Analysis of the oxygen intake, cardiac frequency and energetic expenditure during Jump Fit lessons

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ABSTRACT

Jump Fit lessons further the improvement of the general physical fitness through choreographies performed on an elastic surface with rhythm and movements variation with intervals and low impact. However, not much is known about the actual energetic expenditure and the behavior of the metabolic variables related to Jump Fit lessons. The objective of this study was to identify and to evaluate the behavior of the functional variables such as: heart rate (HR), oxygen intake ($\dot{V}O_2$), metabolic equivalent (MET) and energetic expenditure through routine spirometry measurement of a Jump Fit lesson. The tests were performed in four visits by 10 women who practice Jump Fit with age of 26.8 (± 7.2), body mass of 57.6 kg (± 6.8) and height of 162.2 cm (± 3.9). The spirometric evaluation of the several stages of the lesson revealed the following average results: HR of 160.3 bpm (± 8.9), $\dot{V}O_2$ of 1.59 $L.min^{-1}$ (± 0.45), RQ 0.87 (± 0.10) and total energetic expenditure of 386.4 kcal (± 13.8). The Jump Fit lesson average intensity corresponded to 75% (± 7.7) of the $\dot{V}O_{2peak}$. For the analysis of the metabolic variables behavior in the different stages of the lessons, the results were treated through ANOVA for repeated measures with Bonferroni verification. The *t*-test was used to identify if differences between the functional responses in rest and EPOC phases occurred. The level of significance of $p < 0.05$ was adopted. It was concluded that from the magnitude of the functional responses, the Jump Fit lesson provides increase on the cardiorespiratory resistance, thus contributing effectively for the maintenance and improvement of the physical fitness and health in quality of life.

Key words: Cardiorespiratory variables. Exercise physiology. Physical conditioning. Training. Physical fitness.

INTRODUCTION

The employment of physical exercise programs for health promotion in quality of life sends us to ancient times. Epidemiological studies have demonstrated that the regular practice of physical exercises is related to the decrease on the causes of mortality influenced by the reduction on the main risk factors involving health of individuals[1].

Moderated exercises have always been recommended for contributing and improving health, however, there are recent and consistent evidences that the high intensity exercises present significant and important effects on health and provide higher daily energetic expenditure[2]. Intense exercises also contribute positively for health, especially those related to the increase of the energetic expenditure, increase of lean body mass, increase in the post-exercise energy expenditure, reduction in the lipidic profile, influencing reductions of up to two times the mortality rates[3-6]. On the other hand, low daily levels of physical activity produce small reductions in the risk factors, besides not guaranteeing the physical conditioning required for the individual to improve his general physical fitness[7].

Jump Fit is a program of rhythmic exercises performed on a mini springboard and its effects have been considered as beneficial as those achieved by the regular practice of aerobic exercises. The success of this program is mainly related to pleasure and motivation that this activity provides, besides the attainment or maintenance of adequate levels of physical conditioning for the performance of daily tasks.

The equipment used in a Jump Fit lesson allows the performance of exercises that involve the gravity force and acceleration and deceleration due to its elastic surface and a system of special-resistance springs fixation that allows reaching high performance on the execution of exercises. The exercises proposed are presented as preestablished choreographies modified each period of three months. Each choreographic routine involves simple and easy-to-perform movements, what enables the participation of all types of individuals. The lessons are assembled with the use of nine melodies divided in form of intervals, starting with a warm-up exercise followed by a pre-training stage, following a more intense rhythm with five melodies that correspond to the cardio-training. Its final stage is composed of two melodies with slower rhythm for the cool down phase and another for abdominal exercises.

The Jump Fit practice has grown more and more in bodybuilding academies. However, not much is known about the actual behavior of the heart rate (HR), the oxygen intake and its energetic demands in a pre-choreographed training methodology. Thus, the objective of this study was to identify and to evaluate the behavior of the functional variables such as: oxygen intake, HR and energetic expenditure during the number-five Jump Fit lesson methodology through spirometric evaluation.

MATERIAL AND METHODS

Subjects

Ten volunteer women with average age of 26.9 years (± 7.2), body mass of 58.6 kg (± 6.4), height of 162.2 cm (± 6.5) and fat percentile of 19.2% (± 3.9) participated in this study. All reported to be healthy and physically active, performing aerobic activities at least four times a week and familiarized with exercises and equipments used in this study. For the selection of the sample, the following inclusion criteria were respected: a) regular practice of aerobic activity for at least six months; b) fat percentile not higher than 25%, avoiding overweight levels that could impair the movements execution quality; c) negative risk stratification questionnaire[8].

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As exclusion criterion were adopted: a) use of remedies that could influence the behavior of the functional responses, especially the cardiac frequency; b) osteomyoarticular problems that could limit the performance of the proposed exercises; c) lack of familiarization with the Jump Fit lesson. All volunteers signed the consent form according to Resolution number 196/96 of the Brazilian Health National Council.

Procedure for data collecting

The study was performed in four visits at the Functional Evaluation Laboratory from the Physical Education Course – Gama Filho University (Jacarepaguá Campus). In the first visit, the body composition and the cardiorespiratory fitness were evaluated. The volunteers were informed about the objectives of the study and procedures of tests that they would be submitted to. Right next, the volunteers were oriented not to practice high intensity physical activity 48 hours before tests.

Evaluation of the body composition

The checking of the anthropometrical measures followed the procedures recommended by the Society for the Advance of Kinanthropometry (ISAK)[9]. The body mass was determined from balance model *Filizola* with resolution of 100 grams and a fixed stadiometer was used for the height measurements. The flexible metallic tape measure model *Sanny* (Starrett), used for the determination of the body circumferences measure and the caliper rule model *Mitutoyo*, used for the determination of the bone diameters. The triceps, biceps, pectoral, subscapular, abdominal, thigh and leg skin folds checking was performed with the skin folds calipers model *Harpenden* (London). The body density was estimated through the Jackson and Pollock[10] equation; the calculation of the fat percentile was obtained from the Siri[11] equation and the somatotype was calculated through the Heath-Carter[9] anthropometric method.

After anthropometric measurements the volunteers were submitted to a maximal ergospirometric test in treadmill according to recommendations of the Bruce protocol, aiming at the determination of the maximal oxygen intake ($\dot{V}O_{2peak}$) and maximal heart rate. During ergospirometric test, the volunteer were connected to the gases analyzer *Aerosport TEEM 100* (USA) through mouthpiece and nasal clip. The HR was verified in the rest phase with duration of three minutes at the end of each minute of the test stages with duration of three minutes each and in all recovery phase with duration of three minutes, using frequencimeter *Polar* model *Accurex Plus* (USA). The test was considered as maximal when the volunteer presented at least three of the following criteria: the oxygen intake reached a constant level even with the increase on the effort intensity, the respiratory exchange ratio around 1.10, small variation of the HR in maximal effort and when volunteers reached maximal fatigue, voluntarily disabling to continue exercise.

In the second and third visits, a familiarization and training of the Jump Fit lesson 5 choreography occurred using a mini springboard label *Jump Fit*®. The choreography was followed through videotape, where all stages of the lesson 5 were performed, except for the abdominal exercises. The visits occurred with minimum interval of 48 hours, thus avoiding the possibility of fatigue at the spirometric evaluation day.

During the fourth visit, the volunteers performed the spirometric evaluation in the mini springboard with the measurement of the energetic expenditure and oxygen intake, production of carbon dioxide, ventilation and respiratory quotient through the gases analyzer *TEEM 100*, followed by HR evaluation in all stages of the Jump Fit lesson.

Characteristics of the Jump Fit lesson 5

The Jump Fit lesson 5 is composed of nine melodies as follows: warm-up exercises, pre-training stage, five cardio-training stages (stages one, two, three, four and five), the cool down period and the abdominal exercises. Each one of these stages presents duration of approximately five minutes and six short pauses of 30 seconds between them and two long pauses of 90 seconds, performing a total time of approximately 50 minutes.

For this study, the characteristics of stages warm-up, pre-training, cardio-training(s) 1, 2, 3, 4, 5, cool down, short and long pauses were maintained. 15 minutes of rest and 15 minutes of recovery were added.

Collecting of variables during Jump Fit lesson

In the present study, the functional responses related to the nine melodies of the lesson 5 were verified, rejecting the last melody related to the abdominal exercises, once the performance of these exercises was not feasible with volunteer connected to the spirograph. Before data collecting in the Jump Fit lesson 5, the functional variables of the 15 minutes of rest were checked with volunteer sitting down, performing the lesser movement as possible, aiming at reaching stable values in this period of HR, oxygen intake and energetic metabolism. Shortly after rest, the volunteers performed the warm-up and pre-training stages, five cardio-training melodies and cool down without final abdominal exercises. After cool down, the volunteers performed the recovery stage, sitting down for 15 minutes, following the same procedures as the rest phase. During all test stages the volunteers remained connected to the gases analyzer *TEEM 100*. The environment remained cooled with temperature ranging from 18° to 21°C and air relative humidity between 43 to 65% during all test stages.

For the calculation of the energetic expenditure in the Jump Fit lesson 5, the average reached in the Jump Fit test, where higher contribution of the carbohydrate as energetic substrate occurred was adopted and the value of 5 $kcal.LO_2^{-1}$ was considered, also applied in rest or recovery situations[5].

Procedure of data analysis

The data analysis was performed descriptively with the objective to identify and to characterize the sample and the metabolic and cardiovascular responses related to the values of the oxygen intake ($\dot{V}O_2$), production of carbon dioxide, respiratory quotient (RQ), ventilation (VE), HR and energetic expenditure (kcal) in stages of the Jump Fit lesson 5. In order to determine the group's homogeneity in relation to body composition, maximal HR and maximal oxygen intake obtained in the ergospirometric test, the Kolmogorov-Smirnov test was used, indicating that the sample presents normal data distribution. For the behavior analysis of the oxygen intake ($\dot{V}O_2$), energetic expenditure and HR in the different lesson stages, the ANOVA for repeated measures with Bonferroni verification was used. The *t*-test was used to identify differences between functional responses in rest and EPOC phases. The level of significance of $p < 0.05$ was adopted in all cases.

RESULTS

The sample composed for this study was characterized as homogeneous, presenting normal distribution in relation to values of the following variables: age 26.9 years (± 7.2), body mass 58.6 kg (± 6.4), height 162.2 cm (± 6.5), fat percentile 19.2% (± 3.9), lean body mass 47.1 kg (± 3.7) and BMI 22.2 kg/m^2 (± 2.0). Both the BMI and the fat percentile values found in the group evaluated indicate that the sample presents adequate values, in other words, suitable with active and healthy life-style for both variables considering gender, age range and physical activity level. The fat percentile average values suit the percentile 70[2].

According to classification of the ACSM[12] physical fitness level, we verified that the group evaluated presents good general physical fitness considering average $\dot{V}O_{2max}$ of 2.61 $L.min^{-1}$ (± 0.38) and cardiac frequency of 183.5 bpm (± 6.7). According to data obtained through the spirometric analysis during the Jump Fit lesson 5, excluding rest, warming-up, pre-training, cool down and recovery phases, we have found average oxygen intake during stages corresponding to cardio-training of 1.80 $L.min^{-1}$ (± 0.19), being the highest value 2.04 $L.min^{-1}$ (± 0.25) found in the cardio-training stage one and the lowest value 1.50 $L.min^{-1}$ (± 0.53) found in the cardio-stage four. The $\dot{V}O_2$ average values for the descriptive statistics are presented in figure 1.

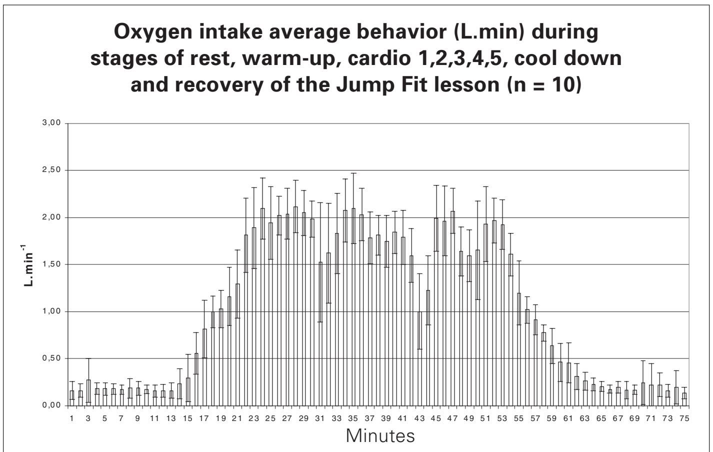

Fig. 1 *– Oxygen intake average values obtained in rest in stages of the Jump Fit lesson 5 and in recovery*

The absolute oxygen intake obtained during Jump Fit lesson 5 ranged from 0.56 to 2.12 $L.min^{-1}$ (1.59 ± 0.45), representing a total energetic expenditure of 386.4 kcal in all stages of the lesson including rest and recovery periods. Comparing the oxygen intake average values of all stages of the lesson 5 to average $\dot{V}O_{2peak}$ reached in the ergospirometric test (2.61 ± 0.38 $L.min^{-1}$), one may conclude that the volunteers performed the Jump Fit lesson at 81.2% of the $\dot{V}O_{2peak}$ with a respiratory quotient response between 0.74 and 0.90 and average value of 0.86. Such results represented physical activity with intensities from moderate to intense (figure 2).

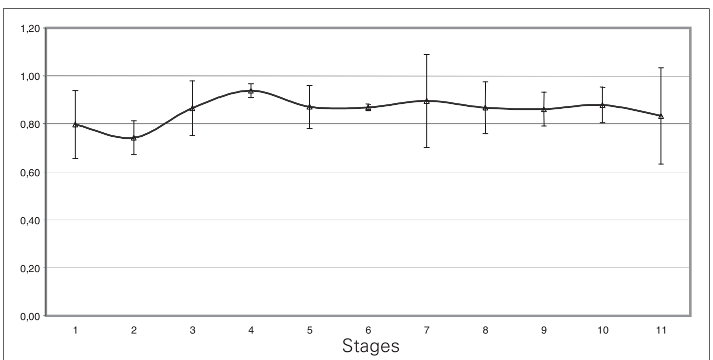

Fig. 2 *– Analysis of the average percentile values of the respiratory quotient during the following stages: warm-up, pre-training, cardio-training 1, 2, 3, 4, 5, cool down and recovery*

Figure 3 shows the HR behavior in rest situations during lesson methodology and in the recovery stage. As observed, the average cardiac frequency during lesson 5, excluding values recorded in rest and recovery stages, ranged from 113 and 171.2 bpm (160.3 ± 8.9). Considering 183.9 bpm (± 7.59) as the maximal average cardiac frequency obtained by volunteers in the maximal ergospirometric test, we concluded that the average physical work intensity related to HR during the Jump Fit lesson 5 represented 87.1% of the maximal average HR reached by volunteers, emphasizing the characteristic intense physical activity.

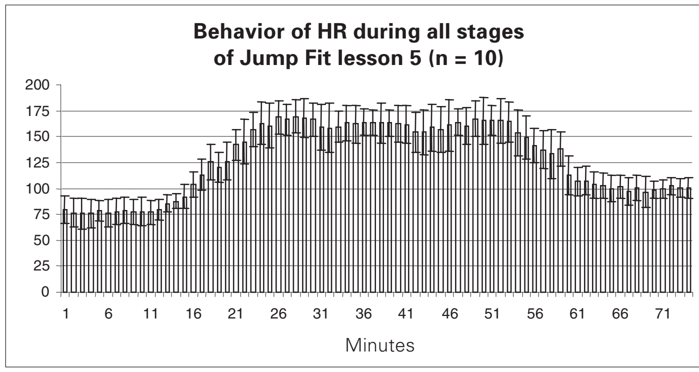

Fig. 3 *– Average values of HR in rest, warm-up, pre-training, cardio-training 1, 2, 3, 4, 5, cool down and recovery*

The HR average percentile values in the lesson 5 ranged from 63.6 to 91.3% when compared to the maximal average HR reached in the ergospirometric test. During cardio-training melodies we verified that the average percentile corresponded to 91.3, 86.8, 89.8, 85.1 and 89.5% respectively, being 88.2% (± 2.5) the general average of the cardio-training stages (figure 3). Significant differences were found in HR responses between cardio-training stages one and four, three and five and cardio-training stages four and five, demonstrating that the cardio-training stages provided different requirements from the cardiovascular system.

We have verified that in the Jump Fit lesson 5 that includes the warm-up, pre-training, cardio-training and cool down and recovery phases that the highest energetic expenditure values are mainly related to the cardio-training stages and the minimal value of 37.52 kcal (± 4.05) was observed in the cardio-training stage four and the maximal value of 52.52 kcal (± 11.9) was reached at the cardio-training stage one. When we compare the average energetic expenditure between the cardio-training stages, we verify that the cardio-training stages one and four, one and five, two and four, two and five, three and four and three and five present significant differences.

With the objective of verifying if the lesson furthered significant changes related to the energetic expenditure in the recovery phase, we compared the energetic expenditure between rest and recovery phases and verified significant difference between measures. In this lesson methodology, the average energetic expenditure furthered great alteration on the magnitude of the effort post oxygen consumption (EPOC).

Considering all cardio-training stages in the Jump Fit lesson including warm-up, cool down and recovery, the total energetic expenditure was of 386.4 kcal (± 13.8). Figure 3 presents the total energetic expenditure of all stages of the Jump Fit lesson 5.

As demonstrated in figure 4, when average values of HR and $\dot{V}O_2$ were transformed into average percentile values and the behavior of both variables were compared in all stages of the Jump

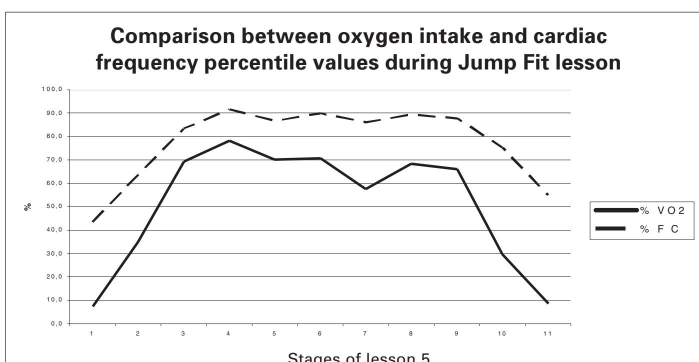

Fig. 4 *– Analysis of the average percentile values of HR and* $\dot{V}O_2$ *during Jump Fit lesson 5 (r = 0.94;* r^2 *= 0.88)*

Fit lesson 5, we find linear behavior between responses of HR and $\dot{V}O_2$. The Pearson correlation test presented r = 0.94 and $r^2 = 0.88$, indicating that, for the group analyzed, the HR and $\dot{V}O_2$ responses presented linear behavior even when arm movements concurrently with leg movements were performed.

DISCUSSION

Scientific evidences have emphasized the importance of intensity, duration and frequency of physical activities as components of an aerobic exercises program for the improvement of the physical fitness and benefits associated to health[13]. The ACSM[12] recommendations include intensities of 50% to 85% of the $\dot{V}O_{2max}$, frequency of three to five times a week and duration of 20-60 minutes per session. Among factors that compose the overload, the intensity seems to be the most important factor, furthering adaptations that will occur according to training methodology used[14,15]. Although the cardiorespiratory evaluation has been applied to several activities such as running and cycling[16] and lessons of localized physical exercises and step training[15], its measurement in the Jump Fit lessons is not scientifically reported. The cardiorespiratory increment phenomenon is empirically observed in this lesson methodology applied in bodybuilding academies.

The maximal aerobic power represents the maximal rate that energy can be produced in muscle by the oxidative metabolism, where the gold standard method is considered among all existing methods[17]. The $\dot{V}O_{2max}$ is the component of the aerobic fitness that best represents the organism capacity to transport and to release oxygen into the muscle, directly influencing on the adaptive responses of the cardiorespiratory system (central component) and on adaptations occurring at tissue level (peripheral component). The central component effectiveness depends on the pulmonary diffusion, the cardiac debt and on the hemoglobin affinity. The factors that influence the peripheral adaptations, increasing the absorption and the utilization of the oxygen by the musculature involved, are related to the muscular glycogen supply, to the capillary density, to the mitochondrial density and volume, to the oxidative enzymes and to the muscle myoglobin content[18].

We emphasize that the average $\dot{V}O_2$ reached in this study is in agreement with scientific recommendations for the development of the aerobic fitness, according to ACSM[12,22] physical fitness level classification. We verified that the individuals evaluated presented good general physical fitness[12,22], considering the average $\dot{V}O_{2max}$ of 2.61 $L.min^{-1}$ (± 0.38).

According to the average $\dot{V}O_2$ obtained in the several stages of the lesson methodology applied and according to the individuals' physical fitness level, we classify a Jump Fit lesson as an aerobic exercise from moderate to high intensity[1], being its training methodology the number five, a good proposal for increment and improvement of the cardiorespiratory condition both for trained as for untrained individuals.

The average HR behavior during the number five lesson stages was of 155.6 bpm (± 16.2), which represented 85% (± 8.9) of the maximal average HR obtained in the maximal test, seems to indicate that such methodology may be considered as an activity with moderate to intense intensity[12,22]. The ACSM[12,22] recommendations suggest that the training intensity suitable to increase the cardiorespiratory conditioning in active individuals may range from 60 to 85% of the maximal HR. Comparing our results to the scientific recommendations[3,12,22], we can infer that the HR response in the Jump Fit activity may be considered as a physical activity able to promote positive effects on health improvement.

With regard to the HR response during physical exercises, some studies have demonstrated no linear relation between HR and $\dot{V}O_2$ in physical exercises with concurrent requirement of arms and legs, as example, the aerobic gymnastics and the step training[15,23-25]. However, in cyclic activities, running or walking that use lower limbs predominantly, the linear relation existing between HR and oxygen intake increases significantly, depending on several anatomical and physiological considerations[26-28]. However, the Jump Fit lesson methodology used in this study also recommends the use of lower limbs concurrently with upper limbs and the HR progressively followed the physical exercise intensity, thus forming a linear relation between HR and oxygen intake during activity.

The total average energy expenditure of the current study was of 386.4 kcal (± 13.9), being found within range recommended by ACSM[2], which determines that the exercise sessions must present energy expenditure of 300-500 kcal. However, the Jump Fit lessons, in their different training methods, present variations that may be applied to increment the energetic expenditure such as: higher legs and arms movement intensity, higher strength when pushing the springboard canvas, utilization of movements involving larger muscular groups, increase on the melody's rhythm, changes on choreography's sequences. Such increments may provide higher energetic activity, thus reflecting in improvements on the esthetic components and health.

Data based on literature[5,6] consider that the energy used during physical effort and recovery demonstrates that high-intensity or moderate exercises have significant influence on the EPOC magnitude, especially at the first minutes of the recovery phase. In our study, when we compared the energetic expenditure of the rest and recovery phases, a significant difference was found. Such fact indicates higher EPOC magnitude in function of the Jump Fit lesson intensity. It is important to emphasize that the EPOC elevation may be influenced by the lesson methodology and by the physical fitness level of the individuals.

In short, the results obtained in the methodology number five of the Jump Fit lesson suggest that the responses of HR, oxygen intake and energetic expenditure are in agreement with the ACSM[2,12,22] and AHA[28] recommendations in relation to the ideal zone of a physical exercise training (60 to 90% of the maximal HR and 50 to 85% of the $\dot{V}O_{2max}$), providing increases in the cardiorespiratory resistance and it should be indicated as a lesson modality in bodybuilding academies with the objective of improving the aerobic condition and contributing effectively for the maintenance and improvement of the physical fitness, health and quality of life.

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