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CAFFEINE SUPPLEMENTATION (6MG/KG) IMPROVES TOTAL TIME TO EXHAUSTION IN A FIXED SPEED PROTOCOL, WITHOUT PHYSIOLOGICAL ALTERATIONS IN RUNNERS

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RESUMO

Objetivo: O objetivo deste estudo foi avaliar os efeitos da cafeína sobre o tempo total até a exaustão e outros parâmetros metabólicos. Materiais e Métodos: O desenho experimental da pesquisa foi realizado no modelo duplo-cego, controlado com placebo e randomizado. Em duas diferentes sessões, 5 indivíduos do sexo masculino (25 ± 5 anos) ingeriram 6mg/kg de cafeína em cápsulas ou a mesma quantidade do placebo no modo duplo-cego. Os participantes foram submetidos a um teste incremental até a exaustão em uma velocidade fixa de 10% acima do limiar de lactato, e as variáveis foram coletadas a cada 3 minutos até a exaustão. Foram avaliadas a variável percepção subjetiva de esforço, tempo total individual, frequência cardíaca e lactato. Resultados: Os resultados mostraram um aumento no tempo até a exaustão com a administração da suplementação de cafeína em comparação com o placebo (13.2 ± 2.68 min. cafeína contra 9 ± 3 min. placebo, $p<0.01$) e não apresentou resultados significativos para o lactato, a frequência cardíaca e a percepção subjetiva de esforço. Conclusão: Concluímos que uma dose de cafeína de 6mg/kg é suficiente para melhorar o tempo total até a exaustão, sem modificar outros parâmetros fisiológicos importantes para os corredores.

Palavras-chave: Cafeína. Fadiga. Atletas. Performance Esportiva.

ABSTRACT

Caffeine supplementation (6mg/kg) improves total time to exhaustion in a fixed speed protocol, without physiological alterations in runners

Objective: The aim of this study was to evaluate the effects of caffeine on total time to exhaustion and other metabolic parameters. Materials and methods: A double-blind, placebo controlled and randomized experimental design was used in this investigation. In two different sessions, 5 male (25 ± 5 years old) ingested 6mg of caffeine/kg in capsules or placebo in a double blinded manner. The subjects were submitted to an incremental test until to exhaustion on a fixed speed of 10% above lactate threshold, variables were collected every 3 minutes until exhaustion. Individual total time, heart rate, rating of perceived exertion and lactate were measured. Results: Our results show increased exhaustion time for caffeine supplementation than placebo (13.2 ± 2.68 min. caffeine vs 9 ± 3 min. placebo, $p<0.01$), with no other significant changes for lactate, heart rate or perceived exertion. Conclusion: We concluded that a 6mg/kg caffeine dose is adequate to improve total time to exhaustion without changing other important physiologic parameters of runners.

Key words: Caffeine. Fatigue. Athletes. Athletic performance.

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INTRODUCTION

Running is one of the most popular sports in Brazil, due to its democratic and practical features.

Although fatigue is a common problem in several sports, for long distance running, fatigue is both, a regular element of training and also an obstacle to overcome (Millet et al., 2010).

Fatigue can roughly be divided in muscular (peripheral) and mental (central), a division corroborated by other authors (Enoka, Duchateu, 2008).

They point out that there is a great variety of explanations to fatigue, starting from metabolic unbalances on the motor unit up to mechanisms mediated by the central nervous system.

Central fatigue refers to superior processes and can be defined as a failure on the voluntary muscle activation that is progressively induced by the progression of exercise (Williamson, 2010).

Changes in the sensory information from active muscle, in the periphery, happen during fatiguing exercises (Seifert, Petersen, 2010).

That decreases the capacity of the organism to generate strength. Thus, central and peripheral elements are combined in the fatigue process.

Several elements are used, both in training and competition, to delay fatigue onset or to decrease its intensity and therefore, run faster or longer, one of the main nutrition element is caffeine (Artioli et al., 2010; Kreider et al., 2010).

Caffeine is an important resource that acts both in the central nervous system and in the muscles (Davis, Green, 2009). One key element affected by caffeine is the subjective perceived exertion scale (Borg's scale) (Ganio et al., 2009; Ivy et al., 2009).

With ergogenic effects largely described in the literature, cheap and easily obtained from several natural sources, caffeine is one of the most popular substances used by athletes.

However, there seems to be a narrow limit to caffeine use, especially to runners. This limit is between a small dose that has no ergogenic effects and a high dose that stimulate too much the organism, increasing heart rate, metabolism and speeding up the fatigue process.

A review recently published by the ISSN shows positive results with doses between 3 and 6 mg/kg of body weight and states that 9 mg/kg doses are potentially deleterious (Goldstein et al., 2010).

This review quotes an article from 1995, where the authors, after testing doses of 3, 6 and 9 mg/kg of body weight, state that with 9 mg/kg most of the participants considered the effects of caffeine "above the desired" (Grahan, Spriet, 1995).

So, the aim of this study was to evaluate if 6mg/kg of body weight of caffeine is able to the affect the fatigue onset process on long duration and high intensity running.

MATERIALS AND METHODS

All experiments were approved by the University ethical committee under the protocol number REC/MPU 144004/2012.

We evaluated 5 male students with an average age of 18 to 25 years. All of them were recreational runners, healthy and familiar to treadmill running.

Participants were supposed to come to the laboratory 3 times during the protocol. In the first one, they were explained about the experiment, signed a consent form, and if consented, they did an ergoespirometric test to determine the individual lactate threshold.

After that, on second and third time, participants did the time to exhaustion test with either placebo (PG) or caffeine (CafG) in a double blind manner. There was no fixed order to the caffeine or placebo capsules in order to make sure that the participants would not be influenced by the supplement.

The amount of caffeine was calculated to be 6mg/kg of body weight (according to the review published by Ganio et al., 2009 and Goldstein et al., 2010), and the number of capsules was the same for the placebo. Subjects took the capsules 40 minutes prior to the test, an average time for caffeine to be fully active in the organism.

The test was carried out in a treadmill with a fixed speed, equivalent to 10% above the individual lactate threshold, until the exhaustion of the individual.

We recorded the individual time to exhaustion at the end of the test and in every 3 minutes we recorded the rate of perceived

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exertion (Borg scale), heart rate and lactate concentration from blood collected on a capillary tube and measured in a Yellowsprings portable lactate analyser.

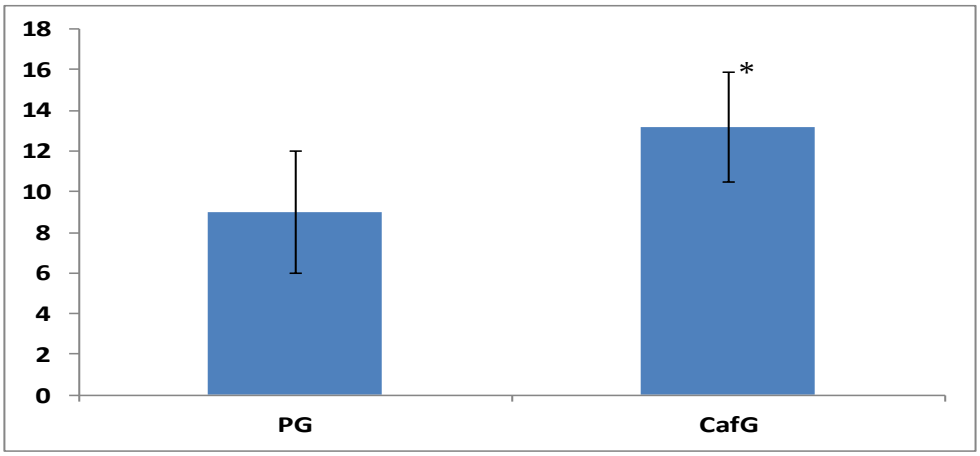
After data was analyzed for normality by a Shapiro Wilk test, we compared both groups with a paired T test, since both groups were composed by the same people. Significance was set as $p<0.05$ and we used the SPSS program for the analysis.

RESULTS

With a 6 mg/kg of body weight dose, our results showed a significant increase ($p=0.02$) in the total time to exhaustion when the group ingested caffeine compared to placebo (9 ± 3 minutes PG and 13.2 ± 2.68 minutes CafG).

This result (observed in figure 1), reinforces the results in the literature, Ganio et al., (2009) and Ivy et al., (2009) performance increase in total time to exhaustion in runners.

A recently published study, Lee, Lin, Cheng, (2012) presented an increase in subjects consuming a mixture of caffeine and creatine, with doses similar to that used in our study.



Legend: *p<0.05 compared to PG.

Figure 1 - Total time to exhaustion (minutes) from both experimental groups.

However, when we observe the other analyzed parameters, we noted that there were no significant differences comparing both groups.

Our results of BORG scale, for perceived exertion, showed lower values for the CafG group with 9 minutes from the start of the test (17.6 ± 2.52 PG and 15.75 ± 4.55 CafG $p=0.22$) although that was not a significant difference.

Lactate concentration results showed lower values for CafG, with 3, 6 and 9 minutes from the start of the test (4.64 ± 2.36 mmol/L PG and 4.0 ± 1.56 mmol/L CafG 3 minutes $p=0.38$; 6.4 ± 2.37 mmol/L PG and 4.85 ± 1.77 mmol/L CafG 6 minutes, $p=0.36$ and 7.31 ± 1.45 mmol/L PG and 6.16 ± 0.72 mmol/L CafG 9 minutes, $p=0.16$).

Although these results were not significant, they are probably related to the total time to exhaustion result, once lower lactate concentration is directly related to the delay on fatigue (Rouhola et al., 2010).

Other studies with a 5 mg/kg of body weight dose also didn't report changes in the lactate concentration in a incremental test (Karapetian et al., 2012).

Heart rate results didn't show any significant differences when both groups are compared. This result is not in accordance with what is shown in the literature, Desbrown et al., (2012) which presents significant increases in the heart rate with doses of 3 and 6 mg/kg of body weight when compared to a placebo group. Although the experimental group was composed of cyclists, the authors didn't

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observe differences in their performance when the two doses were compared.

As our test was of high intensity, high heart rate values were expected. However, the absence of difference between groups shows us that the caffeine dose was high enough to improve performance, but not to change important parameters such as heart rate or lactate concentration.

All the perceived exertion data, lactate concentration and heart rate from the entire test can be observed in figure 2.

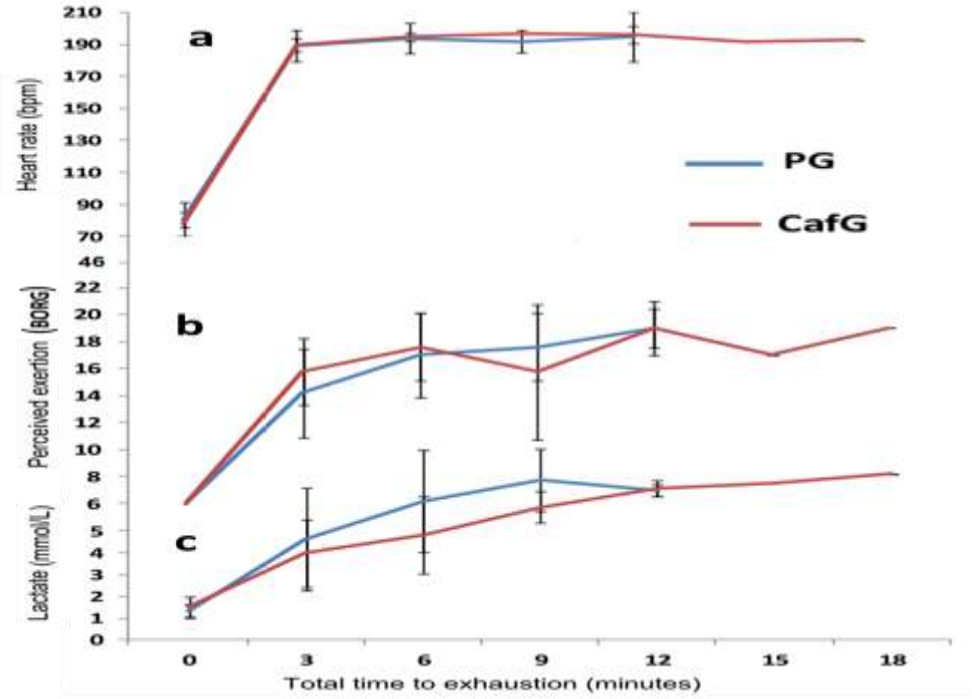

Figure 2 - Perceived exertion, **Lactate concentration (mmol/L) and** Heart rate (bpm) during the entire test for both groups.

DISCUSSION

The major finding of this study is that acute caffeine supplementation at 6 mg/kg appears to be effective for enhancing performance in runner, as demonstrated by a significant increase in total time to exhaustion combined with the absence of changes on heart rate, rating of perceived exertion and lactate.

Several studies have demonstrated that caffeine supplementation is effective to improve performance in different exercise modalities (Goldstein et al., 2010; Bazzucchi et al., 2011; Maughan, Greenhaff, Hespel., 2011; Cooper et al., 2014; Christensen et al., 2014).

One published study showed that 6mg/kg of caffeine was effective for enhancing strength but not muscular endurance in resistance trained women (Goldstein et al., 2010).

In addition, it has been demonstrated that, ingesting gels containing 100 mg of caffeine and 25 g of carbohydrate per serving one hour before, immediately prior to and in the middle (45 min) of a 90-min intermittent sprint test is effective for temporarily decreasing perceived effort, attenuating fatigue (at 68 min) and maintaining higher blood glucose levels during the final stages of intermittent endurance exercise in recreationally trained athletes (Cooper et al., 2014).

It was also demonstrated that ingestion of a small dose of caffeine (3 mg/kg) improved the performance of elite rowers performing 6 min maximal rowing, with the difference

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occurring in the last 3 min of the test (Christensen et al., 2014).

In the present study we have not observed changes in physiological parameters, such as HR, RPE and lactate concentration. It has been demonstrated that, caffeine supplementation improves muscle performance during short-duration maximal dynamic contractions of the elbow flexor muscles (Bazzucchi et al., 2011).

The authors suggest that, caffeine potentiates muscle recruitment, and along with the improved electrically induced twitch contractions, reinforces the notion that the effect of caffeine is both central and peripheral in its origin.

Future studies are needed for a complete understanding of the mechanism involved in the exercise performance improvement promoted by caffeine supplementation.

The small number of subjects and the lack of hormone levels are limitations of this study in order to speculate the mechanisms by which the results happened.

CONCLUSION

In conclusion, our data demonstrated that 6mg/kg of caffeine is a dose that is able to improve running performance with no negative effects on other important physiological parameters.

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