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Evaluation of physiological characteristics of female handball athletes

Original Article

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ABSTRACT: Introduction: The handball is characterized by a variety of displacements accomplished with intensity alternation. In this way, the knowledge about the predominant energy sources in the actions, with the intention of bringing more effectiveness to the structuring and the prescription of the training, becomes fundamental. Because of that, the objective of this study was to determine the physiological characteristics of female handball athletes. **Materials and Methods**: The sample was constituted of 20 female athletes, participants of the Associação Atlética Universitária de Concórdia team - SC, in 2007. The maximum aerobic potency (Bruce Protocol); maximum anaerobic potency (Wingate Test) and lactate threshold (Lactacidemia) were evaluated. **Results**: The obtained results were: VO_{2max} 45.3±3.0mL.kg^{-1}.min^{-1}; maximum anaerobic potency 10.1±1.2Watts.kg^{-1}; early lactate 2.9±0.8mmol.L^{-1} and late lactate 5.2±1.9mmol.L^{-1}. The results demonstrate that the athletes present values inside the reference patterns for female handball athletes. **Discussion**: The evaluated variables in this study, when associated to other intervening factors for the performance, contribute in a significant way as parameters for the diagnosis of the athletes' training situation, as well as for the elaboration of an individualized training program seeking an improvement of the performance.

Keywords: Oxygen Consumption, Exercise Test, Sports.

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RESUMEN

Evaluación de características fisiológicas de atletas de balonmano femenino

Introducción: El balonmano se caracteriza por una variedad de desplazamientos realizados con alternancia de intensidad. Así se vuelve fundamental el conocimiento sobre las fuentes energéticas predominantes en las acciones, con el objetivo de volver más eficaz la estructuración y la prescripción del entrenamiento. Delante de eso, el objetivo de ese estudio fue a determinar las características fisiológicas de atletas de balonmano femenino. **Materiales y Métodos**: La muestra se constituyó de 20 atletas del sexo femenino, integrantes del equipo de la Asociación Atléticas Universitaria de Concordia - SC, en 2007. Habían sido evaluadas la potencia aeróbica máxima (Protocolo de Bruce), la potencia anaeróbica máxima (Test de Wingate) y umbral de lactate (Lactacidemia). **Resultados**: Los resultados obtenidos fueron: VO_{2max} 45,3±3,0ml.kg^{-1}.min^{-1}; potencia anaeróbica máxima 10,1±1,2Watts.kg^{-1}; lactate pre 2,9±0,8mmol.L^{-1} y lactate post 5,2±1,9mmol.L^{-1}. Los resultados demuestran que las atletas presentan valores dentro de los patrones de referencia para atletas de balonmano del sexo femenino. **Discusión**: Las variables evaluadas en este estudio, cuando asociadas a otros factores interventores para el rendimiento, contribuyen de forma significativa como parámetros para el diagnóstico del estado de entrenamiento de atletas, bien como, para la elaboración de uno programa de entrenamiento individualizado visando una mejora de la *performance*.

Palabras clave: Consumo de Oxígeno, Prueba de Esfuerzo, Deportes.

RESUMO

Avaliação de características fisiológicas de atletas de handebol feminino

Introdução: O handebol caracteriza-se por uma variedade de deslocamentos realizados com alternância de intensidade. Desta forma, torna-se fundamental o conhecimento sobre as fontes energéticas predominantes nas ações, com o intuito de tornar mais eficaz a estruturação e a prescrição do treinamento. Diante disso, o objetivo desse estudo foi determinar as características fisiológicas de atletas de handebol feminino. **Materiais e Métodos**: A amostra constituiu-se de 20 atletas do sexo feminino, integrantes da equipe da Associação Atlética Universitária de Concórdia - SC, em 2007. Foram avaliadas a potência aeróbica máxima (Protocolo de Bruce), a potência anaeróbica máxima (Teste de Wingate) e o limiar de lactate (Lactacidemia). **Resultados**: Os resultados obtidos foram: VO_{2max} 45,3±3,0ml.kg^{-1}.min^{-1}; Potência Anaeróbica Máxima 10,1±1,2Watts.kg^{-1}; Pre-Lactate 2,9±0,8mmol.L^{-1} e Post-Lactate 5,2±1,9mmol.L^{-1}. Os resultados demonstram que os sujeitos apresentam valores dentro dos padrões de referência para atletas de handebol do sexo feminino. **Discussão**: As variáveis avaliadas neste estudo, quando associadas a outros fatores intervenientes para o rendimento, contribuem de forma significativa como parâmetros para o diagnóstico do estado de treinamento de atletas, bem como, para a elaboração de um programa de treinamento individualizado, visando uma melhora da *performance*.

Palavras-chave: Consumo de Oxigênio, Teste de Esforço, Esportes.

INTRODUCTION

The handball is a complete collective sporting modality, characterized by the great amount and variety in its movements, ball manipulations and interaction with other athletes. Looking for a better dynamic and objectivity, the handball passed through several evolutionary processes that, consequently, started to demand from the athletes' larger physiologic adaptations and specific morphologic characteristics.

The athletes' income in the handball of high level depends directly on several variables. There are not differentiated levels as to the importance of those variables linked directly to the high level handball[1]. Among them, the morphologic, physiologic, technician-tactics, psychic and environmental variables are highlighted.

"The evaluation of the performance implicates the recognition and denomination of the individual level of the components of the sporting performance or of a conditioning situation" [2]. It is essential that all the variables related to the athletes' performance be evaluated.

Even with that importance, it is still noticed a lack of studies that use evaluations and analyses with direct measures, seeking to determine the maximum aerobic potency the maximum anaerobic potency, the anaerobic threshold and the lactate threshold, in athletes of the feminine handball in Brazil.

The objective of this study was to determine the female handball athletes team of the Associação Atlética Universitária de Concórdia - SC - for the results to contribute for the scientific community, academics and teachers of Physical Education, as a source of concrete data for futures studies and for the professionals directly involved with the modality in issue, as reference of the diagnostic parameters and of training prescription.

All the participants of the study agreed in signing the term of free and clear consent, containing: objective of the study; evaluation procedures; possible consequences; emergency procedures; character of voluntarity of the individual's participation; and exemption of responsibility on the part of the evaluator and of the Institution that will shelter the experimental treatment.

MATERIALS AND METHODS

Approval of the study

This research is in accordance with the terms of the Resolution 196/96 of the Conselho Nacional de Saúde from 10/10/1996 (3) for the realization of a research in human beings.

The research project was submitted to the Local Committee of Ethics in Research Involving Human beings of the Universidade do Contestado - UnC - Concórdia - SC and approved under the registered number 69/07.

Sampling

The population was constituted of female athletes members of the handball team of the Associação Atlética Universitária de Concórdia - SC. The sample was constituted by 20 of those athletes.

Exclusion criteria were considered: the athlete present any type of serious or chronic condition that could compromise or become a factor of medical impediment for the accomplishment of the daily activities of training; any muscle esqueletical conditions that served as intervening factor to the practice of the activities (articular injury, muscular injury, recent fractures or tendonitis);

neurological problems; and the use of medicines that could cause disturbances of the attention.

The exclusion criteria were identified through initial anamnesis.

Collection of data

The collection of the data took place in the Laboratório de Fisiologia do Exercício e Medidas e Avaliação da UNOESC - Joaçaba - SC.

Initially, the members of the sample were informed on the objectives and the applied methodology during the evaluation protocols, and suggested to sign the term of free and cleared consent.

Soon afterwards, the members of the sample answered to an anamnesis and, finally, they were evaluated in agreement with the established protocols and scientifically accepted, commented later.

The used instruments were: estadiometer - for accomplishment of the height measure; scale - for evaluation of the total body weight; ATL SUPER treadmile - Inbrasport - for evaluation of the maximum aerobic potency (maximum consumption of oxygen - VO_{2max}); Biotec 2100 cicloergometer (Cefise) - for the evaluation of the maximum anaerobic potency; and Accusport lactimeter - for evaluation of the lactate threshold.

RESULTS

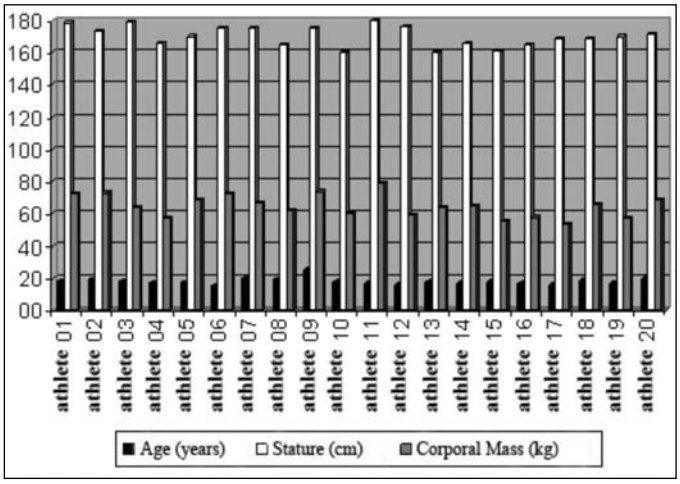
Later, the results and analysis of the data obtained in the research are demonstrated, being these illustrated by graphs and tables and confronted with the supporting literature.

The results presented in the Table 1 demonstrate that the group of athletes presents the average value of 18.0±2.1 year-old.

Table 01 - Average values and their derivatives for age, corporal mass and stature of the female handball athletes of the Associação Atlética Universitária de Concórdia - 2007

n=20	age (years old)	stature (cm)	corporal mass (kg)
mean	18.0±2.1	170.23±6.21	64.9±7.1
minimum	15	160.00	53
maximum	25	180.00	79

Figure 01 - Values for age, stature and corporal mass of female handball athletes of the Associação Atlética Universitária de Concórdia - 2007



Already in relation to the body mass and to the height, the presented average values were, respectively, 64.9±7.1kg and 170.23±6.21cm.

In the Figure 1 can be noticed that the athletes' age is similar, representing a homogeneous group in relation to the age. The largest age found was the one from the Athlete 09 with 25 years old, and the smallest age was the one of the Athlete 06 with 15 years old.

Already in relation to the height, the largest value found was of 180.00cm, from the Athlete 11, and the smallest found value was of 160.00cm, of the Athlete 10. On the body weight, was verified that the Athlete 11 presents, besides the largest height, the largest body mass, of 79.0kg. The smallest body mass verified was the one of the Athlete 17, with 52.6kg.

In what concerns the athlete's physical constitution, it is known that the demands are specific for each sporting modality. When observing the modalities separately, are clear the differences of the players' physical composition in what concerns the function exercised by each athlete during the game or during the exam.

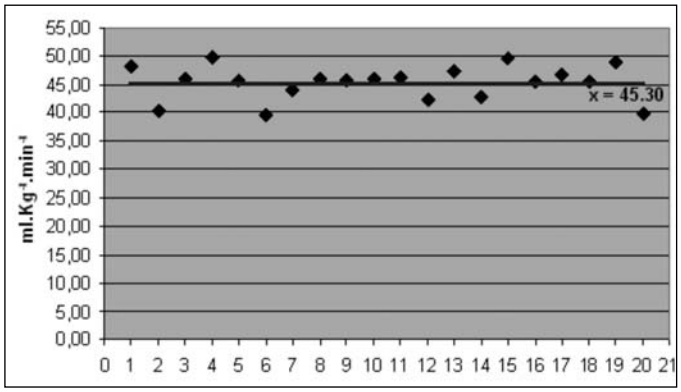
It is indispensable to tell that one should not overestimate the meaning of the anthropometric constants in the different sports. Years of researches indicate that the great height is fundamental in sports like the paddle, the basketball, the handball and the volleyball. Being this way, it is necessary to have care when elaborating parameters related to the height and to the body mass, for each sporting modality.

In relation to the height, the medium value presented by the group meets a little below the mean verified in another study accomplished with female athletes, participants of the best adult category European National team, where a variation was observed between 174cm and 177cm [6].

Table 02 - Values for maximum aerobic potency (maximum consumption of oxygen - VO_{2max}) of female handball athletes of the Associação Atlética Universitária de Concórdia - 2007

n=20	VO_{2max} ($ml.kg^{-1}.min^{-1}$)
mean	45.3±3.0
minimum	39.6
maximum	49.9

Figure 02 - Values for maximum aerobic potency (maximum oxygen consumption - VO_{2max}) of female handball athletes of the Associação Atlética Universitária de Concórdia - 2007



Handball athletes that present larger height and larger length of the extremities of the body tend to take advantage in the actions of the game, such as: in the personal contact, in the possession and in the ball handling, in the throw and in the blockade.

These obtained data demonstrate the homogeneity of the group and the similarity in relation to the samples of other studies accomplished with selections of high income.

In the Table 2 is observed that the maximum aerobic potency, represented by the maximum consumption of oxygen (VO_{2max}) of the sample, had as mean 45.3±3.0ml.kg^{-1}.min^{-1}. As for the minimum and maximum values, the indexes of VO_{2max} were of 39.61ml.kg^{-1}.min^{-1} and 49.94ml.kg^{-1}.min^{-1}, respectively.

This mean presented by the group was below the one expected in another study with athletes of Brazil National Team of Female Handball, where the found mean was 52.95±3.80ml.kg^{-1}.min^{-1} and the followed protocol was of Lerger's[7]. The values of the present study were also very close to the found in another study, also accomplished with athletes of Brazil National Team of Female Handball**,** this time from the Adult category, where the measures were based through the ergoespirometer, being found the mean of 45.3±5.4ml.kg^{-1}.min^{-1} [16].

The VO_{2max} is proportional to the body weight[2]. "Values above 70ml.kg^{-1}.min^{-1} are considered favorable for a good performance in resistance competitions; values below 60ml.kg^{-1}.min^{-1} point out the incapacity for international competition. In no-trained normal people, in the range from 25 to 30 years, values of 45ml.kg^{-1}.min^{-1}" [2] are observed.

It is important to stand out that there are factors that can affect the individual answer to the aerobic training and, consequently, affect VO_{2max}, should be taken into account. Some of those factors are: the hereditariness; the age; the sex; and the training specificity[8].

Regarding the influence of those factors, it is believed that, when evaluating the VO_{2max} in a homogeneous population, using the same protocol for evaluation, the variation of the obtained results will depend on pre-determined genetic factors[9]. Each individual's maximum functional capacity depends on his/her genetic potential, of the sex and age group in which is found[9].

Several studies present values related to the VO_{2max} in athletes and non-athletes. Through a research[10], where the VO_{2max} of 95 men and 38 women athletes, was observed that the largest values of VO_{2max} among the men were those of five cross-country skiers, with mean of 83ml.kg^{-1}.min^{-1}, being of 85.1ml.kg^{-1}.min^{-1} the largest individual value. In relation to the female sex, was observed that the largest values were also found among cross-country skiers, being of 66.3ml.kg^{-1}.min^{-1} the largest individual value.

Another study verified VO_{2max} among athletes of both sexes, elite distance runners and cross-country skiers, where she can be observed aerobic capacities that varied from 80ml.kg^{-1}.min^{-1} to 84ml.kg^{-1}.min^{-1} [8]. The value of the highest VO_{2max}, registered in male athletes, was presented by the Norwegian champion of cross-country, with 94ml.kg^{-1}.min^{-1}. Among the female athletes, the maximum value was registered by a Russian cross-country skier, with a VO_{2max} 77ml.kg^{-1}.min^{-1}.

Other authors[11] present values of VO_{2max} that vary between 30ml.kg^{-1}.min^{-1} and 40ml.kg^{-1}.min^{-1} for untrained men and values of VO_{2max} that vary between 65ml.kg^{-1}.min^{-1} and 80ml.kg^{-1}.min^{-1} for trained men. A difference of 107% can be observed among the presented values. However, the authors detach that the values for trained men represent endurance athletes' data, and they observe that "it is necessary to have caution when admitting that the percentage difference among having workout and untrained it necessarily represents the result of the training, because you differentiate genetics among individuals probably exercise a powerful influence on many factors".

In a study accomplished in Brazil, with male rowers from the states of São Paulo and Santa Catarina, the average values of VO_{2max} 39.67ml.kg^{-1}.min^{-1} were observed in the rowers of Santa Catarina and 50.40ml.kg^{-1}.min^{-1} in São Paulo's rowers[12].

In the handball a study was accomplished with a female group of athletes of elite of Brazil[13]. The researched sample presents a

Table 03 - Values for maximum anaerobic potency of female handball athletes of the Associação Atlética Universitária de Concórdia - 2007

n=20	maximum anaerobic potency(Watts.kg^{-1})
mean	10.1±1.2
minimum	7.9
maximum	11.8

Figure 03 - Values for maximum anaerobic potency of female handball athletes of the Associação Atlética Universitária de Concórdia - 2007

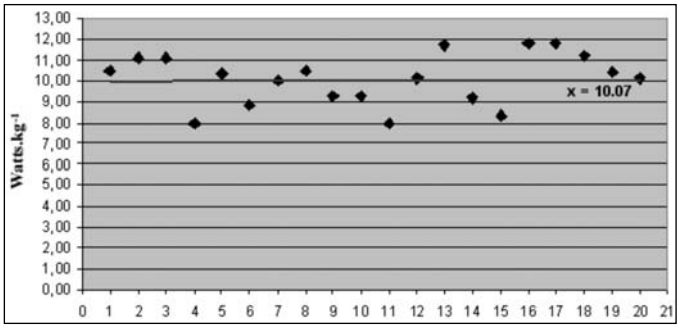
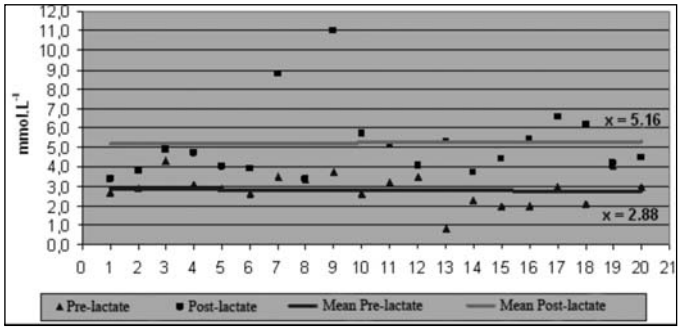


Table 04 - Values for threshold of lactate in female handball athletes of the Associação Atlética Universitária de Concórdia - 2007

n=20	pre-lactate (mmol.L^{-1})	post-lactate (mmol.L^{-1})
mean	2.9±0.8	5.2±1.9
minimum	0.8	3.4
maximum	4.3	11.0

Figure 04 - Values for threshold of lactate in female handball athletes of the Associação Atlética Universitária de Concórdia - 2007



mean VO_{2max} 41.30±6.34ml.kg^{-1}.min^{-1}. The same authors still highlight that, in a study of Haymes & Dickinson, accomplished with runners in 1980, an average result of 52.72ml.kg^{-1}.min^{-1}, was verified while, with the tennis players, it presented a mean of VO_{2max} 44.20ml.kg^{-1}.min^{-1}. To those authors, the handball athletes' fact researched have presented a smaller level of VO_{2max} when compared with other elite athletes, it can become worse in the fact that VO_{2max} is very related to the level of physical activity developed by the individual. Therefore, that might have happened for them have been tested in the beginning of the training season. Authors [7] declare that this statement should be reviewed, because it is known that VO_{2max} is a variable that have an individual limit of development, in other words, has a limited degree of improvement, and also that, in incoming athletes, the variation of the levels in relation to the training periods is minimum.

In another study accomplished in the handball, with nineteen athletes of the Adult Female Brazil National Handball Team**,** during a training phase for the Pan-American Games of 1989, a mean VO_{2max} of 46.10ml.kg^{-1}.min^{-1} [14] was verified. The authors tell that the presented value was larger than the observed in the study of Soares *et al*.[13], and they explain that might have happened, probably, in function of the own evolution of the sporting training, in relation to the periods studied in the researches. According to the authors, it might have happened for three reasons. The first, for the fact of the training be improved in the specificity of the sport, being able, to alter the absorption capacity and the use of oxygen in the physical activity. The second presented reason was that the evaluated athletes in that study had a larger body weight, altogether with a larger height and thin body mass, being able to in a certain way to have influenced with determined significance on the motor performance of those, having as consequence an improvement in the functional aspect. The third party and the last reason commented, that in the authors' understanding would be the less probable, referring to the protocols used for the calculation of VO_{2max}, because the protocols used were not exactly the same.

A study accomplished in West Germany during the games realized between male participant teams of the national championship of handball, had as the objective to try to establish under which circumstance the activity of the player appears[15]. This study demonstrated clearly that is the displacement in race, accomplished in an average speed and without ball possession, that prevails in the game. The distance traveled in that speed is, on average, 3,127m. Those displacements are inserted by numerous direction and rhythm changes, as well as of frequent rush [15].

That same study presented results regarding VO_{2max} during the game. The presented results showed that an athlete keeps a consumption of constant oxygen around 82% to 90% of his/her VO_{2max} [15]. This way, the energy cost is certain in function of the athlete's capacity of elevating his/her level of VO_{2max}, making possible a better use of his/her technical-tactic qualities.

When analyzing the results of a study accomplished in Brazil with a group of athletes of female handball elite, in which the average value of VO_{2max}, determined through the test with cicloergometer using the protocol of Balke, was of 41.30±6.30ml.kg^{-1}.min^{-1} [13]. Analyzing another study, in that the mean of the 19 athletes' of Brazil National Team of Adult Female Handball VO_{2max}, determined through the test with cicloergometer using the protocol of Balke, was of 46.10±5.43ml.kg^{-1}.min^{-1} [14], together with the average values of VO_{2max} obtained in the present researches, is observed that the athletes' of the Associação Atlética Universitária de Concórdia - SC presents very close values to those previously researched.

The VO_{2max} mean of the present sample, when compared to the results of another research with non-athletes and athletes of several modalities[8], shows us that the athletes of Asssociação Atlética Universitária de Concórdia - SC have a superior VO_{2max} if compared to those of the female non-athletes. When compared to the athletes female of the basketball modalities, riding, swimming and volleyball, is verified that the athletes researched in this study present results inside the mean of the mentioned groups, presenting however, an inferior VO_{2max}, when it is compared with athletes' of the paddle and ski groups (cross-country).

It is worth to emphasize the importance of raising the athletes' VO_{2max}, because the starting of the aerobic system is the fundamental element in the resynthesis of ATP. However, one cannot forget that, in the efforts of short duration (inferior to 2min), happens a predominance of the anaerobic system[15] and that, besides the maximum aerobic potency, there are other physical capacities that influence in the handball athletes' sporting performance.

In the Table 3 are exposed the values of the female handball athletes of the Associação Atlética Universitária de Concórdia. The found mean was of 10.1±1.2Watts.kg^{-1}.

The figure 3 represents each athlete's performance in relation to the maximum anaerobic potency, and the higher result was of 11.80Watts.kg^{-1}, reached by the Athletes 16 and 17, and the lowest result was of 7.90Watts.kg^{-1}, obtained by the Athletes 04 and 11.

The mean for maximum anaerobic potency, found in the present researches, is above the mean found in the study accomplished with Brazil National Team of Adult Handball[16]. This difference can be due to the homogeneity of the sample, that accomplishes the same training type and proves its homogeneity with the values for maximum anaerobic potency very close to each other, while Brazil National Team of Adult Female Handball counted on athletes from several clubs and with levels of differentiated trainings, justifying so the diversity of values for this same variable.

The values for lactate threshold (pre and post) of the feminine handball athletes of the Associação Atlética Universitária de Concórdia are represented in the Table 04. The mean of pre-lactate, obtained by the athletes, was of 2.9±0.8mmol.L^{-1}. Already the mean of after lactate was of 5.2±1.9mmol.L^{-1}.

In the Figure 4 it is noticed the variation of the pre-lactate and before lactate in the sample. The largest value of pre-lactate was of 4.3mmol.L^{-1}, reached by the Athletes 03 and 19, and the smallest value of pre-lactate was of 0.8mmol.L^{-1}, reached by the Athlete 13. Already in relation to the after lactate, the largest value was of 11.0mmol.L^{-1}, reached by the Athlete 09, and the smallest value was of 3.4mmol.L^{-1}, obtained by the Athletes 01 and 08. Its is important to emphasize that this value might have been found in function of a mistake during the collection process.

During a progressive exercise until the exhaustion, a lineal increase is observed in VO_2 until the anaerobic threshold. The point where the non-lineal increase of the blood type lactate happens during the exercise is denominated lactate threshold or lactate accumulation in the blood[17].

At rest, the lactate blood is of approximately 0.5mmol.L^{-1} to 1.0mmol.L^{-1}. Already during or after the exercise, it can surpass the 10mmol.L^{-1} or 12mmol.L^{-1}. Between high level athletes, the lactate can even reach from 14mmol.L^{-1} to 16mmol.L^{-1} during an exhausting exercise[17].

The handball athletes, at least in some phase of the departure, present lactate concentrations above the lactate threshold, mainly during the second time of game, when the values of blood lactate can be between 9mmol.L^{-1} and 12mmol.L^{-1} [18].

DISCUSSION

The physiological characteristics of female handball athletes of the female team in Associação Atlética Universitária de Concórdia - SC were delimited through different tests and instruments.

The present study conclude that the group of athletes of the Associação Atlética Universitária de Concórdia who were part of the sample, presented average value of the maximum aerobic potency 45.3ml.kg^{-1}.min^{-1}, lower than the one found by a study accomplished with atlhetes from Brazil National Team of Junior Female Handball[7], where the protocol of Leger was followed and the values which were found were very close to the ones shown in another study, also accomplished with athletes from the Brazil National Team of Female Handball[16], but from the adult category, in which the measurements were taken through the ergoespirometry.

Regarding the average value of the maximum anaerobic potency, it can be observed that it is above average in relation to the study accomplished with Brazil National Team of Adult Female Handball[16]. Lastly, the average value of the pre-lactate threshold obtained by the athletes was 2.9±0.8mmol.L^{-1} and the post-lactate was 5.2±1.9mmol.L^{-1}.

The variables evaluated in this study, when associated to other factors that are intervenient for the productivity, contribute in a significant way for the diagnosis of the athlete's training condition as well as for the elaboration of a individualized training program aiming at the improvement of the performance.

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