same type of training and were participating in an official competition presented by the São Paulo Federation.

Criteria for exclusion were considered to be: female gender, any incompatibility due to health reasons and not having experience playing handball and futsal, respectively.

The athletes of both groups were submitted to an anthropometric evaluation of weight and height (**Table 1**) and an electrocardiographic register, according to the recommendations of the National Council of Ergometry (1995). Afterwards, the

Table 1.

Anthropometric characteristic of handball and futsal athletes (Mean \pm Standard Deviation).

Sports	Age (yr)	Weight (Kg)	Height (cm)
Handball	18.85 \pm .89	78.28 \pm 10.56	1.83 \pm .02
Futsal	19.44 \pm 1.81	69.2 \pm 4.68	1.74 \pm 4.88

Wingate Test was performed on a CYBEX[®] ergometric cycle metabolic bike 6000, in the Cardiovascular Rehabilitation Laboratory of the University of the Vale do Paraíba—UNIVAP, in the city of São José dos Campos, SP—Brazil.

The Wingate Test was characterized by the performance of the greatest number possible of pedal revolutions against a resistance fixed at 7.5% of body mass (Bello Junior, 1998), with a duration of 30 s. Before the test, the subjects remained at rest for 180 s on the bicycle, followed by 60 s of uninterrupted physical activity, the 30 initial seconds being performed in a submaximum phase and the 30 subsequent seconds in a maximum phase, in other words, the Wingate Test.

Before the execution of the test, the participants were instructed to do stretching and warm-up of the trunk, superior and inferior members by using the bicycle itself. As a simulation of the test; they were interrupted after 5 seconds from the start to rest for 2 minutes before initiating the definitive test.

After the Wingate test, the individuals performed a period of active recuperation on the cycle ergometric for 2 to 3 minutes.

Data Analysis: The data was analyzed using a non-paired t-student test. The level of significance adopted was $p < .05$

Results

The results illustrated in **Table 2** constitute maximum (MP) and average (Ap) power, absolute and relative for each group, obtained by the Wingate Test. In **Table 3**, the data represents the MP corresponding to each interval of 5 seconds of the Wingate Test.

The groups studied presented significant statistical differences for the values of absolute MP and Ap. However, there was no significant difference when the variables studied were relative MP and Ap and Fatigue Rate.

The analysis of Absolute Maximum Power (MP) for the 0 to 15-second time interval demonstrated significantly higher values in handball athletes when compared to Futsal players. On the other hand, there was no significant statistical difference when the values of the interval of 15 - 30 seconds were analyzed.

Discussion

There are few study reports available in scientific literature regarding the physiological variables of futsal (Lima et al., 2005). Futsal training should follow principles that take into account that during the game there are, evidently, moments of lactic and alacticanerobiosis.

Due to its exceptional qualities from a formative, educational and sportive perspective, handball is appreciated by both genders because it simultaneously develops resistance, ability, coordination, speed and strength; all at the same time, it is an explosive game. In addition to offering various qualities that are quite specific, it unifies the three natural athletic phases:

Table 2.

Values of the Mean and standard deviation of maximum and average potency, absolute (W) and relative (W/kg) and the fatigue rate (%), MP = maximum potency; Ap = average potency; W = Watt; W/Kg = W/corporal weight; FR = Fatigue Rate; SD= standard deviation.

		Handball		Futsal		P < 5%
		Mean	SD	Mean	SD	
MP	(W)	879.45	182.22	749.00	71.94	1.60%
	(W/Kg)	11.6	1.31	10.76	1.06	8.51%
Ap	(W)	671.91	109.37	600.42	52.72	2.79%
	(W/Kg)	8.77	.57	8.63	.79	31.88%
	FR (%)	47.82	7.77	43.42	8.82	10.98%

Table 3.

Mean and standard deviation (SD) of maximum potency (W) for each 5 seconds of the Wingate Test, SD = standard deviation; Sec = seconds; TT = Test T.

Sec	Handball		Futsal		TT
	Mean	SD	Mean	SD	p < 5%
0 - 5	813.45	138.00	717.08	69.92	2.21%
5 - 10	785.09	131.87	689.75	56.34	1.62%
10 - 15	716.82	131.80	635.75	54.71	3.18%
15 - 20	647.09	121.58	579.67	64.99	5.39%
20 - 25	574.91	103.04	517.92	70.20	6.66%
25 - 30	493.73	76.24	461.50	64.45	14.23%

running, jumping and throwing (Bello Junior, 1998).

Rannou et al. (2001) evaluated professional French Handball players who trained for 120 minutes a day, 5 times a week for 7 years. The authors disclosed an absolute maximum power of 1067 W and a relative maximum power of 14.5 W/Kg. In contrast, the values of the Handball team found in our study were inferior to those encountered by Rannou et al. (2001), corresponding to 879.45 and 11.46 for absolute and relative MP, respectively. The fatigue rate of this modality in our study was 47.82%. It is possible that the discrepancies encountered in the two studies are due to differences in training, professional level and the number of training sessions per week.

Franchini (2002) and Okano et al. (2001) suggest that the MP observed during the test is indicative of anaerobic power while the Ap would be indicative of anaerobic capacity. According to Campeiz and Oliveira (2006), the peak of power or MP represents the potential to generate energy through the alactic anaerobic system (ATP-CP), which is depleted in 5 to 10 seconds, its maximum peak being reached between 1 and 5 seconds and characterized by explosive movements.

On the other hand, the anaerobic capacity is obtained at the end of the 30 seconds of the test which, according to Bar-Or (1987), reflects the capacity to support the acidosis related to the capacity of the glycolytic system, in other words, the efficiency of the lactic metabolism, reflecting directly on the capacity of the athletes to support longer efforts of force and speed.

Based on this point of view, it is possible to consider that the handball athletes presented alactic anaerobic power and greater anaerobic capacity in relation to the futsal players. However,

considering that the relative MP and relative Ap did not present significant statistic differences between the groups studied, it is possible to infer that the better performance of the absolute MP (anaerobic power) and of the absolute Ap (anaerobic capacity) of the handball players were influenced by the differences of corporal mass.

In relation to the observation of MP during the Wingate Test, both of the groups studied presented a gradative decrease. According to Thomas et al. (2002), the adenosine triphosphate-creatine phosphate (ATP-CP) is responsible for providing energy for muscular contraction at the beginning of the exercise and in exercises of short duration and high intensity (that is, a duration of less than 5 seconds). Therefore, since the system is rapidly depleted in a short time (due to the muscles' low capacity of storage), in just a few seconds the potency tends to fall.

Although the behavior of anaerobic performance of the studied individuals through the analysis of MP during the Wingate Test was the same, the handball group presented significantly higher MP values in the 0 to 15-second interval. It can be suggested that the handball team presented greater alactic anaerobic power in the initial stages of the Wingate Test.

Perspectives

In the Wingate Test, the handball players presented greater absolute maximum and average power than the futsal athletes. On the other hand, there was no significant statistical difference for relative maximum or average power and fatigue rate among the handball and futsal players.

The results demonstrate that the differences manifest themselves mainly in the maximum power, absolute average and, therefore, in the explosive characteristics of the athletes. We can suggest that handball presents greater alactic anaerobic power in relation to futsal and that the importance of the characteristics and specific training of the sports probably contribute to the determination of the predominant metabolic medium during the practice. These results suggest that both sports modalities demand high performance of anaerobic power, requiring rapid movements in a short time.

Determining the physiological profiles of these sports can help to indicate the type of training and the specific training that could create better physical performance.

On the contrary, the Wingate Test showed that it is a useful and reliable tool in the evaluation of handball and futsal players.

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