



## RESEARCH PAPER

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## Effects of caffeine, L-carnitine and their combination on 400-m freestyle performance in female swimmers

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### Abstract

This study is aimed to examine the effect of caffeine, L-carnitine, and their combination on lactate blood level, and exercise time during a 400 m freestyle swimming trial. 16 adolescent female freestyle swimmers were randomly divided into 4 groups; caffeine (3mg/kg), carnitine (1.5g), caffeine + carnitine (3 mg/kg + 1.5 g), and placebo. Supplements were consumed on 4 separate occasions before completing maximal 400-m freestyle trial. In each of the trials, Supplements were consumed 30 min prior to testing by Applying a single blind experimental design then the Statistical analysis was carried out on the relevant data using anova test. No significant differences ( $p = 0.05$ ) were observed for performance in all groups whereas blood lactate concentration values in min 1 were lower in the caffeine trials compare to other groups. These findings showing that consuming 3mg/kg caffeine, 1.5 g L-carnitine and their combination has no meaningful effect on performance.

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## Introduction

Caffeine is one of the most frequently consumed drugs in the world, and has minimal health risks (Graham, 2001). It is found in numerous foods including chocolate and beverages, with coffee, tea, and soft drinks being consumed most frequently (Fredholm, Battig *et al.*, 1999).

It has been reported that caffeine (CAF) inhibits phosphodiesterase, an enzyme-degrading cAMP, consequently increasing cAMP concentration in the adipose tissues and adrenal gland. The increased cAMP concentration caused the stimulation of catecholamine secretion from the adrenal medulla and consequently caused the stimulation of stored fat mobilization (Poehlman *et al.*, 1989). Therefore it has been suggested that CAF can induce an increase in free fatty acids in blood and spare glycogen in liver and muscle (Graham, Rush *et al.*, 1994 ; Nehling & Debry, 1994 ; Henry , 1967).

By operating as an adenosine-receptor antagonist (Biaggioni, Paul *et al.*, 1991) caffeine increases neurotransmitter release, augmenting motor-unit recruitment and enhancing skeletal-muscle contractility (Williams, 1991). Furthermore, it stimulates the cerebral cortex, preventing drowsiness and improving mental alertness (Williams, 1991). It has been suggested that the increase in postexercise blood lactate concentrations after caffeine ingestion might be the result of the liberation of calcium, which in turn increases glycogenolysis, generating greater anaerobic metabolism and improvements in total work output (Collomp, Ahmaidi *et al.*, 1992, Jackman, Wendling *et al.*, 1996).

Supplementation with L-carnitine has gained popularity in recent years due to anecdotal accounts of its ability to enhance performance. Two separate mechanisms have been suggested for potential benefits of using L-carnitine to enhance performance. one study has reported (Fritz,1968) that increased levels of L-carnitine may increase fatty acid oxidation since carnitine is required to transport long-chain fatty acids across the mitochondrial membrane.

Another possible function of L-carnitine would allow for the maintenance of the acetyl CoA/CoA ratio, which would decrease the inhibition of the pyruvate dehydrogenase complex and enhance the conversion of pyruvate to acetyl CoA (Beltz , Costill *et al.*, 1988). Thus, lactate accumulation could be reduced during incremental exhaustive exercise and result in enhanced performance (Siliprandi *et al.*, 1990). In a study has reported (Vukovich *et al.*, 1994) a lower lactate accumulation during cycle exercise at 100% of VO<sub>2</sub>max following L-carnitine supplementation for 7 and 14 days.

Nevertheless, it appears that caffeine may increase lactate formation and, possibly, exercise performance during intense exercise and lactate accumulation may decrease following L-carnitine supplementation. However, the effects of CAF or CAR trial on swimming performance are in controversy, and a clear conclusion remains to be addressed.

And there appears to have been no research investigating caffeine, L-carnitine and their combined effects on swimming performance. Thus, this may indeed be important to know the effects. The aims of this study was to investigate the effects of ingesting caffeine, L-carnitine and a combination of the two to determine whether any would bring about an improvement in 400m freestyle swimming performance and the blood lactate concentration after the trial.

## Materials and methods

### Participants

Sixteen highly trained adolescent female freestyle swimmers from karaj swimming team volunteered to participate in the investigation ( $N = 16$ ). All participants were fully informed about the rationale for the study and of all experimental procedures to be undertaken . Participants were between 12 and 15 yr of age, The subjects were trained for at least 3y. Subject characteristics are shown in Table 1

In randomized trial the 24 hr before trial participants were restricted from performing high-intensity

exercise. A randomized double-blind fashion was used. Subjects were divided randomly into 4 groups Caffeine, carnitine, a combination of both, and placebo. Each subject completed 4 trials The order was randomized. Subjects arrived at the swimming pool 60 min before exercise They were given gelatin capsules(Caf:3 mg/kg or LC:1.5g or C+ LC 3 mg/kg +1.5g or placebo with water (250mL) 30 min before exercise. Lactate measures were taken from the subjects at 1 and 10 minutes post-exercise. Blood lactate was determined using a portable lactate analyzer (nova lactate plus).the trial was performed in a 25-m indoor swimming pool. 30 min After the ingestion time, participants immediately commenced a 1000 m warm-up equivalent to normal practices of current adolescent swimmers. The experimental protocol was approved by the azad University of karaj.

Statistical analysis. All values are reported as  $M \pm SD$ . Statistical analysis was carried out using SPSS 11.0.0, (Standard Version). Normality distribution of the data checked by KS test. The level of significance was fixed at  $p < 0.05$ . To compare the differences between groups, the one-way ANOVA repeated measure method was used.

## Results

There was no significant difference observed between treatments for absolute performance time in all groups results shows in Table 2. Despite no statistical difference in mean scores 5 out of 16 participants recorded their fastest times after C ingesting and 5 out of 16 recorded their fastest times after C+CAR

ingesting 2 participants recorded their fastest times after ingesting CAR and 2 participants recorded their fastest times after ingesting placebo 1 participant has same record after ingesting CAR and C+CAR another one has same record after ingesting C and CAR and C+CAR. Blood lactate concentration was not different between the various groups at 10 min ( $p > .05$ ). Blood lactate concentration was different between the various groups at 1min ( $p \leq .05$ ) Blood lactate concentration at 1min was higher for C group than other group Table 3. When compare the result it shows lactate concentration at caffeine level is more than L- carnitine ( $p \leq .05$ ) and there is no significant differences in lactate concentration at caffeine level and C+CAR ( $p=1$ ) but lactate concentration at caffeine level is more than placebo ( $p \leq .05$ ). Moreover there is no significant differences in lactate concentration at L- carnitine level and C+CAR ( $p=0.131$ ) finally lactate concentration at placebo level is less than C+CAR.

**Table 1.** Physical characteristics of subjects.

Age(y)	13.87 $\pm$ 1.14
Height(cm)	160.87 $\pm$ 58.75
Body weight(kg)	56.31 $\pm$ 1.31
Body mass(kg/m <sup>2</sup> )	21.69 $\pm$ 4.34

## Discussion

The purpose of this research was to compare the effect of ingesting caffeine, L- carnitine and their combination on the 400-m freestyle performance time and the blood lactate level within female athlete swimmers.

**Table 2.** Comparison of record (s) on 400-m Freestyle Performance,  $M \pm SD$ ,  $N = 16$ .

Record				ANOVA
Coffeine	L-Carnitine	Coffeine and L- Carnitine	placebo	
Mean $\pm$ SD	Mean $\pm$ SD	Mean $\pm$ SD	Mean $\pm$ SD	
396.2 $\pm$ 41.5	397.8 $\pm$ 45.88	394.7 $\pm$ 48.6	400 $\pm$ 47.3	$F_{(3,45)}=1.42$ $P=.248$

In this research all of the subjects received the same amounts of caffeine, so the establishment of outside credibility of the research was enhanced. The analysis

of the out-coming results of this research shows that consuming 3mg/kg of caffeine has no significant effect on 400-m freestyle performance time. These

outcomes are similar to previous studies showing no improvement with caffeine supplementation (Collomp, Ahmaidi, *et al.*, 1991; Dodd, Brooks, *et al.*, 1991; Greer, McLean *et al.*, 1998) and contrasts with other studies showing improvement (Anselme, Collomp *et al.*, 1992; Bell, Jacobs *et al.*, 2001; Bell, & McLellan, 2002) in one study they (Burke, Facsm, *et al.*, 2006) failed to detect an improvement in swimming sprint performance following supplementation with low levels of caffeine. Other study (Hill, 2006) has reported that caffeine dose of 2 mg/kg body mass did not significantly improve 50m

swimming time in elite level swimmers. other researchers have shown an ergogenic effect of caffeine during short-term high-intensity exercise predominantly involving fast-stwitch muscle fibers (Anselme *et al.*, 1992; Collomp *et al.*, 1992). Notably, caffeine appeared only to maintain mean swimming velocity in the second 100-m swim in the former study (Collomp *et al.*, 1992), and in the latter study it appeared to increase pedalfrequency during four 6-s sprint efforts, thereby improving work output, although the highest workload achieved was the same with or without caffeine (Anselme *et al.*, 1992).

**Table 3.** Comparison of Lactic acid concentration 1min after 400-m Freestyle Performance,  $M \pm SD$ ,  $N = 16$ .

Lactic acid				ANOVA
Coffeine	L-Carnitine	Coffeine and L- Carnitine	placebo	
Mean± SD	Mean± SD	Mean± SD	Mean± SD	
9.06±1.6	7.97±2.02	8.95±1.9	7.32±1.8	$F_{(3,45)}=7.54$ $P<.001$

Furthermore, according to the result of the test about blood lactate, we are concluding that consuming 3mg/kg caffeine has no meaningful effect on the amount of blood lactate of the subjects in 10 min but has meaningful effect on the amount of blood lactate in 1 min. Regarding the effects of caffeine on the amounts of blood lactate. In an investigations they expressed that consuming 250 milligram of caffeine remarkably increased the concentration of blood lactate in unexercised and unexercised swimmers (Collomp *et al.*, 1992), Greer reported that consuming 6 mg/kg of caffeine have no considerable effect on the amount of blood lactate (Greer *et al.*, 1998).

one study (Glaister *et al.*, 2008) also reported increased blood lactate concentrations both pre-and post-testing with caffeine. Other studies have also reported increases in blood lactate levels with caffeine supplementation (Anselme *et al.*, 1992; Bell *et al.*, 2001; Carr, Dawson, *et al.*, 2008; Collomp *et al.*, 1991).

Caffeine ingestion before repeated high-intensity exercise has previously been reported to produce elevated postexercise blood lactate concentrations,

generated by greater anaerobic metabolism and improved total work output (Anselme *et al.*, 1992; Collomp *et al.*, 1992).

Previous investigations of both prolonged (Graham & Spriet, 1991; Graham & Spriet, 1995; Spriet, MacLean, *et al.*, 1992) and intense (Anselme *et al.*, 1992; Collomp *et al.*, 1991; Collomp *et al.*, 1992; Collomp, Caillaud, *et al.*, 1990) exercise have reported that caffeine ingestion was associated with increased blood lactate concentrations. This could indicate that there was an increased production by the active muscle, but it could also be due to decreased blood clearance, Probably a small increase in blood lactate because of caffeine consumption was caused by increasing the discharge of catecholamine (epinephrine, and norepinephrine).

However, unlike the present study that found a significant elevation of blood lactate after caffeine ingestion, in a study (Doherty, 1998) showed no significant increase in lactate. Thus, Doherty suggested that an increased rate of anaerobic glycolytic flux, leading to higher production and accumulation of lactate, is not a critical mechanism of

action for explaining the ergogenic effects of caffeine. Doherty postulates that there are other central and peripheral elements involved. A probable reason for these ambiguities may be related to the training level of the subjects.

The difference in the type of applied tests for measuring power (cycling, running, swimming) and the degree of caffeine consumption (5-6mg/kg and 250 mg) probably have led causing of this contradictory of the results. Therefore, the more precise and exceeding researches are necessary in order to be aware of the effect of caffeine consumption on 400-m freestyle activities.

Another major finding of this investigation was that administration of 1.5 grams of L-carnitine did not affect on Performance time and Blood lactate concentrations.

From the previous data, we find that CAF can induce an increase of FFA in blood and spare glycogen in the liver and muscle (LeBlanc, Jobin *et al.*, 1985), and CAR can increase fat utilization by the transport of long-chain fatty acids into the mitochondrial matrix for  $\beta$ -oxidation (Broquist & Borum, 1982).

The main function of Carnitine is to stimulate fatty acid production in mitochondria and reduce lactate production (Siliprandi *et al.*, 1990).

In a review study (Matera *et al.*, 2003) also demonstrated that reduced lactate production during exercise is another function of L-Carnitine supplementation. In an investigations (Lee, Paik *et al.*, 2003) also reported that 4g per day of Carnitine causes significantly lowers the blood lactate concentration. Increased fatty acid oxidation decreases fatigue upon Carnitine activation, and especially, lactate accumulation caused peripheral fatigue is decreased (Siliprandi *et al.*, 1990). There is higher acetyl-carnitine concentration than acyl-carnitine in skeletal muscle during high intensity exercise (Constantin-Teodosiu, Carlin, Cederblad *et al.*, 1991; Minkler, Brass, *et al.*, 1995). This high level

of acetyl-CoA accumulation suppresses pyruvate dehydrogenase activation and affects acetyl-carnitine and lactate accumulation. Eventually, Carnitine intake has a positive effect on lactate concentration. However, a study (Chun Y, 2008) reported that 2g per day of Carnitine might not have a positive effect on lactate accumulation in Judoists. This implies that there is a close relationship between the amount of Carnitine intake and lactate recovery based upon subjects' characteristics.

In a study\_ (Colombani, *et al.*, 1996) has previously been reported acute administration of L-carnitine did not affect the metabolism or improve the physical performance of the endurance-trained athletes during the run and did not alter their recovery.

In a study they (Brass, Hoppel & Hiatt, 1994) found That Carnitine administration had no effect on muscle total carnitine content or the workload-dependent accumulation of acylcarnitines in skeletal muscle. Carnitine had no effect on the respiratory exchange ratio, muscle lactate accumulation, plasma lactate concentration, muscle glycogen utilization, or plasma beta-hydroxybutyrate concentration during exercise. Thus the skeletal muscle carnitine pool is segregated from dramatic changes in the plasma carnitine pool, and short-term administration of carnitine has no significant effect on fuel metabolism during exercise in humans. In a research (Jacobs, Goldstein, *et al.*, 2009) examine the effects of a single dose of GPLC on the performance of repeated high intensity stationary cycle sprints with limited recovery periods in resistance trained male subjects and find that short-term oral supplementation of GPLC can enhance peak power production in resistance trained males with significantly less LAC accumulation.

In the present study, perhaps the acetyl CoA/CoA ratio in the muscle was not influenced, ultimately not disrupting the accumulation of lactate. Further controlled experiments at varying intensities need to be performed to determine the potential benefits of L-carnitine supplementation upon performance.

To summarize, the conclusion of current research is showing that consuming 3mg/kg caffeine, 1.5 g L-carnitine and their combination has no meaningful effect on performance. More researches are necessary in order to investigate the acute effects of different amount of caffeine and L-carnitine on 400-m freestyle performance time and the blood lactate level.

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