166 - EXCESS POS-EXERCISE OXYGEN COMSUMPTION: A COMPARATIVE STUDY IN UNTRAINED SUBJECTS

CAMILA MARIA DE MELO, REGINA URASAKI, SILVIA ROCCA,
SANDRA MARIA LIMA RIBEIRO
Universidade São Judas Tadeu, São Paulo, Brasil
smlribeiro@uol.com.br

1. INTRODUCTION

The evaluation of the energy expenditure is of importance for the nutritional accompaniment of individuals, either in programs of weight loss, profit of muscular mass or weight maintenance.

The daily energy expenditure is composed to: - basal metabolic rate (BMR), for the thermic effect of foods (TEF) and physical activity (PA). The last one is the one that suffers greater variability, being able to represent between 30% and 100% of the basal, depending on individual factors (FAO/OMS/UNU, 1998). The exercise implies in energy expenditure during its execution, and can also generate a called "deficit" of oxygen, that means the prolongation of the time where the energy expenditure is increased. This deficit is known as EPOC (Excess Pos Exercise Oxigen consumption).

Although the existence of the EPOC is claimed, studies are still unconclusive in respect to magnitude, duration, metabolic aspects or other factors involved. The duration and intensity of the activity must be related with the magnitude of results (MEIRELLES, 2004). Amongst the less clear factors, the low physical conditioning of the individuals could be cited. Nowadays, it has been unquestionable the importance of the physical exercise in programs of loss weight. The individuals that look for these programs in the majority of the times are untrained, and therefore it is important to understand different answers of the organism to exercise.

The present study aims to evaluate the intensity and duration of the excess pos-exercise oxygen consumption (EPOC) in endurance and resistance exercise, in untrained subjects.

2. METHODS:

The protocol was cross-sectional, "cross-over" type. Five untrained men, 20 to 25 years old were studied. They were familiar with the proposed activities, but were not involved in a consistent resistance or endurance exercise training program. The individuals were not ingesting any medicine that could interfere with the metabolic rate. Moreover they did not present heart, muscle or bone diseases.

Weight (Filizola® scale) and stature (Secca® stadiometer) wee evaluated. With these values the BMI (Body mass index) were calculated The body composition was analysed by bioimpedance analyzer (Biodinamics model 450a). Fat percentage, weight of fat and fat-free mass were measured The experimental protocol is shown in Figure 1

1° day: Introduction to the experimental protocol, followed by maximal repetitions test, anthropometric and bioimpedance measurements. ⇩		
Days 2,3 e 4 (randomic*)		
Aerobic Exercise	Resistance exercise	Control Situation
⇩ Race in treadmill, for 45 minutes, at 65% of the maximal heart rate (HRmáx = 220- age (yers)±10bpm) (*Karvonen et al. 1957*)	⇩ 45 minutes of training, consisting of: chest press, inclined chest press, leg press, overhead press, knee extensions, seated row and low row. The three series of twelve repetitions had been done from the load determined by 8 - 12 repetitions test, with 2min intervals betwen they.	⇩ Measurement of O2 consumption without any type of exercise.

Figure 1: Experimental protocol. (*)-All the subjects of the study had all of the protocols, with interval of one week between them. The order of the exercises was not sequencial.

The resting energy expenditure (REE) was made with the use of the VO2000 (Imbrasport®), with the following parameters being evaluated: VO2 (oxygen consumption, in $L.min^{-1}$), VCO2 (carbonic dioxide production, in $L.min^{-1}$), RQ (respiratory quotient VCO2/VO2). The test was initiated with at least 8h fasting individuals without practical of physical activity in the last 72hs.

The individuals arrived at the laboratory at 8h a.m., and were accomodated in a stretcher, in a room with controlled temperature. They were connected at the mask for the collection of respiratory gases and the individuals had remained per 15 minutes in adaptation to the equipment. The collection was made during the 15 subsequent minutes, from which the 24h resting energy expenditure (REE = [(4,686 + 1,096 x (RQ - 0,707)) x VO2] x 24 (Weir,1949)) was evaluated

After that, the subjects had received a standardized meal, and carried out the exercise session. Subsequently, the REE was again measured, immediately after the session (IA), 2 h after, 4 h after and 24 h after. For this last one, the individuals returned to their homes, and were guided to take their meals, not exceeding 35-40Kcal/Kg of body weight. The subjects returned to the laboratory in the next day, fasting, and was evaluated the REE. In the controll situation day, the oxygen consumption was measured without any exercise. The values were compared at diferent moments and protocols by ANOVA-two away, with the software SPSS for windows, and the values with p<0,05 were considered to be significant.

3. RESULTS

The body composition of the subjects are shown in Table 1, and the values of REE in Table 2.

Table 1: Antropometric measurements of subjects.

Subjects	BMI (Kg/m^2)	Fat (%)	Fat (Kg)	Lean mass (Kg)
1	25,4	15,6	11,7	63,4
2	19,9	8,9	5,5	56,0
3	21,8	12,7	9,1	62,4
4	24,6	15,6	12,3	66,7
5	24,8	17,3	13,3	63,4
Mean ± SD	**23,3 ± 2,35**	**14,0 ± 3,1**	**10,5 ± 3,1**	**62,4 ± 3,9**

Table 2. Oxygen comsumption and resting energy expenditure (REE).

Subjects	Oxigen Comsumption (VO2) ($mL. Kg^{-1}.min^{-1}$)	REE in 24h Kcal. Day^{-1}
1	1,34	698,81
2	1,62	1013,48
3	2,06	1013,48
4	3,16	1759,35
5	3,18	1421,42
Mean ± SD	**2,27 ± 0,77**	**1112,10 ± 422,58**

Tables 3 and 4 show the oxigen comsumption values at the days of aerobic and resistance exercise, respectively.

Table 3: Oxigen comsumption at the aerobic exercise protocol ($mL. Kg^{-1}.min^{-1}$).

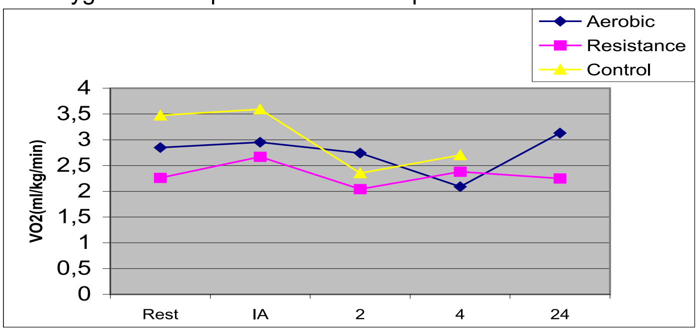
Subjects	Rest	IA	2h	4h	24h
1	2,93	2,68	2,41	2,4	2,92
2	1,62	3,29	2,93	2,61	3,03
3	3,28	3,4	2,6	2,47	3,40
4	2,44	2,25	2,0	1,33	3,17
5	4	3,12	3,74	1,64	3,11
Mean±SD	**2,85±0,66**	**2,95±0,48**	**2,74±0,65**	**2,09±0,57**	**3,13±0,18**

Table 4. Oxigen comsumption at the resistance exercise protocol ($mL. Kg^{-1}.min^{-1}$).

Indivíduos	Repouso	IA	2h	4h	24h
1	1,34	2,21	1,89	2,22	2,55
2	1,61	3,41	2,23	2,54	2,15
3	2,02	2,35	2,01		2,05
4	3,16	2,7	2,58	2,62	2,51
5	3,17	2,7	1,82	2,15	3,84
Mean±SD	**2,26±0,86**	**2,67±0,46**	**2,04±0,17**	**2,38±0,23**	**2,25±0,26**

Figure 1 shows the means of oxigen comsumption, at the diferent moments, and protocols: aerobic, resistance exercise and control situation.

Fig 1. Mean values for oxygen consumption at the diferent protocols.



The tables 5 and 6 show, at the moment IA, the oxigen comsumption, divided in 10 minutes intervals, at aerobic and resistance exercise.

Table 5. Oxygen consumption immediately after (IA) the aerobic exercise, divided in 10 minutes intervals ($mL. Kg^{-1}.min^{-1}$).

Tabela 6. Oxygen consumption immediately after (IA) the resistance exercise, divided in 10 minutes intervals ($mL. Kg^{-1}.min^{-1}$).

Subjects	0-10min	11-20min	21-30min
1	2,46	2,58	2,70
2	2,72	2,89	3,55
3	2,23	2,93	3,47
4	2,31	2,06	2,3
5	2,52	2,7	2,99
Mean ± SD	2,59 ± 0,19	2,74 ± 0,35	3,13 ± 0,53

Tabela 6. Oxygen consumption immediately after (IA) the resistance exercise, divided in 10 minutes intervals (mL. $Kg^{-1}.min^{-1}$).

Subjects	0-10min	11-20min	21-30min
1	2,31	2,64	1,74
2	3,03	3,25	3,44
3	2,43	2,23	2,43
4	2,23	2,96	3,18
5	2,53	2,49	2,89
Mean ± SD	2,51±0,31	2,71±0,4	2,74±0,67

4. DISCUSSION:

Physical exercise is a physiological state characterized by increase in substrate oxidation, that can be measured from gas exchange analysis. The understanding of these mechanisms is of basic importance , because they can determine the metabolic benefits of the physical exercise. Severi et al (2001) pointed to the importance of nutrition and exercise in the metabolic changes, and the importance of the indirect calorimetry in these parameters.

The substrate oxidation in exercise generates an accumulation of substracts, and these must be removed in the recovery process. Furthermore, all the synthesis processes are stimulated after the exercise, mainly muscular protein and glycogen. These are some of the facts that determine the existence of the EPOC. Williams & Horvarth (1995) speculated the metabolic processes that could be responsible for the EPOC, detailing: increase of cardiac debit, reduction in blood pressure, increase of the carbon dioxide, that consequently would increse the heart rate.

Despict to great variability, the subjects of the present study did not modified the oxygen consumption significantly after the aerobic exercise. Measurements of the oxygen consumption after-exercise were performed at the moments IA, 2h and 4h. For each measurement, the mean values from 30 minutes was used. Comparing these results with the study of Willians & Horvath (1995), some aspects must be considered. The authors compared some parameters with the EPOC, in dynamic exercise (50% VO2max). The VO2, when compared with the time of duration of the exercise, return to the normal values in a interval of 10 minutes. Based on this, the Tables 5 and 6 in the present study describe the measurements, at the moment IA, divided in intervals of 10 minutes. When the variations of these values were evaluated , in the aerobic exercise we observed a rise in the interval between 21 and 30 minutes. What facts could lead to a delay in the rise of the EPOC?

Generally it has been accepted that the period of recovery after-exercise is divided in two phases: the fast period, where the rise in the oxygen consumption is more related to lactate, and the rises in circulating cathecolamines. The relation between increase of lactate level and increse in oxygen consumption was citted by Pinz & Portner (2003). From studies with *Bufo marinus*, the authors hypothetise that, while the measure of lactate concentration in the interstitial space is smaller of the intracellular concentration, a lactate transport is initiated through the cellular membrane. This mechanism would set in motion of the Na+/K+ bomb, and increase in the activity of the Na+ - K+ ATP-ase, increasing the oxygen consumption. The period of long duration is less understood. Some authors attribute this period to the normalization of the body temperature. This period can be responsible for a increase in the oxygen consumption smaller than 10%. Trying to explain, the behavior of the oxygen consumption in the 30 minutes period after-exercise on the basis of the two components of EPOC, it can be speculated that the aerobic exercises protocol did not have great interference in the fast component, but presented a trend to increase the consumption of the period of long duration (Tables 3 and 5).

It can then be assumed that the aerobic exercise, being more dynamic, provided higher blood pressure alterations, body temperature and cardiac debit. The control of the blood pressure at these moments could have clarified these questions. On the other side, the anaerobic exercise, being typically of high intensity and, involving muscular glycogen for energy production, generated higher lactate production, together with higher release of cathecolamines. These facts had led to increased EPOC immediately pos-exercise.

The results of the present study are in accordance with Jamurtas *at al* (2004), where the oxygen consumption was increased until 24h after exercise of weight lifting. Melanson *et al* (2002), investigated the effect of different intensities exercises, in the 24h energy expenditure. The authors did not observe differences when the exercises were developed at 40% or 70% VO2max. Moreover they did not observe alterations in the fat oxidation in any protocol, in disagreement with other results from the literature (Bahr et al, 1991; Horton et al, 1998; Wolfe et al, 1990). Melanson et el (2002) attribute this fact to the accomplishment of meals. In the present study the individuals took their meals in the interval between 2h and 4h after the exercise, with the aim of reproduce daily situations. Observing Fig. 1, between 2h and 4h, a drop in the oxygen consumption was observed. Thus, it seems that the accomplishment of the meal, in the aerobic exercise, hindered the increase in oxygen consumption.

In conclusion, the established exercise protocols did not cause significant increases in the EPOC. However, it was possible to observe that the resistance exercise causes immediate response, while the aerobic exercise intervened the consumption of oxygen in a longer period, that possibly reached the period of 24h after the exercise. Studies that involve a major number of subjects, and controling the major possible number of variable certainly will contribute to elucidate the raised questions.

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SANDRA MARIA LIMA RIBEIRO
Universidade São Judas Tadeu- Coordenadoria de Pós Graduação.
Rua Taquari, 546- Mooca- São Paulo- Brasil
smlribeiro@uol.com.br

EXCESS POS-EXERCISE OXYGEN COMSUMPTION: A COMPARATIVE STUDY IN UNTRAINED SUBJECTS

ABSTRACT

This study aims to evaluate the intensity and duration of the EPOC in endurance and resistance exercise, in untrained subjects. Five individuals had initially carried through a test with 8-12 maximal, for determination of the exercise load. The maximal heart rate was took from the prediction: HRmax = 220-age. Three evaluations had been made, in three different days, with interval of at least one week between them. Oxygen consumption was measured with a metabolic analyzer VO2000 immediately after the exercise (IA), 2h after, 4h and 24h after. The days of evaluation for each subject had been randomized: resistance exercise (ER), aerobic exercise (EA) and control situation. Average values for ER were 2,26±0,86(before exercise), 2,67±0,46(IA), 2,04±0,17(2hs), 2,38±0,23(4hs) and 2,25±0,26(24hs). Average values for EA were 2,85±0,66(before exercise), 2,95±0,48(IA), 2,74±0,65(2hs), 2,09±0,57(4hs) and 3,13±0,18(24hs). No significant difference could be observed. The time duration and intensity of exercise in this study, had not significantly modified the oxygen consumption.

CONSUMO DE OXIGÊNIO PÓS-EXERCÍCIO (EPOC): ESTUDO COMPARATIVO EM INDIVÍDUOS JOVENS E NÃO TREINADOS.

RESUMO

O presente estudo teve por objetivo avaliar a intensidade e duração do consumo de oxigênio pós-exercício (efeito EPOC) em modalidades de *endurance* e contra resistência, em indivíduos não treinados. Foram avaliados cinco indivíduos do sexo masculino, e foram feitas três avaliações, em três dias diferentes, com intervalo de pelo menos uma semana entre elas. Foi avaliado o consumo de oxigênio nos momentos: imediatamente após o exercício (IA), 2h após, 4h e 24h após. Os dias de avaliação para cada indivíduo foram randomizados: exercício resistido (ER), baseado em teste prévio de 8-12 repetições máximas, exercício aeróbio (EA), planejado em 65% da FCmáx, e situação controle (sem realização de exercícios). Para o EA foram encontrados (em mL/kg/min): 2,850,0,66(repouso), 2,950,48(IA), 2,740,65(2hs), 2,090,57(4hs) e 3,130,18(24hs). Para o ER os valores foram: 2260,86(repouso), 2,670,46(IA), 2,040,17(2hs), 2,380,23(4hs) e 2,250,26(24hs). Embora algumas diferenças numéricas tenham sido encontradas, estas não foram significativas. Como conclusão, a duração e a intensidade dos exercícios impostos não alteraram significativamente o consumo de oxigênio nos momentos avaliados, mas puderam direcionar a existência de diferentes componentes do EPOC (rápido e de longa duração), em diferentes tipos de exercício.