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EFFECT OF ACTIVE AND PASSIVE RECOVERY ON INTERMITTENT EXERCISE PERFORMANCE

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ABSTRACT

The intermittent exercise consists of a series of repeated blocks of work or effort, alternated with periods of recovery. They are used in many types of training for different sports, targeting different goals, but are mainly used in training programs to improve the maximal oxygen consumption. It is extremely important to deeply study such exercise, not only because it is a training method, but also because a large number of sports have the characteristic of intermittency (soccer, football, basketball, volleyball, tennis, etc.). The effects and physiological adaptations of this form of exercise is dependent on the interaction of various parameters such as type of exercise, duration of the effort, duration of the recovery, intensity of the effort, type of recovery and total exercise time. Therefore, the purpose of the study was to compare the performance during intermittent exercise, between the situations of active recovery and passive recovery using the blocks of effort with predominance of the alactic system (i.e. short duration and maximal intensity). The objective is to contribute not only to the sports science, but also with trainers, coaches and athletes so that they can improve their training through such exercise.

Keywords: high intensity; intermittent exercise; training; performance; interval training

INTRODUCTION

There are a wide array of training programs that seek to improve sport performance. One common approach includes intermittent exercise methods. The intermittent exercise consists of a series of repeated bouts of effort, alternated with recovery periods (10). Intermittent exercise methods are used for training athletes in many different sports, targeting various goals. However, these training programs are mainly used with the goal of improving maximal oxygen consumption of individuals (19). Since a large number of sports have the characteristics of intermittency (e.g., soccer, football, basketball, volleyball, tennis, etc.), it is of broad relevance the improvement of the understanding of intermittent exercise.

The physiological effects and adaptations from intermittent exercise are highly dependent on the interaction of a variety of parameters such as type of exercise, duration and intensity of the effort, duration and type of recovery, as well as the total exercise time (9).

While it is a consensus that recovery periods are significantly important to performance in intermittent exercise, the most effective type of recovery has yet to be agreed upon. Some studies reported that active recovery resulted in better performance during intermittent exercise (4,6,17), while others observed better performance using passive recovery (7-9). Also, a number of studies found no significant differences in performance between active and passive recovery (5,20).

Performance during intermittent exercise depends highly on an individual's ability to recover (3). It is well understood that during the recovery period the oxygen consumption remains high, and therefore the energy resynthesis increases through the contribution of the aerobic system (14,15). This high oxygen consumption is important in order to restore the metabolic environment to resting conditions through processes such as the replenishment of oxymyoglobin (MbO2) stores, the resynthesis of phosphocreatine (PCr), the metabolism of lactate, and the removal of accumulated intracellular inorganic phosphate (Pi) (12).

Dupont et al., (9) reported that passive recovery resulted in a better performance than active recovery in a time to exhaustion intermittent exercise. The better performance for the passive recovery was due to slower deoxygenation during the passive recovery when compared with the active recovery (9). The authors also implied that the greater oxygen availability, the greater phosphocreatine resynthesis (9).

Active recovery is responsible for a high rate of removal of lactic acid (4,6,17), and consequently decreasing the accumulation of hydrogen ions, primarily responsible for muscle fatigue in exercises with high contribution of the glycolytic system. Also during active recovery the oxidative system is increased when compared to passive recovery, which typically results in better resynthesis of creatine phosphate.

The purpose of the study is to compare the performance during intermittent exercise, of active and passive recovery using short bouts of maximal intensity effort (alactic system). The objective of this study is to improve upon the current scientific knowledge in this area and enable trainers, coaches, and athletes with relevant information in order to improve athletic performance.

METHODS

Ten male college soccer players were evaluated (21.4±2.79 years; 73.33±9.01 kg; 1.76±0.1 m). After approval of the Ethics Committee of the Pontifical Catholic University of Paraná (PUC-PR), all subjects signed an informed consent prior to study activities. The tests were performed at the exercise physiology laboratory of the PUC-PR.

The study followed a repeated measures experimental research design and subjects were assessed with the following tests:

Two cycle ergometer (CEFISE®) tests of the lower limbs, each consisting of 10 bouts of 6 seconds maximal intensity effort, with a load of 7.5% of the individual's total body mass, intercalated with 18 seconds of passive recovery (PR) or active recovery (AR). In PR, each subject sat on the cycle ergometer during the 18-second periods of break. In AR, each subject maintained cycling 60 rpm for the 18-second periods of pause, with a load of 1 Kp. In the last two seconds, the individual stopped completely to start the next bout of effort without taking advantage of the inertia. The test sequence was random, but respecting an interval of at least 24 hours and a maximum of 14 days between tests. On test day one, load-efforts were determined based on the individuals' body mass and height of the cycle ergometer bench. All the data were included in an evaluation form and retained for the second test.

The variables obtained through the program Ergometric 6.0® were: power generated every second, peak power (PP) of each bout, mean power (MP) of each bout, and fatigue index (FI) of each bout. The fatigue index over the bouts was determined after analysis, and corresponded to the difference between the highest and lowest PP at the end of the test.

Statistical analysis were performed utilizing SPSS (IBM SPSS software®, 15.0) using repeated measures ANOVA for comparison between blouts and between each type of recovery. Also performed was a Student t-test for paired samples for comparison between the Fatigue Index of the two types of recovery. A significance level (p) of 0.05 was assumed.

RESULTS

The PP for Passive Recovery was measured as 7.9 ± 0.9 W/kg, while for the Active Recovery the PP was 8.3 ± 1.1 W/kg. There was no statistically significant difference ($p = 0.43$) between the PP of Passive Recovery and Active Recovery (Figure 1).

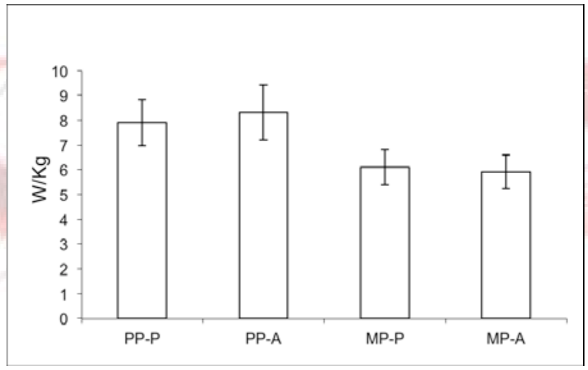

Figure 1: Peak Power (PP) and Mean Power (MP) of both types of recovery (A = Active and P = Passive). (No significant difference for PP ($p = 0.43$), and MP ($p = 0.50$)).

Regardless of the type of recovery, it has been observed that in general, the first bouts have a significant difference compared to the last bouts. In the bouts 1 through 6, PP reached a significantly higher value than the bouts 8, 9, and 10 (p = 0 01) (Figure 2).

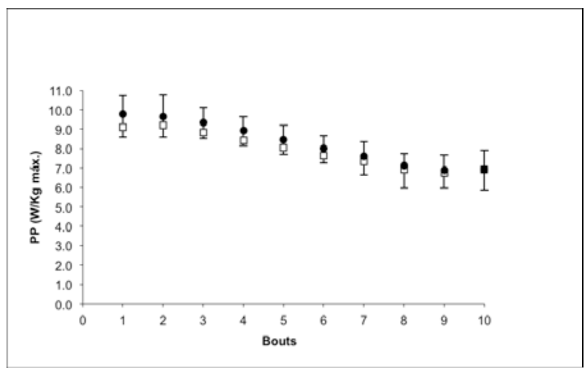

Figure 2. Peak Power (PP) of 10 bouts of effort for each type of recovery (☐ = Passive and ☐☐= Active). (No significant difference between types of recovery ($p = 0.43$) and significant differences between bouts ($p = 0.01$)).

The MP for Passive Recovery was 6.1 ± 0.7 W/kg, while the MP for Active recovery was 5.9 ± 0.7 W/kg. There was also no significant difference ($p = 0.50$) between types of recovery (Figure 1). Regardless of the type of recovery, it was observed that for MP bouts 1 through 4 were significantly higher than the bouts 7, 8, 9, and 10 ($p = 0.01$) (Figure 3).

The average of the Fatigue Index (FI) along the bouts during Passive Recovery was 2.9 ± 1.1 W/kg, while in Active Recovery was 3.3 ± 0.9 W/kg, but no significant difference was found ($p = 0.42$) (Figure 4).

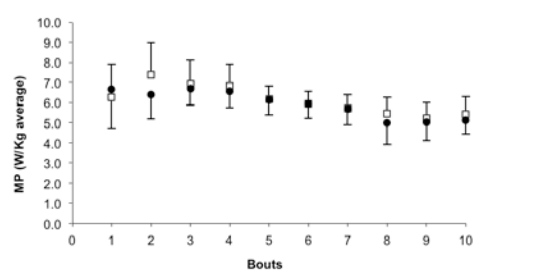

Figure 3. Mean Power (MP) of 10 bouts of effort for each type of recovery (□ = Passive and □□= Active). (No significant difference between types of recovery ($p = 0.50$) and significant differences between bouts ($p = 0.01$)).

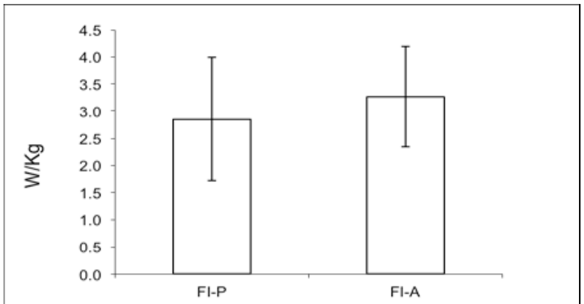

Figure 4. Fatigue Index (FI) for both types of recovery over the bouts of effort. (No significant difference between the types of recovery ($p = 0.42$)).

DISCUSSION

These results shown that there is a significant fall in power production over the bouts of effort for both mean power (MP) and peak power (PP), regardless of the type of recovery (Figures 2 and 3).

This decrease in power production may be related to several physiological factors such as the depletion of energy substrates (16), reductions in calcium release by the sarcoplasmic reticulum (2), elevation of H+ (13) and the accumulation of Pi (inorganic phosphate). These last two have influence in inhibiting the release of calcium from the sarcoplasmic reticulum (1) and the binding of calcium to troponin C (2). The accumulation of H+ as a result of increased production of lactic acid also promotes the inhibition of enzymes such as the PFK (Phosphofructokinase) (13), which is the enzyme "gatekeeper" of glycolysis and primarily responsible for all the glycolytic pathway (10) and phosphorylase, the enzyme responsible for converting glycogen into glucose (18). During high intensity exercise, the major sources of ATP resynthesis comes by breaking the PCr and by degradating muscle glycogen into lactate. Thus, during intermittent exercise a decline of the contribution of these processes occur, which forces the aerobic contribution to increase. These increased contribution of the aerobic system explains the fall of the power production (13).

The power production in the tenth bout is slightly greater than the last couple of bouts, due to psychological factors (motivation) that positively affect the power output.

In the study of Gaitanos et al., (11), the subjects performed 10 bouts of 6 seconds of effort alternating with 30 seconds of recovery. They reported that from the first untill the last bout, the decrease of the mean power was of 26%, while the drop in peak power was of 33%. In the present study the decrease of mean power during the test was of 28%, while the drop in peak power along the test was of 29%. In the study of Signorile et al., (17), also with 6 seconds of effort intercalated with 30 seconds of recovery but repeated only 8 times, they reported that in both types of recovery the peak power had a significant decrease in the sixth bout, which is equal to what was found in the present study. Regarding the fatigue index, the present study found no significant difference between the types of recovery, as like the study from Signorile et al., (17).

Concerning to the types of recovery, there were no statistically significant differences between Active and Passive recoveries for both Mean and Peak Power, as well as for the Fatigue Index. This suggests that for intermittent exercise with efforts of predominance of the glycolytic system it is indicated the use of Active recovery due to a high rate of lactate removal (4,6,17). This lactate removal will consequently decreases the accumulation of hydrogen ions, which is a major contributor of muscle fatigue. However, for intermittent exercise with efforts of predominance of the alactic system, which does not have the characteristic of promoting a high lactate accumulation, there is no difference between Active and Passive recovery.

Knowing that during recovery the aerobic system is responsible for the resynthesis of ATP and CP, restoration of MbO2 stores, metabolism of the Lactic Acid and removal of intracellular Pi (12), we can see that the benefits of Active recovery, such as the removal of lactic acid (17), and the benefits of Passive recovery, such as the high rate of reoxygenation that accelerates resynthesis of CP (9), are equivalent. Therefore, there is not a clear recovery type better than the other for intermittent exercise efforts of predominance of the alactic system.

Toubekis et al., (20) investigated the influence of different types of recovery (Active and Passive) in swimmers, and they found very similar results. They found no significant difference between the types of recovery, altough he concluded that Passive recovery is most suitable for swimmers. Therefore, coaches and trainers who use interval training should, based on their experience and on science, choose what best fits each specific situation.

CONCLUSION

The protocol used in this study, with repeated bouts of maximum intensity and short duration, found that the type of recovery (Passive and Active) has no interference on either power production (PP and MP) or fatigue index. For this specific type of exercise both types of recovery can be used according to the objectives of the coaches, trainers and athletes.

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