ABSTRACT: The purposes of this study are: to compare the response of blood lactate and heart rate in two different programs of training: Body Pump (BP), Body Combat (BC), and to characterize the physiological profile of these exercises in relation to its intensity. Sixteen women divided in two groups participated of this study, BP (n=9) and BC (n=7). For the determination of blood lactate samples it were collected 25 ml of blood from ear lobe at the end of uneven songs over the two activities. The heart rate was monitored during all workout. The statistic treatment used was a t-student test. It can be concluded that Body Combat modality seems to determine a bigger intensity during the workout, as It was demonstrated at the biggest values of heart rate, when compared with the Body Pump. Moreover, the values of blood lactate indicate high intensity domain for the two programs, suggesting that these activities seem to be efficient for the control of the corporal mass and improvement of the aerobic capacity.

Keywords: body pump, body combat, training, heart rate, blood lactate.
INTRODUCTION

The search for a better life quality is doing with that more and more the people modify some habits, among them the regular practice habit of the physical activity. The objectives that take to that practice increase of the exercise are many, as, for instance, the the cardiorespiratory capacity improvement, the weigh loss, the muscular mass increase, the health promotion, among others. It is worth to detach that a study accomplished by Matsudo et al. (2002) in the São Paulo state of two main objectives, which are appeared: the weigh loss and the health promotion. In that same study were verified, also, which places are more sought for the physical activity practice and, in first place, were pointed the streets and the parks and, in second, the gyms. Fact that can partly explain the growth every year of the number of academies in the country.

Those data, allies to the referred increase in the gyms number, drive, for its time, to the competition among these spaces, taking, consequently, the “fitness industry” to constantly look for new modalities of physical activities, more and more efficient and supportive, with the intention to attract more students and to supply the market needs.

In this sense, a great number of activities has been offered at the gyms, and the more practiced at the present time are the ones that work under the franchise form, as: Body Pump, Body Combat, RPM, Body Step, Body Balances, Spinning, Jump Fit, among others.

However, a lack of scientific studies can be verified with the intention of providing a better understanding of the acute and chronic physiologic effects of such activities, what could be of great relevance for the quality of the professionals’ work that act at gyms, as well as for their apprentices’ safety.

RESUMEN

Dominiós de la intensidad y de la sobrecarga metabólica en lecciones de body pump y body combat

Los objetivos de este estudio habían sido: comparar la contestación del lactato sanguíneo y frecuencia cardíaca en dos diversos programas del entrenamiento: Body Pump (BP) y Body Combat (BC) y caracterizar el perfil fisiológico de estos ejercicios en la relación su intensidad. 16 mujeres se dividieron en dos grupos habían participado de este estudio BP (n=9) e BC (n=7). Para la determinación del lactato sanguíneo las muestras habían sido recogidas afirmo 25 ml de sangre del lóbulo del oído al final del las músicas ímpares para las dos actividades. La frecuencia cardíaca fue supervisada durante toda la lección. Como tratamiento estadístico, se ha usado la prueba t-student. Puede-se concluir que la modalidad Body Combat parece determinar una mayor intensidad durante a aula, como demostrado pelos maiores valores de frecuencia cardíaca, quando comparados ao Body Pump. Entretanto, os valores de lactato sanguíneo indicam dominios de intensidade pesada para os dois programas, sugerindo que estas actividades parecem ser eficientes para o controle da massa corporal e melhora da capacidade aeróbica.

Palabras clave: body pump, body combat, entrenamiento, frecuencia cardíaca e lactato sanguíneo

MATERIALS AND METHODS

Subject

Voluntarily participated of this study 16 seemingly healthy women, non smokers and without cardiorespiratory disturbances. The women were workout for at least three months in the respective modalities in that were appraised. The volunteers were divided in
two groups: nine women for Body Pump (BP) and seven women for Body Combat (BC). All the participants of this study signed a consent term after the explanation of all of the procedures that would be accomplished in the study. The study was also approved by the Committee of Ethics and Research of Santa Casa de Misericórdia de Limeira.

**Anthropometric evaluation and corporal composition**

The following variables were measured: body mass (kg), stature (cm) and body fat percentile (% F). For the body mass a Filizola® platform electronic scale was used accurately of 0.1 Kg. For the stature an estadiômetro was used accurately of 0.1 cm, in agreement with the procedures suggested by Gordon et al. (1988). The body fat percentile was measured for the doubly indirect method, starting from the thickness of the cutaneous folds of the following anatomical points: subscapular, supra iliac and thigh. All the measures were made in triplicate, being adopted as result the mean value of the three measures. For the measures of cutaneous folds a Lange® lipidometer was used accurately of 0.5 mm. The measures were always accomplished on the subject’s right side by a same appraiser, using the procedures mentioned by Guedes (1994). For the estimate of the % F the equation of Siri (1967) was used, starting from the estimate of the certain corporal density through the equation proposed by Guedes (1994).

**Collection of blood during the classes and lactato dosage**

25 ml of earlobe blood were collected, being used heparinized glass capillary and gaged. After each collection, the blood was stored immediately in microtubes of the Eppendorff type of 1.5 ml, containing 50 µl of NaF1% solution. Afterwards, the tubes were stored in thermal container containing ice and taken to the laboratory for the determination of the sanguine lactato concentrations through the electrochemical analyzer model YSL 1500 STAT. The collections were accomplished at the end of the odd music (5 min, 18 min, 32 min, 42 min and 51 min) for the three activities.

**Characteristics of the appraised training programs**

Body Pump: it is a program of training of resisted exercises accomplished with bars and anilhas using the beginnings of the training with free weights, modified for the atmosphere training in group. Its main characteristic is the work of located muscular resistance with a high volume of repetitions in each exercise. Body Combat: it is similar to the traditional aerobic gymnastics, however, its difference is in the choreography that is based on blows and kicks of different martial arts.

**Statistical analysis**

Were used the statistical methods of mean, pattern deviation (±) and student t test for comparison among the modalities, being adopted a level of significance of p < 0.01.

**RESULTS**

The physical characteristics of the female subjects of the two appraised groups are present in the Table 1.

In the Table 2, there are present the values of sanguine lactato obtained during the classes for the groups BP and BC. The sanguine lactato didn’t present significant differences in the music 1 (5 min), 5 (32 min) and 9 (51 min) among the groups. On the other hand, in the music 3 (18 min) and 7 (42 min), the sanguine lactato was significantly larger in the group BP.

Regarding the FC behavior, differences were not verified in the music 1 (5 min) among the two appraised groups. In compensation, very significant larger values were verified in the group BC.

| Table 1 - Mean values of the subject characteristic regarding the groups: body pump (bp) and body combat (bc). |
|---------------------------------|----------------|----------------|----------------|
|                                 | Age (years)    | Body Mass (kg) | Height (cm)    | % Fat (%)      |
| BP (N = 9)                      | 26.8 ± 6.57    | 55.5 ± 2.72    | 163 ± 0.05     | 23.1 ± 2.23    |
| BC (N = 7)                      | 26.1 ± 6.08    | 58.8 ± 6.74    | 163 ± 0.05     | 25.9 ± 2.71    |

| Table 2 - Mean values of the concentrations of sanguine lactato (mm) obtained during the classes for the groups: body pump (bp) and body combat (bc). |
|---------------------------------|----------------|----------------|----------------|----------------|----------------|----------------|
|                                 | Music         | 1 5 7 9       | 1 5 7 9       | 1 5 7 9       | 1 5 7 9       | 1 5 7 9       |
| Time                            |               |               |               |               |               |               |
| BP (N = 9)                      | 3.33 ± 1.0    | 5.79 ± 1.53 a | 4.91 ± 1.26   | 6.52 ± 1.31 a | 6.07 ± 1.28   |               |
| BC (N = 7)                      | 3.01 ± 0.76   | 3.50 ± 1.20   | 4.92 ± 1.99   | 4.31 ± 0.99   | 5.65 ± 1.83   |               |

ap < 0.01 in relation to BC

| Table 3 - Mean values of the heart frequency (bpm) obtained during the classes for the groups: body pump (bp) and body combat (bc). |
|---------------------------------|----------------|----------------|----------------|----------------|----------------|----------------|
|                                 | Music         | 1 3 5 7 9     | 1 3 5 7 9     | 1 3 5 7 9     | 1 3 5 7 9     | 1 3 5 7 9     |
| Time                            |               |               |               |               |               |               |
| BP (N=9)                        | 126.4 ± 19.0  | 119.4 ± 181 a | 124.3 ± 13.2 a| 146.6 ± 17.5 a| 112.6 ± 9.3 a |               |
| BC (N=7)                        | 143.8 ± 6.9   | 169.8 ± 7.0   | 168.3 ± 10.6  | 179.5 ± 7.9   | 150.7 ± 14.0  |               |

ap < 0.01 in relation to BC
in relation to BP in the music 3 (18 min), 5 (32 min), 7 (42 min) and 9 (51 min), as demonstrated by the Table 3.

The results presented by the Graph 1 show that the mean values of FC of the class - so much in absolute values as relative - were significantly larger (p < 0.01) in the program BC (162.4 and 86%) in relation to BP (125.9 and 61.4%). In compensation, differences (p > 0.05) were not verified among the mean values of sanguine lactato among the programs BC (4.27 mM) and BP (5.32 mM).

**DISCUSSION**

Several parameters, such as maximum oxygen consumption (VO$_{2\text{max}}$), answer of the sanguine lactato (LAC), subjective effort perception (SEP) and heart frequency (HF), have been used for the prescription and evaluation of the training intensity. And, of these, HF has been used a lot in the sphere of the sport and also in gyms, mainly, for being a no invasive method, of easy applicability and of low operational cost (GUGLIELMO, 2000; VIANNA et al., 2005).

The monitoring method of the heart frequency has been thoroughly used because its easiness and for respecting the activity specificity to be evaluated. This method provides an indirect registration of the physiologic process that reflects the amount and intensity of the physical activity, and the heart frequency is also typically used to esteem the energy expense of the physical activity, based on the criterion of the linear relationship between the heart frequency and oxygen consumption (VO$_J$) (ASTRAND, RODAHL, 1977) and, for that, those variables are expressed in percentile relative to its maximum.

However, the evaluation for the identification of the maximum values of those variables is not always possible, in that way, some mathematical equations have been proposed. In the case of HF, the equation proposed by Karvonen (220-age) has been thoroughly accepted by the scientific community in the identification of HF$_{max}$, being also recommended by American College of Sports Medicine (ACSM, 1990) in the prescription and control of the effort intensity.

Heyward (1998) proposes three levels of effort intensity, using the percentile of maximum HF (%HF$_{\text{max}}$). Light, moderate and heavy levels that correspond, respectively, to < 64%, 64-81% and > 81% of HF$_{\text{max}}$.

ACSM (1990) recommends for the aerobic training and increase of the cardiorespiratory capacity intensities between 60% and 90% of the maximum heart frequency (HF$_{\text{max}}$) or between 50% and 85% of the maximum oxygen consumption (VO$_{2\text{max}}$).

The lineal relationship between the percentile of the maximum heart frequency (%HF$_{\text{max}}$) and the percentile of the maximum oxygen consumption (%VO$_{2\text{max}}$) can be verified mainly in cyclical activities of aerobic prevalence (LONDEREE et al., 1995). However, in some academy activities, as the aerobic gymnastics, step training and body pump that linearity relationship cannot be verified (OLSON, WILLIFORD, SMITH, 1992; VIANNA et al., 2005; STANFORTH, STANFORTH and HOEMEKE, 2000).

Partly, that linearity loss between the% HF$_{\text{max}}$ and the% VO$_{2\text{max}}$ can be explained by the choreographies used in a large part of the academies routines, which involve the movement of inferior and superior members simultaneously; that movement type can take to a larger activation of the simpatico nervous system, culminating in a larger adrenergic answer and, therefore, increasing the heart beats without to have necessarily increased VO$_J$ (OLSON, WILLIFORD, SMITH, 1992; OF ANGELIS et al., 1998).

Unlike that what happens with the relationship between HF and VO$_J$ in some activities, the relationship of those variables with the answer of the sanguine lactato can be very imprecise, could happen great variations between a certain intensity related to the fixed concentration of sanguine lactato and the relationships with the %HF$_{\text{max}}$ and %VO$_{2\text{max}}$ (GUGLIELMO, 2000).

Possibly, those differences can be explained by the different mechanisms that determine those variables, mainly VO$_{2\text{max}}$ and LAC; while VO$_{2\text{max}}$ is more linked to the central component of the organism, as the offer of O$_2$ central, LAC is more related to the outlying modifications, as, for instance, the muscle lactato oxidation capacity (DENADAI, 1999, 2000).

In that way, the answer of the sanguine lactato has been a lot investigated in the last decades, mainly, in the activities of prevalence of the aerobic metabolism. Besides, that physiologic variable can also have wide relevance in the models of intermittent and acyclic exercises, as in the activities developed in academies, because the sanguine lactato is one of the main direct indicators of the energy metabolism used during the exercise, could also classify in a more necessary way its intensity (GAESSER and POOLE, 1986).

When the lactato concentration is used in the blood to identify the exercise metabolic overload, one of the main references is the anaerobic threshold (LAN) or OBLA (onset of blood lactate accumulation), regarding a fixed concentration of 4 mM of lactato in the blood, which has been proposed as representative of the maxim stable phase between the production and lactato removal (HECK et al., 1985) or, still, the level of VO$_{2\text{max}}$, in that the aerobic energy is supplemented for anaerobic mechanisms (WASSERMAN, 1984).

More recently, LAN has shown the most appropriate index, overcoming the maximum oxygen consumption (VO$_{2\text{max}}$), for the prescription of the intensity of the exercise, control of the effects of the training and for the evaluation of the performance (COYLE, 1995; DENADAI, 2000).

An interesting relationship presented by Gaesser and Poole (1986), relating intensity of effort and lactato concentration, proposes that the effort, in relation to its intensity, it can be classified in three domains: moderate, heavy and severe. The moderate effort corresponds to those intensities that can be accomplished without the modification of the sanguine lactato in relation to the rest values, in other words, the lactato stays below 2 mm. The heavy effort would be starting from the smallest intensity of effort in that the
lactato increases, and it has as limit superior to 4 mM, on mean. For its time, the severe effort is that in this stable phase of lactato doesn’t exist in the blood, whose index continues rising during the whole time of effort, until the exhaustion.

Kindermann et al. (1979) suggests that the intensity regarding the concentration of 2 mM of sanguine lactato be the minimum intensity for the improvement of the aerobic capacity.

Based in these references, the results of this study showed that, in the two appraised modalities, the mean concentrations of sanguine lactato (BP = 5.32. 1.26 and BC = 4.27. 1.06) obtained during the classes were superior to 4 mM, which characterize an intensity domain between heavy and severe. Regarding the relative values of HF of the classes, the obtained values were: for BC, 86% of HFmax and for BP, of 61.4% of HFmax that suggest domains of light intensity for BP and heavy for BC.

Regarding BP, we didn’t find in the literature any study approaching the lactato answer in that class type, however, Puga et al. (2005) verified the answer of LAC in the training resisted with loads of 40% to 50% of the maximum load, that, Les Mills (2005), they are similar to the loads used in BP, and they found values of sanguine lactato that vary from 4.0 to 6.68 mM in different exercises. In another study, Hunter, Seelhorst, Snyder (2003) found values of LAC of 4.0 mM for exercises accomplished with loads of 25% of 1 RM and 7.9 mM for loads accomplished to 65% of 1 RM.

Stanforth, Stanforth and Hoemeke (2000) evaluated the physiologic and metabolic answers during classes of Body Pump in 15 men and 15 women, all physically assets. The values of %HFmax and %VO2max were obtained starting from the maximum values obtained in an incremental test in treadmill. The results revealed values of 30.0% of VO2max during the classes for the men and 28.0% for the women, while the values of HF were from 66.4% of HF max to the men and of 59.5% for the women.

More recently, Pfitzinger and Lythe (2003) evaluated VO2 and the HF answer in 5 men and 5 women between 31 and 34 years, practicing of Body Pump. The results of the study showed values of relative intensity of effort, so much for the men as for the women, respectively of 74.3% and 74.1% of maximum HF, while the values of the %VO2max were from 41.6% to the men and of 39.8% for the women. Comparing the results of the two studies above mentioned, the largest values found by Pfitzinger and Lythe (2003) in relation to the %HFmax and %VO2max during the classes of BP, can be partly explained by the samples size, initial levels of physical fitness among the individuals, besides the ergometers used to obtain HFmax and VO2max among the two studies, treadmill x bicycle. In those studies the answer of the sanguine lactato was not verified and the authors ended that the intensity of the classes regarding the %VO2max is not enough for the improvement of the aerobic capacity, with base in the ACSM criteria (1990).

The authors’ conclusion regarding the inefficiency of BP for the improvement of the aerobic or cardiorespiratory capacity lives in the fact that capacity to be related to the increase of VO2max. Studies have been demonstrating that the resisted training doesn’t increase VO2max nor in sedentary individuals nor in the well trained (LeMURA et al., 2000; MARCINIK et al., 1991), possibly for the low %VO2max used. However, we should remind that VO2max is not the only index used for the aerobic evaluation, of that it sorts out that the resisted exercises cannot be efficient to generate alterations at central levels, which is related to VO2max, but it can generate considerable outlying alterations, until could modify the anaerobic threshold (MARCINIK et al., 1991).

In relation to Body Combat, as previously mentioned, it is an activity that seems a lot with the traditional gymnastics aerobics, being basically differed by the used choreographies. The values of sanguine lactato found in BC in the present investigation are quite different from the moderated by Romero and Denadai (1995), that evaluated the modalities of the step and the gymnastics aerobics. The authors found mean values of 1.05 and 1.10 mM during the step classes and aerobic gymnastics, respectively. However, in that study arms movements were not used above the waist line.

On the other hand, in another study driven by De Angelis et al. (1998) which evaluated classes of gymnastics aerobics in 30 healthy young women, the authors found mean values of lactato in the blood of 4.80 mm. They found, also, intensities of effort during the classes of 74.8% to 92.8% of HFmax and of 52.8% to 72% of VO2max, suggesting that this class type is enough for the improvement of the cardiorespiratory component and for the corporal weight maintenance.

An interesting study accomplished by Bellissimo et al. (2004) evaluated the effects of eight weeks of Body Combat training on morphofunctional variables in 19 sedentary women. The results of the study showed that the intensities during the classes located between 62.0% and 88.8% of maximum HF, while the concentrations of sanguine lactato were between 2.52 and 4.89 mM. The results also demonstrated that, after the training period, there were significant improvements in the aerobic capacity, with expressive increase of the ventilatory threshold and of the corporal composition, and with significant improvements in the thin mass and body fat component.

In the same way, Krause and da Silva (2004) also found improvement in the aerobic capacity in sedentary young women submitted to the BC training, with significant increases in VO2max after eight weeks of training.

Therefore, with base in those information and in the obtained results, it seems that the BC program demands more from the cardiorespiratory system, suggesting, in that way, to be more efficient as for the objective of increase of VO2max, while the program BP seems to demand more of the outlying system, as demonstrated by the largest values of LAC in some moments of the classes, suggesting to be more efficient for the anaerobic threshold increase. However, both programs seem to be efficient for the aerobic aptitude improvement.
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