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## ORIGINAL

### ANALYSIS OF THE PHYSIOLOGICAL PARAMETERS OF JUNIOR SPANISH BADMINTON PLAYERS

### ANALISIS DE PARÁMETROS FISIOLÓGICOS EN JUGADORES JUVENILES ESPAÑOLES DE BÁDMINTON

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## ABSTRACT

The aim of our study was to determine the physiological characteristics of young badminton high level players and to compare the physiological parameters obtained in the laboratory and during a match. Nineteen youth players were studied, 12 men and 7 women. A maximal exercise test in the laboratory was performed to the patients and anthropometrics parameters were taken. Their heart rate, lactate concentration and subjective ratings of perceived exertion were tested during competition.

The maximum oxygen consumption ( $VO_2$  max) has averaged  $56.07 \pm 6.5$  ml/Kg/min. The peak lactate  $3.18 \pm 1.78$  MML-1 and the average maximum heart rate (HR max) was  $196.75 \pm 5.29$  ppm, no significant differences in any of the parameters studied between males and females or between the laboratory and the competition.

**KEYWORDS:** Badminton, oxygen intake, field test, lactate, anthropometry.

## RESUMEN

El objetivo de nuestro estudio es conocer las características fisiológicas de los jugadores juveniles de bádminton de alto nivel y comparar los parámetros fisiológicos obtenidos en el laboratorio y durante un partido. Se estudiaron 19 jugadores en edad juvenil, 12 varones y 7 mujeres. A todos se les realizó una prueba de esfuerzo máxima en el laboratorio y mediciones antropométricas. Durante la competición se les monitorizó la frecuencia cardiaca, se analizó la concentración de lactato y se valoró su percepción subjetiva al esfuerzo (RPE).

El consumo máximo de oxígeno ( $VO_2$  máx.) medio se situaba en  $56,07 \pm 6,5$  ml/Kg/min. El pico de lactato en  $3,18 \pm 1,78$  mL<sup>-1</sup> y la frecuencia cardiaca máxima media (FC máx.) era de  $196,75 \pm 5,29$  p. p. m., sin diferencias significativas en ninguno de los parámetros estudiados entre varones y hembras en el laboratorio y la competición.

**PALABRAS CLAVE:** Bádminton, consumo de oxígeno, test de campo, lactato, antropometría.

## INTRODUCTION

Badminton is a sport with a high dynamic component and a low static component (1). The length of matches varies according to the inherent conditions of the competition and it requires high-intensity effort throughout the match, with short rest periods (2-3). Previous studies have analysed physiological features during matches, showing the importance of producing aerobic and alactic anaerobic energy during badminton matches (2, 4).

The performance of a maximal exercise test in the laboratory taking lactate measurements and determining metabolic thresholds allows us to measure the physiological response to exercise (5). The aim of our study is to analyse different physiological parameters while a maximal exercise test is performed in the laboratory and to compare them with those obtained during a match. It would be useful to know if the parameters measured in the laboratory bear some relation to those obtained during competition; in this way, the exercise test could be of interest for monitoring and planning training for junior badminton players.

## **MATERIAL AND METHOD**

We performed a descriptive study on 19 Spanish junior badminton players, which is the total number of high-level (technical) players in the Autonomous Community of Madrid (Spain) in this sport: 12 males and 7 females (the properties of the sample are displayed in Table I).

All subjects and their legal guardians were informed about the nature and characteristics of the study and they signed their informed consent beforehand, in accordance with the ethical principles established by the declaration of Helsinki for research involving human subjects (6). The study was approved by the ethics committee of the Official Medical Association of Madrid.

The following functional evaluation tests were carried out in the laboratory:

-Prior sports physical examination performed by the authors of the study: (medical history, physical examination, baseline ECG and baseline forced spirometry).

-Anthropometric and body composition study. The measurements were taken in accordance with ISAK's recommendations (7) by a single accredited researcher, one of the co-authors of the article. Body composition was studied, obtaining the body mass index or the Quetelet index, fat weight in accordance with Faulkner's equation (8), bone weight in accordance with Von Döbeln-Rocha's equation (9-10) and muscle weight in accordance with Lee's formula (11). To study the somatotype, the Heath-Carter (12) method was employed, using the Duquet-Carter nomenclature (13).

-Maximal exercise test on a treadmill, with incremental speed protocol of (2 km/h/2') on a fixed gradient (3%) until exhaustion. All the players included in this study met the maximal ergospirometric criteria for an exercise test (14-15).

A Jaeger® Oxycon Pro system was used to analyse exhaled gases. This system analyses exhaled gases breath by breath. The monitoring of the players in the laboratory was carried out with a General Electric® electrocardiograph system model Fe 770.

We detected aerobic (VT1) and anaerobic (VT2) ventilatory thresholds using the ventilatory equivalent method (16), once a consensus was reached among all the authors of the article.

The same players were studied playing matches on different days, with a minimum of one week between each match studied. Capillary blood samples were taken at the start and the end of the match and after 2 minutes of recovery, and the lactate concentration was analysed. This analysis was carried out using the YSI® 1500 SPORT Lactate Analyzer.

During the whole match, HR was monitored with a Polar® heart rate monitor, including the phases of competition and rest.

After the match, the players conducted a self-assessment using the Borg scale (17-18) and they noted their own central and peripheral rating of perceived exertion.

All the data obtained were processed using the SPSS 19 statistics software. Descriptive and frequency statistics: Mean and Standard Deviation (Mean +/- SD) were used. The non-parametric statistical tests (Wilcoxon) were used in order to evaluate the significance of the differences found. The significance level was established at  $P < .05$ .

## RESULTS

The mean game time per match was 17.2±0.2 minutes and rest periods were in accordance with the rules (a maximum of 2 minutes per match).

### Anthropometric data

Tables I and II display the anthropometric data and the somatotype of the study population. We did not find statistically significant differences between males and females in the anthropometric parameters studied.

Comparing the weight and height data with the tables most commonly used in our country (19), we found that males had a percentile of  $P_{50}$  for weight and height, and a body mass index (BMI) of  $P_{50-75}$ , while females had a percentile of  $P_{90}$  for weight and height, and a BMI percentile of  $P_{50-75}$ .

With regard to the somatotype, we found significant differences in mesomorphs and ectomorphs ( $P < .05$ ) and higher endomorphic values in females. The male junior badminton players had a mesomorph somatotype, while the female players were mainly endomorphs (Table II). Figure 1 contains the somatochart for our sample, divided according to sex.

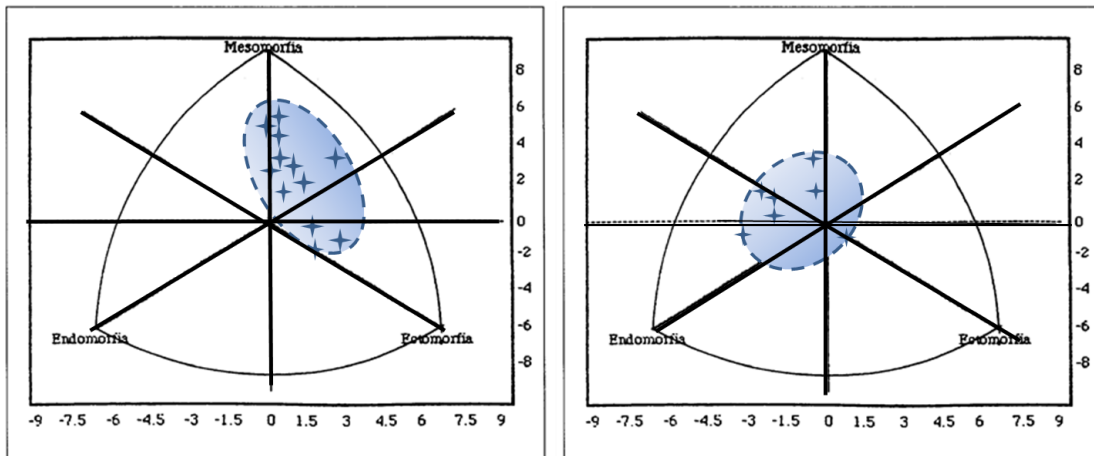
Table I: Anthropometric data

Sex	Age (years)	Height (cm)	Weight (kg)	% fat	% muscle	% bone	BMI
Male	16.45+/- 3.69	170.80+/- 11.23	61.10+/- 16.66	12.03+/- 2.83	46.33+/- 3.04	17.50+/- 2.14	20.56+/- 3.39
Female	13.25+/- 1.70	165.38+/- 3.63	59.27+/- 5.21	15.52+/- 3.07	45.35+/- 1.70	15.00+/- 0.91	21.63+/- 1.25
Total	15.60+/- 3.54	169.35+/- 9.95	60.61+/- 14.31	12.96+/- 3.20	46.07+/- 0.70	16.83+/- 0.56	20.84+/- 0.76
<i>P</i>	0.23	0.13	0.10	0.51	0.21	0.092	0.12

Table II. Somatotype

Sex	Endomorphs	Mesomorphs	Ectomorphs	Somatochart X	Somatochart Y
Male	2.49+/-0.53	4.14+/-0.86	3.58+/-1.17	1.08+/-1.47	2.20+/-2.66
Female	4.17+/-1.18	2.59+/-0.56	2.59+/-0.56	-1.57+/-1.65	0.66+/-1.37
Total	3.18+/-0.28	3.50+/-2.59	3.17+/-0.59	-0.11+/-0.48	1.57+/-0.56
<i>P</i>	0.08	0.01	0.037	0.03	0.18

Figure 1- Somatochart



Male

Female

Figure 1 Key  
 Mesomorfa = Mesomorphs  
 Endomorfa = Endomorphs  
 Ectomorfa = Ectomorphs

Functional data in the laboratory

Table III shows the values obtained in the laboratory: Maximal oxygen consumption and ventilatory thresholds. We did not find significant differences between males and females in any of the variables studied.

**Table III.** Mean laboratory values

	(VO <sub>2</sub> max ml/mn)	(VO <sub>2</sub> max ml/Kg/mn)	HRmax	HR VT1	%VO <sub>2</sub> VT1	HR VT2	% VO <sub>2</sub> VT2
<b>Male</b>	3829.22+/- 668.76	58.22+/- 6.09	195.33+/- 5.14	145.44+/ -17.60	57.57+/ -6.71	179.22+/ -8.67	85.17+/- 6.70
<b>Female</b>	2823.00+/- 51.64	49.63+/- 1.62	201.00+/- 3.46	160.67+/ -3.25	64.33+/ -10.39	183.00+/ -8.88	83.10+/- 8.49
<b>Total</b>	3577.67+/- 729.97	56.07+/- 6.52	196.75+/- 5.29	149.25+/ -16.57	59.26+/ -7.85	180.17+/ -8.48	84.65+/- 6.83
<b>P</b>	0.053	0.189	0.42	0.13	0.30	0.88	0.19

VO<sub>2</sub> max.: Maximal oxygen intake

### Data during competition

No significant differences were found between males and females in the parameters studied (Table IV).

The maximal HR and the mean HR during the match were 96.64% and 91.76% with respect to the maximal HR obtained in the laboratory.

**Table IV:** Mean values obtained in the match

Sex	Max HR (bpm)	Mean HR (bpm)	Mean HR 1st rest (bpm)	Mean HR 2nd rest (bpm)	Baseline lactic Mm/L	Peak lactic Mm/L	2 <sup>nd</sup> rest lactic	Central RPE	Peripheral RPE
<b>Male</b>	188.10+/- 10.54	168.90+/- 13.01	135.90+/- 17.86	143.88+/- 22.05	1.64+/- 1.21	3.15+/- 1.99	2.87+/- 1.42	13.00+/- 1.88	12.00+/- 1.56
<b>Female</b>	197.33+/- 3.05	179.00+/- 6.00	152.67+/- 14.18	158.33+/- 7.63	1.63+/- 1.15	3.30+/- 1.12	2.73+/- 1.95	13.67+/- 1.15	11.67+/- 0.577
<b>Total</b>	190.23+/- 10.07	171.23+/- 12.35	139.77+/- 18.08	147.82+/- 19.94	1.63+/- 1.15	3.18+/- 1.78	2.83+/- 1.47	13.15+/- 1.72	11.92+/- 1.38
<b>P</b>	0.71	0.32	0.81	0.45	0.88	0.49	0.49	0.48	0.19

RPE: rating of perceived exertion

### DISCUSSION

Badminton is a very popular recreational sport but few people play it at a competitive level in Madrid. The players studied correspond to the total number of technical players in the Community of Madrid.

With regard to the anthropometric evaluation, we used the equations recommended for sportspersons (20), we considered the possibility of employing other formulas recommended for adolescents to obtain a fat and muscle percentage (Slaughter and Poortmans respectively) (20), but eventually we included our players in the sportspersons group, regardless of their age.

Our players displayed a slightly lower fat percentage and a slightly higher muscle percentage than the mean values for the general population of their age, compared with the data that we had previously obtained (n:100) (21-22).

The total average length of the matches analysed was significantly lower than the data provided in highly competitive matches (3), probably due to the younger age and lower competitive level of our sample, since the duration of the points is notably lower.

The absolute values of max VO<sub>2</sub> were higher in males with respect to females, although the differences were not significant. The mean maximal VO<sub>2</sub> obtained in the laboratory is between 51 and 62ml/kg/min, depending on the work (2, 23-26), similar values to those that we obtained (56.1 +/- 6,5 ml/kg/min). Faude et al (2) found slightly higher values in males, yielding oxygen consumption of 61.8ml/kg/min, while in females, the values were similar (50.3ml/kg/min). Ooi et al (25), presented similar values to ours for elite sportspersons (56.9ml/kg/min) and lower values for recreational sportspersons (56.9ml/kg/min), while Dias et al. (27) obtained values lower than ours in females (43.8ml/kg/min) and Hughes (26) and Majumdar et al (23) in males.

Our players are younger and have an acceptable aerobic capacity for their age, similar to that of older players. Furthermore, these values are close to those found in elite Spanish sprinters and jumpers and lower than those of endurance athletes (5).

The maximal HR reached during the match is similar to that found in other studies we consulted (2-3, 23). In our study, we obtained 96.64% of the maximal HR, a higher percentage than that found by other authors in a recent work (4). Nevertheless, mean HR during the match was higher than that obtained by other authors for elite sportspersons (2-3, 23), and similar to that obtained for sportspersons of the same age group (4).

These high HR values may be due to the characteristics of the game itself. High intensity, short duration exercises are required, generating a high level of stress, with resulting sympathetic nervous system stimulation and, consequently, an increase in the HR. Furthermore, young sportspersons are more vulnerable to stressful situations, and as such their mean HR increases with respect to older players.

We did not find significant differences between the maximal and submaximal heart rates obtained in the laboratory or those obtained during the game between males and females. We noted that the mean heart rates during the match correspond to those obtained in the laboratory between VT1 and VT2, which is of practical interest for the use of heart rates in planning training.



The peak lactate concentration during a badminton match does not reach high values according to hitherto performed studies, and is between 2 and 5 mM.l<sup>-1</sup> depending on the authors (2-3, 23-24). These data coincide with those that we obtained, and in our study they are 3.2±1.8 mM.l<sup>-1</sup>.

In studies carried out on high-level badminton players during a real match, the peak lactate concentrations obtained were higher than those that we obtained (3, 23). Since this study focuses on young players, they may not be able to tolerate high lactate concentrations during competition. Furthermore, in any case, lower match duration and recovery phases during the match may prevent high concentrations of lactate from being obtained and as such, the appearance of fatigue is minimised, as was noted in this work, with peripheral RPE values of 12 and central RPE values of 13 being obtained at the end of the match (Perception of the exercise between light and somewhat intense). There were no differences between males and females. These data are lower than those obtained by Fernández-Fernández et al (4), although the latter do not differentiate between central and peripheral RPE.

## CONCLUSIONS

Junior badminton players achieve similar maximal heart rate values in the laboratory and in matches and there is no difference between males and females.

Mean heart rate obtained during the match corresponds with that obtained in the laboratory and it is between VT1 and VT2.

The above mentioned findings are of practical interest for the use of heart rates in the planning badminton training.

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