

COMPARISON OF AEROBIC POWER AND CAPACITY BETWEEN ATHLETES FROM DIFFERENT SPORTS



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COMPARAÇÃO DA POTÊNCIA E CAPACIDADE AERÓBICA ENTRE ATLETAS DE ALTO RENDIMENTO DE DIFERENTES MODALIDADES ESPORTIVAS

COMPARACIÓN DE POTENCIA Y CAPACIDAD AERÓBICA ENTRE ATLETAS DE ALTO RENDIMIENTO DE DIFERENTES MODALIDADES DEPORTIVAS

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ABSTRACT

Introduction: Ergospirometry is a noninvasive procedure used to assess physical performance or the capacity of an individual, through an analysis of expired gases and respiratory variables. This procedure is crucially important in sports, and makes a significant contribution to the measurement of cardiorespiratory fitness indices, such as maximal oxygen consumption (VO_2 max) and the anaerobic threshold (AT). **Objective:** To assess aerobic capacity and potency in professional and junior soccer players, handball athletes, and women soccer players. **Methods:** Forty-eight athletes participated voluntarily and were divided into 4 groups. The first group consisted of 12 youth soccer players in the under-20 category, the second group was made up of 12 professional soccer players, the third group was made up of female soccer players, and the fourth group consisted of handball players. **Results:** We analyzed values such as peak VO_2 , average speed and heart rate at the anaerobic threshold as well as pulmonary ventilation. We found that the values were always greater for the group formed by professional soccer players, with the exception of mean maximum O_2 consumption, in which the difference between this group and that of soccer players in the junior category was not significant. In other physical valences, there was a degree of similarity between the other groups, with special emphasis on pulmonary ventilation, which was significantly lower in the group of female soccer players. **Conclusion:** The particularities of each sport, such as pitch dimensions, duration, and tactical system, together with the morphology and sex of the athletes, directly influence peak VO_2 , AT and VE values in athletes who play different sports. **Level of Evidence III; Development of diagnostic criteria in consecutive patients (with gold reference standard applied).**

Keywords: Spirometry; Sports medicine; Soccer; Physiology; Ventilation.

RESUMO

Introdução: A ergoespirometria é um procedimento não invasivo, utilizado para avaliar o desempenho físico ou a capacidade de um indivíduo, pela análise de gases espirados e variáveis respiratórias. No esporte, é de fundamental importância e traz significativa contribuição na verificação de índices de aptidão cardiorrespiratória, como é o caso do consumo máximo de oxigênio (VO_2 máx.) e do limiar anaeróbico (LA). **Objetivo:** Avaliar a potência e a capacidade aeróbica em atletas profissionais e juniores do futebol, atletas de handebol e mulheres futebolistas. **Métodos:** Participaram voluntariamente 48 atletas divididos em 4 grupos. O primeiro grupo foi composto por 12 jovens futebolebolistas na categoria sub-20, o segundo grupo era formado por 12 futebolistas profissionais, o terceiro grupo foi formado por futebolistas do sexo feminino e o quarto grupo, por atletas de handebol. **Resultados:** Foram analisados valores como pico de VO_2 , velocidade média e frequência cardíaca do limiar anaeróbico, além da ventilação pulmonar; verificaram-se valores sempre maiores para o grupo formado por jogadores de futebol profissional com exceção do valor médio de consumo máximo de O_2 , no qual a diferença para futebolistas da categoria juniores não foi significativa. Em outras valências físicas, houve alguma semelhança entre os demais grupos, com destaque para a ventilação pulmonar, que foi significativamente menor no grupo de futebol feminino. **Conclusão:** As especificidades da modalidade, como dimensões do campo de jogo, tempo de duração, sistema tático, em conjunto com a morfologia e o sexo dos atletas influenciam diretamente os valores de VO_2 pico, LA e VE nos atletas de diferentes modalidades. **Nível de Evidência III; Desenvolvimento de critérios diagnósticos em pacientes consecutivos (com padrão de referência "ouro" aplicado).**

Descritores: Espirometria; Medicina esportiva; Futebol; Fisiologia; Ventilação.

RESUMEN

Introducción: La ergoespirometría es un procedimiento no invasivo, utilizado para evaluar el desempeño físico o la capacidad de un individuo, utilizando análisis de gases espirados y variables respiratorias. En el deporte, es de fundamental importancia y trae significativa contribución en la verificación de índices de aptitud cardiorrespiratoria, como es el caso del consumo máximo de oxígeno (VO_2 máx.) y el umbral anaeróbico (UA). **Objetivo:** Evaluar la potencia y la capacidad aeróbica en atletas profesionales y juveniles de fútbol, atletas de hándball y mujeres futbolistas. **Métodos:** Participaron voluntariamente 48 atletas divididos en 4 grupos. El primer grupo fue compuesto por 12 jóvenes futbolistas en la categoría sub-20, el segundo grupo era formado por 12 futbolistas profesionales, el tercer grupo fue formado



por futbolistas del sexo femenino, y el cuarto grupo por atletas de hándball. Resultados: Se analizaron valores como pico de VO₂, velocidad promedio y frecuencia cardíaca del umbral anaeróbico, además de la ventilación pulmonar; se verificaron valores siempre mayores para el grupo formado por jugadores de fútbol profesional con excepción del valor promedio de consumo máximo de O₂ donde la diferencia para futbolistas de la categoría junior no fue significativa. En otras valencias físicas hubo cierta semejanza entre los demás grupos, pudiendo ser destacada la ventilación pulmonar, que fue significativamente menor para el grupo de fútbol femenino. Conclusión: Las especificidades de la modalidad, como dimensiones del campo de juego, tiempo de duración, sistema táctico, en conjunto con la morfología y sexo de los atletas influyen directamente en los valores de VO₂ pico, UA y VE en los atletas de diferentes modalidades. **Nivel de Evidencia III; Desarrollo de criterios diagnósticos en pacientes consecutivos (con patrón de referencia "oro" aplicado).**

Descriptor: Espirometría; Medicina deportiva; Fútbol; Fisiología; Ventilación.

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INTRODUCTION

Oxygen uptake (VO₂ max.) can be defined as a maximal volume of oxygen that a individual person can absorb per time unit.^{1,2,3} VO₂ Peak is the higher value observed during the effort test, it has been considered a important performance parameter, because the capacity of human to be able for long term exercise depends priority of aerobic metabolism. Overall, a index useful to determine a capacity functional cardiorespiratory in athletes.^{2,3,4} The Oxygen Uptake was for long time the more important and used pathway to show aerobic skills, but some research's has been showing that index isn't enough to discriminate performance in aerobic events.⁵ And it has permanent of these methods of training and means the rates for athletic fitness aerobic for sport becomes pertinent.⁶ The anaerobic threshold is the point where the transition from aerobic to anaerobic metabolism occurs and is also an index that satisfactorily reflects physical fitness, being used in training as an evaluation and in the training of athletes.^{1,5} When the edge is removed from the respiratory rays, it can be defined as a stress current on the production of lactic acid that exceeds its removal, having a hyperventilation as a consequence.⁷

Ergospirometry, a non-invasive and useful procedure for the evaluation of physical exercise or functional capacity of an individual, reconciles an analysis of gas, sneezing, respiratory variables and oximetry.^{8,9} This method is able to determine the performance indicators, such as the exercise intolerance option and a metabolic mean of performance in exercise prescription.^{1,3}

Football presents changes of intensity, small recovery pauses, acceleration and deceleration, abrupt stops and changes of direction, that is, athletes experience the intermittent movements of nature during training and competitions. Other characteristics, energy production by children is more important, mainly, aerobic metabolism, which is related to the ability to maintain the intensity of effort during play by the recovery of high intensity stimuli.⁵

Handball requires a high level of general and specific conditioning, the effective time of a match is 40 minutes, with consecutive and challenging attacks in high intensity and different components such as accelerations, changes of direction and jumps, a diversity of arguments requires thorough preparation in terms of strength, speed and speed.¹⁰

METHOD

Was tested 48 athletes they were divided into 4 groups of 12 athletes. The group 1 was builded of 12 young men playing soccer in the Under 20 division, with mean age of 17 (± 0.5) years and mean weight of 67.8 (± 4.5) Kg The second group consisted of 12 professional soccer players (FMP), with a mean age of 23 (± 1.6) years and mean weight of 73.1 (± 4.7) kg, the third group was formed by footballers (FF), with a mean age of 21 (± 1.3) and mean weight of 57.6 (± 3.1) kg, and finally the fourth group was formed by handball athletes (MH) with age mean of 19 (± 1.3) and mean weight of 83.8 (± 7) kg.

The study was submitted and approved by the Ethics and Research Committee (CEP) of the University of Vale do Paraíba-UNIVAP. Individuals were informed of this study and a consent form was applied, as determined by resolution 196/96 of the CNS.

A Micromed digital electrocardiograph was used for the study to record and analyze the ECG during exercise; an Inbrasport treadmill, Super ATL model; a VO 2000 gas analyzer of the MedGraphics brand, coupled to a microcomputer, equipped with the Elite software produced by Micromed; nasal clip; disposable electrodes; disposable razor blades; disposable cartridges; alcohol 70.

The tests were performed in the pre-season, more precisely in the pre-competitive period of the four groups of athletes studied in the Laboratory of Evaluation of Physical Effort-LAEF, at the Faculty of Health Sciences-FCS of the University of Vale do Paraíba-UNIVAP. The tests were performed in a controlled environment, at an ambient temperature of 24°C, and with a relative humidity of 60%. The evaluation protocol used was progressive, with steady slope of 2% and initial velocity of 4.0km / h. There was an increase of speed of 1.0km / h every minute of test until the fourth minute; after the fourth minute the speed increase was also 1.0km / h, but occurring every two minutes of testing. The duration of the tests was determined by the exhaustion of the athlete, who when it reached it signaled to the evaluator, who then started the recovery phase with an initial velocity of 5.0km / h, decreasing by 1.0km / h after the first minute held until the end of recovery, determined by the stabilization of the athlete's heart rate.

For the statistical analysis of the data, the One Way-ANOVA variance test was used, considering a level of significance of 5% (p < 0.05).

RESULTS

FMP versus FF p=0.000 (#); FMP versus HM p=2.92E⁻⁴ (ψ); FMJ versus FF p=0.000 (θ); FMJ versus HM p=0.009 (δ); HM versus FF p=0.001 (Φ).

FMP versus FMJ p=0.013 (*); FMP versus FF p=7.71E⁻⁶ (#); FMP versus HM p=5.88E⁻⁵ (ψ).

FMP versus FMJ p=0.026 (*); FMP versus FF p= 5.15 E⁻⁵ (#); FMP versus HM p= 0.002 (ψ).

FMP versus FMJ p=0.001 (*); FMP versus FF p=4.38E⁻⁸ (#); FMP versus HM p=0.007 (ψ); FMJ versus FF p=0.025 (θ); HM versus FF p=0.006 (Φ).

Table 1. Mean and SD of the anthropometric values (weight and age) and analyzed parameters (VO₂ and VE).

Group	Age (year)	Weight (Kg)	VE (l/min)	VO ₂ Peak (ml/kg.min)	Anaerobic Threshold (Km/h)	HR Threshold (bpm)
FMJ	17.17±0.58	67.82±4.54	96.83±6.86	56.48±3.08	13.64±0.45	159.17±3.66
FMP	23.25±1.66	73.15±4.72	111.59±12.64	58.15±4.48	14.24±0.37	163.42±4.21
FF	21.17±1.34	57.67±3.14	85.89±4.21	46.04±2.90	13.18±0.59	156.17±2.76
HM	19.00±1.28	83.83±7.02	98.79±10.24	51.70±3.42	13.30±0.44	157.91±3.51

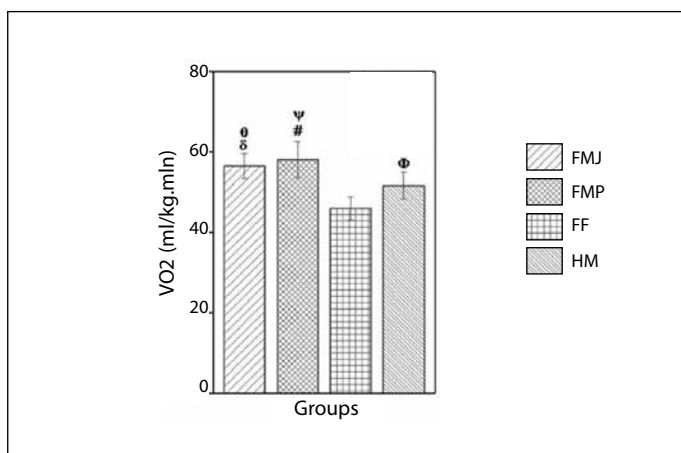


Figure 1. VO₂ peak athletes em diferent sports.

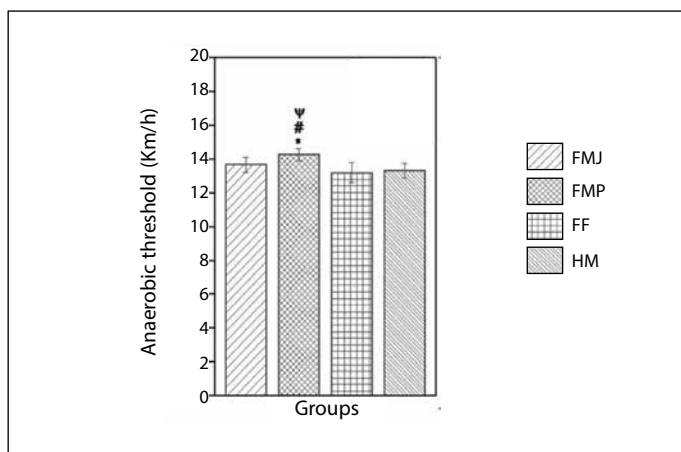


Figure 2. Threshold speed athletes em diferent sports.

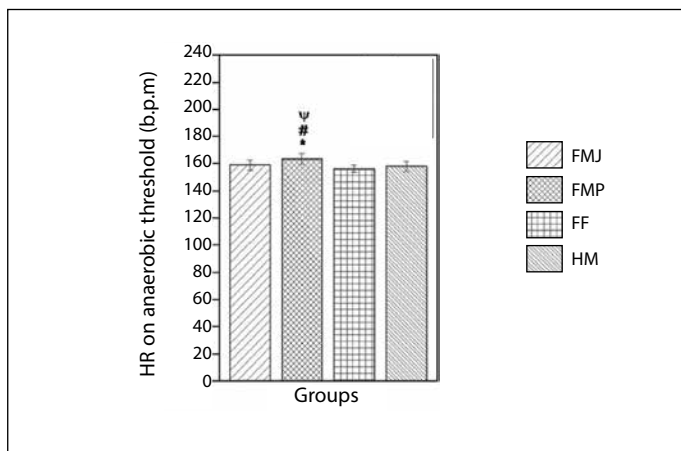


Figure 3. HR on lactate threshold athletes em diferent sports.

DISCUSSION

In this research we can see some important differences, featuring FMP group presenting significant results in VO₂ peaks when compared to results of the same physiological parameters obtained in the FF and H groups. When compared to the VO₂ of the FMP with the VO₂ of the FMJ, there was no significant difference in their results. This fact was

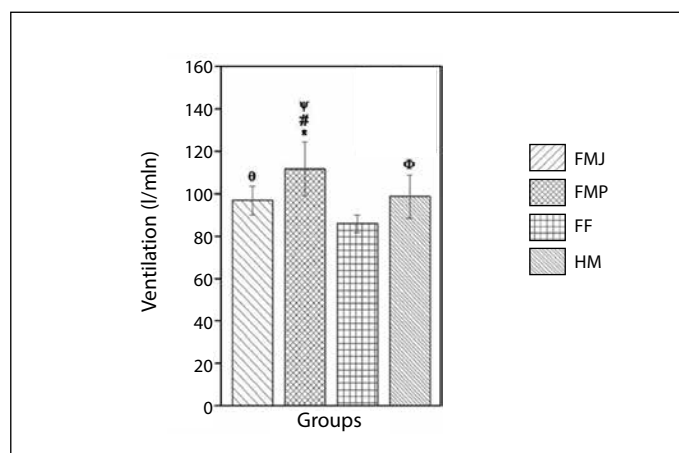


Figure 4. Ventilation athletes em diferent sports.

discussed in several studies, such as^{2,3} which studied the performance of soccer players and showed similarity in the morphological physical composition of the players, with muscle mass being the main factor of balance between the two categories, as analyzed in the present study. The methodology used in physical and technical training in the soccer modality is similar in both categories with regard to the intensity and volume of training.⁷

Still in relation to VO₂peak, the FF and H groups obtained significantly lower values in relation to the field soccer groups (FMP and FMJ). The result should be according to^{7,8,9} a factors such as the difference in lean mass (lower weight in muscle in female athletes). In relation to Handball, researchers such as,⁸ distinguish in their work the occurrence of adaptations of different physical valences caused by the specificity of the spaces where the training and games are developed. Modalities practiced in larger environments allow better aerobic power conditions.^{2,3,7,8}

As in aerobic power, the velocity (km/h) and heart rate (bpm) values of the anaerobic threshold of the FMP group were significantly higher than the other groups, except for the FF threshold HR. E. There was no significant difference between the other groups when compared.

These results can be related not only to the environment where the sport is practiced, but also as a consequence of a good aerobic power, which directly influences the values obtained in aerobic capacity.^{3,11}

Another consideration to be made is muscle efficiency, since professional soccer athletes have a training methodology that is very similar to u-20 footballers. However, due to the results obtained, it is possible to consider more efficiency of the musculature required of professional soccer athletes.^{9,12,13}

Regarding pulmonary ventilation, the FMP group also presents a higher average value when compared to the others. The female group has a lower average value in relation to the other groups, which is related to the morphological difference of the woman, especially in relation to the respiratory system and its capabilities.

CONCLUSION

The Results showed that the enviroment specificity where the sport is, and the characteristics of practices and training, interferes in uptake e oxygen in elite athletes.

All authors declare no potential conflict of interest related to this article.

AUTHORS' CONTRIBUTIONS: Each author made significant individual contributions to this manuscript. RCAF (0000-0003-1585-5311)* was responsible for the preparation and writing of the text, FBS (0000-0002-5133-652X)* was the instructor responsible for the data collection, conducting the assessments with the athletes; WR (0000-0003-1708-0476)* and RALO (0000-0002-2741-0638)* made a crucial contribution to the interpretation and discussion of the data used in the drafting of the manuscript. WSF (0000-0002-4749-3821)* was responsible for the statistical analyses and composition of graphs. RCAF and WR carried out the literature search and the review of the manuscript. All authors contributed to the intellectual concept of the study. *ORCID (Open Researcher and Contributor ID).

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