Maximum consumption of oxygen in step test: a longitudinal study in students of the Preparatory Nucleus of Reservation Officials

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ABSTRACT: Introduction: The aim of this study is to measure the VO2max in ascent and descent step test, in three moments, during the preparatory course for officials of the reservation. Materials and Methods: It’s an applied, longitudinal, analytical, and probabilistic research. The sample consisted of 15 active men, average of age 18.7±0.5 years old. The stature, body mass, heart frequency (HF) of effort were measured and the phases, increment of the bench’s height, number of touches per minute, ascent and descent rhythm of the ergometric bench and time of execution were controlled. The individuals used a cardiofrequencimeter of the brand Polar A5 in the gauging of HF and the Table of Borg in the subjective control of effort. The ergometric test applied was Cirilo’s Electronic Bench Test, in three different moments. The used statistics was descriptive of average, standard deviation, maximum and minimum and inferential, using the Friedman’s test for repeated measures. The significance level was p<0.05 and the used software was the SPSS version 16. Results: In the first moment, a mean of VO2max of 38.34±1.68ml.kg⁻¹.min⁻¹ was obtained, in the second 38.60±0.68ml.kg⁻¹.min⁻¹ and in the third 39.96±1.74ml.kg⁻¹.min⁻¹, with significant differences (p=0.004). Discussion: The level of cardiorespiratory capacity was classified as reasonable, in the three moments of the test, by the index of VO2max. This situation was not characterized in a satisfactory way for the specific needs of the troop during the investigated period, in comparison with the levels of this capacity in other studies with military.

Keywords: Ergometry, Exercise Test, Military Personnel, Physical Fitness.
RESUMEN
Consumo máximo de oxígeno en ergómetro banco: un estudio longitudinal en alumnos del Núcleo Preparatorio de Oficiales de la Reserva

INTRODUCCIÓN: El objetivo de este estudio fue a menoscuar VO$_{2\text{máx}}$ en test de subida y bajada de banco, en tres momentos, durante el Curso Preparatorio de Oficiales de la Reserva. MATERIALES Y MÉTODOS: Se trata de investigación aplicada, longitudinal, analítica, probabilista. La muestra constó de 15 hombres activos, media de edad 18,7±0,5 años. Se midió la estatura, masa corporal, frecuencia cardíaca (FC) de esfuerzo y se controló las prácticas, incremento de la altura del banco, número de toques por minuto, ritmo de subida y bajada del ergómetro banco y tiempo de ejecución. Los individuos utilizaron uno frecuencia cardíaco de la marca Polar A5 en el contraste de la FC y el Tabla de Borg en el control subjetivo del esfuerzo. El test ergométrico aplicado fue el Test de Banco Electrónico de Cirilo, en tres momentos distintos. La estadística utilizada fue descriptiva de media, desvió patrón, máximo y mínimo, por medio del Test de Friedman para medidas repetidas. El nivel de aceptación fue de p<0,05, siendo utilizado el software SPSS versión 16.0. RESULTADOS: El primer momento, se obtuvo una media de VO$_{2\text{máx}}$ de 38,34±1,68ml.kg$^{-1}$.min$^{-1}$, por el segundo 38,60±0,68ml.kg$^{-1}$.min$^{-1}$ y en el tercero 39,96±1,74ml.kg$^{-1}$.min$^{-1}$, teniendo las diferencias significativas (p=0,004). El nivel de capacidad cardiorrespiratoria fue clasificado como razonable, en los tres momentos de test, por el índice de VO$_{2\text{máx}}$. Esta situación no se caracterizó de forma satisfactoria para las necesidades específicas de la tropa durante el periodo investigado, comparándose a los niveles de esta capacidad en otros estudios en militares.

PALABRAS CLAVE: Ergometría, Prueba de Esfuerzo, Personal Militar, Acondicionamiento Físico.

RESUMO
Consumo máximo de oxigênio em ergômetro banco: um estudo longitudinal em alunos do Núcleo Preparatorio de Oficiais da Reserva

INTRODUÇÃO: O objetivo deste estudo foi mensurar o VO$_{2\text{máx}}$ em teste de subida e descida de banco, em três momentos, durante o Curso Preparatorio de Oficiais da Reserva. MATERIAIS E MÉTODOS: Trata-se de pesquisa aplicada, longitudinal, analítica, probabilística. A amostra constou de 15 homens ativos, média de idade 18,7±0,5 anos. Mediu-se a estatura, massa corporal, frequência cardíaca (FC) de esforço e controlou-se os estágios, incremento da altura do banco, número de toques por minuto, ritmo de subida e descida do ergómetro banco e tempo de execução. Os indivíduos utilizaram um frequencímetro cardíaco da marca Polar A5 na aferição da FC e a Tabela de Borg no controle subjetivo do esforço. O teste ergométrico aplicado foi o Teste de Banco Eletrônico de Cirilo, em três momentos distintos. A estatística utilizada foi descritiva de média, desvio padrão, máximo e mínimo e inferencial, por meio do Teste de Friedman para medidas repetidas. O nível de significância foi de p<0,05, sendo utilizado o software SPSS versão 16,0. RESULTADOS: No primeiro momento, obteve-se uma média de VO$_{2\text{máx}}$ de 38,34±1,68ml.kg$^{-1}$.min$^{-1}$, no segundo 38,60±0,68ml.kg$^{-1}$.min$^{-1}$ e no terceiro 39,96±1,74ml.kg$^{-1}$.min$^{-1}$, havendo diferenças significativas (p=0,004). Dsicussão: O nível de capacidade cardiorrespiratória foi classificado como razoável, nos três momentos de teste, pelo índice de VO$_{2\text{máx}}$. Esta situação não se caracterizou de forma satisfatória para as necessidades específicas da tropa durante o período investigado, comparando-se aos níveis desta capacidade em outros estudos em militares.

Palavras-chave: Ergometria, Teste de Esforço, Militares, Aptidão Física.
This way, this study tries to analyze the impact of MPT on the levels of the cardiorespiratory capacity during the period of nine months.

**MATERIALS AND METHODS**

**Approval of the study**

This study was approved, under the number 965/07, for the Comissão de Ética do Centro de Ciências da Saúde (CCS) of the Universidade Federal da Paraíba (UFPB).

**Characterization of the study**

The research was framed as of longitudinal character, follow-up with primary data and in matter of quantity and pre-experimental approach.

**Population and sample**

The universe belonged to the officers. The sample consisted of 15 male students, with an average of 18.7±0.5 years old, participants of the Preparing Nucleus of Reservation Officials (NPOR) of the 16º Regimento de Cavalaria Motorizada (RCM), residents in the municipal district of Bayeux - Paraíba. All the students were previously selected, through the medical examination, for the accomplishment of the Army Physical Fitness Test (APFT).

**Variables selected for the study**

The variables selected for the study were: VO$_{2\max}$; effort time (s); age (years old); height (m); body mass (kg); heart frequency (HF) in effort; beats per minute (bpm); height of the seat (cm); physical fitness degree (untrained, assets and trained); rhythm of the metronome (beats.minutes$^{-1}$); and subjective effort.

**Instruments for collection of data**

Anthropometric analogical scale(Plenna); estadiometer (Sanny); monitor Polar heart frequency A5; Table of Borg; metronome; and Cirilo’s automatic electronic ergometer seat, manufactured by Byosistems, with height from 20cm to 50cm, according to figures 1 and 2.

**Procedures for collection of data**

A previous meeting was accomplished in 16th RCM, with students who were participants of the NPOR of the respective unit, informing the objectives of the research and signature of the Informed Consent, according to the Law number 196/96 of the National Health Council$^{12}$, for the voluntary participation of the research. Immediately after, recommendations were made regarding the regular procedures of the collection. In this occasion, the individuals received orientation regarding the uniform, place, schedule and patterns of execution of the anthropometric and ergometric evaluations.

The VO$_{2\max}$ was measured through the Cirilo’s Seat Test, using Sousa’s protocol$^{11}$, in three moments named as follows: AVL1, evaluation after the adaptation phase of people to the military training; AVL2, evaluation during the basic phase; and AVL3, evaluation accomplished in the specific phase of the training.

Each of the three evaluations was accomplished in a single morning, in the previously mentioned sequence. Before the effort test, some criteria were considered: 1) accomplishing ingestion of light foods, 1:00 to 2:00 before; 2) beginning a session of prolongations for the inferior members; 3) not smoking; 4) not ingesting alcoholic drink; and 5) not practicing physical effort. As criteria of interruption of the test: 1) reaching the limit of FC, using the calculation of Karvonen (220-age); 2) losing the rising and falling rhythm in the bank, at least three times during the effort, or falling without fast recovery; and 3) signs of fatigue, as muscular fatigue or cyanotic appearance.

The bench test began with ascents and descents in a height standard of 20cm, being adjusted, in the second moment, to a height that would provide the evaluated people in the rising of the seat, an angular flexing of 45º of the inferior member in execution and, in the last moment, 90º. The time of the test and the rhythm
In the publication of Ceriani et al.,14 involving officials of the army with similar characteristics to those here investigated, was evidenced that the people, in their majority, presented a balanced status and excellent nutritional profile in the body composition, probably due to the fact that the military routine keeps the boys very physically active. Regarding the VO_{2\text{max}}^*, the sum of the three evaluations accomplished in the research presented an average profile of 38.21 ml.kg\(^{-1}\).min\(^{-1}\), compatible value to a conditioning inside of reasonable defined parameters for the American Association of the Heart for a good performance, following the classification mentioned by Marins & Giannichi.15

In a study accomplished by Ribas & Ribeiro16, with 26 physically active helicopter pilots of the Brazilian Army, a VO_{2\text{max}} equal to 57.69±4.45 ml.kg\(^{-1}\).min\(^{-1}\) was observed. Possibly, this income, superior to the pre-official results here investigated, might have happened because of the exigency that obliges the pilots to have a very high physical fitness to tolerate the stress of combat flights, besides the fact that they are an elite group which has years of directed physical training. Opposite to this, they are part of the permanent members of the Brazilian Army. Opposite to this, the students of NPOR didn’t get to participate at least of the 12 months of the training during the research period. Moreover, most of the future officials are not absorbed by the Army, and those that do not comply with the norms stay just for some years, because they are not part of the permanent member of the Military Battalion.

The comparison between the findings of the present field rehearsal and other national16,17 and international researchers18 is pertinent. However, interdependent influential factors, as the regionalization of the youths’ contingent, socioeconomic level, motivation degree, stress level, hours of sleep, genetic predisposition, and feeding should be considered, besides the priority that the responsible instructor emphasizes in the physical training in each military organ, since such components can directly influence in the performance. This determines that, even in a standardized training, the performance response suffer interferences from another variables which were not measured in the study.

Regarding the measurements of the oxygen consumption, observed in three moments (April, July and October/2005), it was noticed that the values showed significant differences (p<0.004), with an elevation of the performance between the initial evaluation (AVL1) and the third evaluation (AVL3). These findings can be justified by the fact that the individuals usually present less aptitude in the diagnostic evaluation, since they are transiting from the civilian life to the military habitat. Sousa et al.,19 with an initial methodology, the studied students of NPOR from the same institution, placed in active helicopter pilots of the Brazilian Army, a VO_{2\text{max}} equal to 47.14 ml.kg\(^{-1}\).min\(^{-1}\) evaluated in a pre-test and, after three months, of 47.08 ml.kg\(^{-1}\).min\(^{-1}\), having this performance been classified by the authors as satisfactory, independent from the statistical significance. It is possible to notice that, when compared with

### Table 1 - Distribution of the descriptive mean values, standard (sd), minimum and maximum deviation of the students’ of the Preparing Nucleus of Reservation Officials (n=15)

<table>
<thead>
<tr>
<th>variables</th>
<th>mean ± sd</th>
<th>minimum</th>
<th>maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>age (years old)</td>
<td>18.7 ± 0.5</td>
<td>18.0</td>
<td>19.0</td>
</tr>
<tr>
<td>height (m)</td>
<td>1.75 ± 0.05</td>
<td>1.69</td>
<td>1.85</td>
</tr>
<tr>
<td>body mass (kg)</td>
<td>68.9 ± 6.5</td>
<td>57.9</td>
<td>79.4</td>
</tr>
<tr>
<td>VO_{2\text{max}} (ml.kg(^{-1}).min(^{-1})) estimated</td>
<td>38.21 ± 1.43</td>
<td>33.86</td>
<td>42.31</td>
</tr>
<tr>
<td>FC(_{\text{peak}}) in test (bpm)</td>
<td>175.2 ± 13.4</td>
<td>13.0</td>
<td>196.0</td>
</tr>
</tbody>
</table>

*Note: VO_{2\text{max}}* is the highest reception of oxygen (O\(_2\)) reached by an individual, breathing atmospheric air at sea level. That variable has been one of the main items in endurance studies and human performance in military populations.

### Table 2 - Average values and comparison of the three tests applied (AVL1, AVL2 e AVL3) in the oxygen consumption of the students of the Preparing Nucleus of Reservation Officials (n=15)

<table>
<thead>
<tr>
<th>Oxygen consumption</th>
<th>mean ± sd</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>VO_{2\text{max}} (ml.kg(^{-1}).min(^{-1})) (AVL1)</td>
<td>38.34 ± 1.68</td>
<td>0.004*</td>
</tr>
<tr>
<td>VO_{2\text{max}} (ml.kg(^{-1}).min(^{-1})) (AVL2)</td>
<td>38.60 ± 0.68</td>
<td></td>
</tr>
<tr>
<td>VO_{2\text{max}} (ml.kg(^{-1}).min(^{-1})) (AVL3)</td>
<td>39.96 ± 1.74</td>
<td></td>
</tr>
</tbody>
</table>

*Note: *p<0.05 (visible difference); Friedman’s non comparable test

**Analytical Plan**

For the formulation of the database, a computerized and graphic package SPSS version 16.0, for the listing of all the results was used. A descriptive statistics was applied for maximum and minimum values, means and standard deviation (sd), besides the application of the inferential technique with no-parametric test (abnormal distribution) of Friedman for multiple compared measures. The level of the adopted significance was p<0.05 for the nullity hypothesis.

**RESULTS**

As shown in tables 1 and 2.

**DISCUSSION**

The capacity of the human being to accomplish exercises of medium and long duration depends, mainly, of the aerobic metabolism. In this way, one of the most used indexes to evaluate that condition is the VO_{2\text{max}} named aerobic potency. The VO_{2\text{max}} can be defined as the highest reception of oxygen (O\(_2\)) reached by an individual, breathing atmospheric air at sea level. That variable has been one of the main items in endurance studies and human performance in military populations.

Independent from the focus of this work had been the oxygen consumption evaluation, for initial diagnosis of the pre-officials’ youth group, basic anthropometric indicators were measured. Thereby, the weight of the body mass was observed (68.9±6.5kg) and the height (1.75±0.05m). Those values are compatible with a good nutritional condition, if the equationing of these means are considered through the Body Mass Index (BMI).

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this research, such difference in the levels of cardiorespiratory aptitude may be related to variables with are not controlled by the researchers or even with measure inclinations, as the technique which was applied by the evaluators in the tests.

Other studies, such as the one accomplished by Dias et al.26, with 28 male officers from the Brazilian Army, between 19 and 20 years old, incorporate in the 1st Group of Antiaircraft Artillery, presented a VO$_{2\text{max}}$ 51.90 ml·kg$^{-1}$·min$^{-1}$. A similar result, published by Neves & Duarte10, came from a study accomplished in the southeast of the country involving a sample composed of 313 active officers. In this work, the outlining with three interventions, also denominated AVL’s, was adopted as a procedure for evaluation. They showed a VO$_{2\text{max}}$ in AVL1 55.9 ml·kg$^{-1}$·min$^{-1}$, in AVL2 57.9 ml·kg$^{-1}$·min$^{-1}$ and in AVL3 54.0 ml·kg$^{-1}$·min$^{-1}$. One of the peculiarities of the collection in the southeast was that AVL1 preceded the training of Paz’s Force and, compared with AVL2, after the training, presented a significant improvement in the officers of the study, in all the indexes represented by the Army PET. In AVL3 there were aptitude decrease and increase of the anthropometric variables that were accomplished in the return of the mission, characterized as detraining. The above-mentioned study corroborated the findings of our work, regarding the decrease of aptitude between evaluations that followed after the intervention of physical training, as well as the fact that the military training, in spite of certain particularities and systemizations, can differ from area to area.

Based on the results obtained in this study, it is believed that, during the period of nine months, the military of NPOR presented a reasonable level of physical conditioning for the health, considering the estimated cardiorespiratory capacity through the VO$_{2\text{max}}$, although not satisfactory for the specific needs of the troop during the investigated period, comparing the profile found in other researches. Regarding the period of the evaluations, a significant difference was observed during the three moments of test, fact attributed to the efficiency of the physical training given in the military institution, that impacted the benefits in the physical quality studied, besides the effects imposed by the transition of the youths who that entered, in their majority, with sedentary characteristics, becoming vigorously active.

New studies are recommended, trying to evaluate the volunteers before the initiation of MPT, in the end of the adaptive phase, in the middle of the basic phase and in the end of the specific phase of the period of military institutionalization, to analyze with more accuracy the effects of MPT on the physical fitness of people with characteristics similar to those investigated in this work, seeking a better adaptation in the periodization of the training, besides the improve of the youths’ health. It is also pertinent to suggest the inclusion of other indispensable indicators to the health and athletic income, such as the case of the valences force and muscular resistance, flexibility and lipidic profile. In addition to a more accurate analysis in the components of the body composition, as well as an follow-up in the evaluation of alimentary ingestion pattern of the officers evaluated in the period of their formation.

REFERENCES