THE EFFECT OF CAFFEINE CONSUMPTION ON THE NON-AEROBIC POWER, THE FATIGUE INDEX AND THE BLOOD LACTATE LEVELS IN THE MALE ATHLETE STUDENTS

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Abstract
The main purpose of this research is to study the effect of caffeine consumption on the non-aerobic power, the fatigue index and the blood lactate levels in the male athlete students. Therefore, 16 individuals with the average weight (68/1 +_ 9/1kg), height (1/73+_7cm), and age (24+_2 years) were selected based on the simple-randomized method from among volunteer participants, and they were divided as match pairs, based on pre-examined fatigue index, into the two groups of caffeine (n=8) and placebo (n=8). Subjects were asked to refrain from having any intensive physical activity 24 hours before the test starts and avoid eating or drinking any caffeine foods or drinks 48 hours before the test. The primary RAST test (pre-test) was performed at least 4 hours after having a meal, and then the individuals blood lactate levels was measured after 6 minutes of the test. The secondary RAST test was done after a week exactly like the first session. The subjects continued caffeine consumption as usual and interrupt it 48 hours prior to the next test. In post-test, the subjects took 6mg caffeine or placebo in the form of gelatin capsules per one kilogram of their weight one hour prior to the test. The analysis of the result, with applying the statistical t-test method (p≤0.05) to the dependent and independent groups, showed that consumption of caffeine has a significant positive effect on average power; minimum power and fatigue index, while it does not have any significant effect on maximum power and the amount of blood lactate. It seems that caffeine consumption is effective in the recovery of fast short-term shuttle activities.
Key words: *Caffeine, Anaerobic Power, Fatigue Index, Blood Lactate Levels, Male Athlete Students*.

INTRODUCTION

It is long time that athletes use various compounds and substances such as vitamins, minerals, supplementary protein and hydrocarbon, phosphate, bicarbonate, sodium, asparagines, alcohol, caffeine as the ergogenic aids for enhancing their energy (26). In recent years, one of supplementation that has attracted many athletes and coaches is caffeine (17, 18, 2).

Caffeine (1, 3, 7- trimethylxanthine) is a stimulant alkaloide that is considerd as the most widespread consuming drug worldwide. The most customary type of the caffeine consumption has been coffee that is almost 54% of its use in the world. Drinking tea is 43%, of caffeine consumption and consuming other material containing caffeine (including chocolate, exercise drinks, drugs…) consists only 3% of the caffeine consumption (14). This chemical is used by most people and routinely by athletes during their athletic activities in order to gain its ergogenic properties.

Caffeine is quickly metabolized in the liver, and it is converted to three types of dimethylxanthine (paraxanthin, theophylline, theobromine) that can be held in blood for long term and produce its related signals (22). Xanthenes like caffeine, control phosphodiesterase which has an effective role on breaking down cyclic adenosine monophosphate (cAMP) (22, 27, 2). If Phosphodiesterase is controlled, cAMP increases, and as a result, lipolysis and glycogenolysis processes would be stimulated (23). In addition, xanthine increases the excretion and discharge of catecholamines and by this way it affects the permeability of calcium ion in muscular tissues. Both of these conversions (increasing cAMP and permeability of calcium ion) stimulate the muscle's contraction ability (19).

Most of the related researches about the ergogenic effects of caffeine concentrate on endurance activities. The effects of caffeine on athletic aerobic activities like ski (5), biking (7), sailing (6), running (25), and swimming (23) is proved, while the potential ergogenic effects of caffeine on short-term intensive and heavy activities is not clear and evident where caffeine may improve the muscular neural transmission (26). Regarding the nature of intensive short-term athletic activities, there are three sensitive points in human's body to caffeine. These three main points includes: central nervous system, muscular neural transmission, and muscle's contraction process (26). The results of the research about the effects of caffeine consumption on non-aerobic activities have been contradictory. Some studies have reported about the significant effects of caffeine, while the results of other researchers indicate a little difference between control and experimental group (13, 14). Other studies have showed the positive effects of 5mg/kg caffeine on the power for pedaling the bike (3, 4, 12). In power-speed test, Enselme and his colleagues (3) have demonstrated that consuming of 25mg caffeine increased maximum non-aerobic power to 7 percent. In spite of that, other studies showed that consuming 250 milligram caffeine on maximum performance (10) and consuming 5mg/kg caffeine on superior performance (9) have no effect on cycling test. Greer and his colleagues (15) also reported that supplemental caffeine in the amount of 6mg/kg decreases the maximum power in final stages of repetitive Wingate test. Regarding the effects of caffeine on the amounts of blood lactate, Collomp and his colleagues expressed that consuming 250 milligram of caffeine remarkably increased the concentration of blood lactate in exercised and unexercised swimmers (8), Greer reported that consuming 250 milligram of caffeine have no considerable effect on the amount of blood lactate (15). 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 intensive short-term activities.

On the other hand, very few studies have been done about the energizing power of caffeine on the function of the short-term activities with intensive stages when there is a short breathing time between those stages. In the case of proving of efficiency of caffeine consumption on the function of intensive repetitive short-term activities through affecting central nervous system like increase of mental awareness, increase of concentration, decrease of fatigue and delay in its beginning, decrease of the time of reaction, and other mechanisms, there is a possibility of that participants may improve their function with consuming supplemental caffeine before race in short-term non-aerobic activities. Therefore, this is necessary that the effect of caffeine to be investigated on non-aerobic activities and blood lactate.

METHODS

Participants

The method used in this research is double-blind semi-experimental. statistical population of the research consisted of male athlete students in the Department of Physical Education in Tehran University. After description of work process and its phases, and examining competency of the students (all subjects must exercise regularly, at least 3 times weekly), statistical sampling was done among competence and volunteers. 16 subjects were selected by simple randomized method (random drawing) and they divided as match pairs, based on pre-examined fatigue index, into the two groups of caffeine (n=8) and placebo (n=8). The average weight (kg), height (cm) and age of subjects was in order of (68/9 +_ 9/1), (1/73+_7), and (24+_2). The University's ethics committee approved the experimental procedures and study protocols.

Experimental procedures

First, one week before starting the test, the subjects completed questionnaires that relates to their health and the amount of their caffeine consumption in different forms (such as coffee, tea, caffeinated drinks, or medication containing caffeine), and they completed RAST test in order to be acquaintance with its performance. The subjects were asked to refrain from having any intensive physical activity 24 hours before the test starts and avoid eating or drinking any caffeine foods or drinks 48 hours before the test (caffeinated substances as a list was provided for them). The first session of RAST test was performed for at least the following 4 hours of having a meal. Under researcher's supervision, the subjects warm themselves by exercise for 5 minutes and completed the test. The RAST test includes 6 times of repetitive fast run with maximum intensity within 35 meter of distances that gets done with 10 second breathing time between each repeat. Prior to the test, the subjects have been warming themselves for 5 minutes and entering the records have been doing by light sensor (photocell). Therefore, a pairs of photocells were located on the starting point and at the end of 35 meter. The subjects have been standing with 70cm distance from starting point in every repeating time. After hearing the instrument's ring, they started to run as fast as they could, and after passing the light sensor, the instruments chronometer have been stopping at the end, and the subject's record was entered by the instrument. In order to eliminate the reaction time, the instrument was set in the order in which its chronometer was starting to work initially after the subject passed the light sensor. For getting the optimum result from RAST test, this is important that the subjects do any of the repetitive running as fast as they could. According to the test guide, maximum power, minimum power, mean power, and fatigue index were computed (1).

Maximum Power=Weight * 35 2/Time of the Fastest Repetition 3
Minimum Power=Weight * 35 2/Time of the Slowest Repetition 3
Mean Power=Total of 6 Run/6
Fatigue Index= (Maximum Power- Minimum Power)/Total time of 6 Repetitive Run

Because 6 minutes time is necessary for repletion of the most lactate in the muscle entering to blood (13), so the subjects blood lactate level measured from their middle fingers of the non-major hands by Scout lactometer instrument from Germany after

6 minutes of RAST test. In the second session, one week after, the test was done exactly like the first time, while it were asked from subjects to continue their weekly activities without consuming nicotine, alcohol, and any kind of stimulating substances and supplemental nutritious products, but continuing to consume caffeine or placebo as usual, and just stop it 48 hours before the next test. In the next test (post-test), One hour before the test started, the subjects consumed 6 milligram caffeine or placebo (Dextrose) per every one kilogram of their weight in the form of 500 milligram gelatin capsules with the same color.

Statistical Analysis

In order to describe data, calculate the mean and standard deviation, we used descriptive statistics, and for analyzing the data we used statistical t-test method for the dependent and independent groups. The analysis of data was done by SPSS software, and the least meaningfulness level (p≤0.05) was selected.

RESULTS

The total result of this research was demonstrated in the form of table (1, 2). On table 1 the amounts of mean power, minimum power, fatigue index, and the blood lactate have presented before and after tests for each group which have distinguished with attention to the results of the t-test. For caffeinated group, it has had the mean power (p=0/017), the minimum power (p=0/004), the fatigue index (0/027) which has had meaningful change before and after the test, while change was not observed in placebo group. In addition, based on the result of independent group's t-test (table 2), it was distinguished that there were no differences between the mean power, the minimum power, the fatigue index, and the blood lactate level of the subjects in both groups which emphasizes on the similarity of the subjects. Findings of the post-test showed that the subject matters did not have a meaningful differences in their maximum power and blood lactate level, however ; the relation of the caffeinated group's mean power (p=0/02), minimum power (p=0/006), and fatigue index (p=0/019) to the placebo group improved to a meaningful degree.

Table 1: The comparison of means of maximum power, minimum power, fatigue index, and blood lactate level, before and after test in each group (caffeinated and placebo)

Variables	Statical Index	pretest M±SD	posttest M±SD	Sig.
caffeine	Maximum Power(watt)	570/12±87/08	576/89±107/97	0.92
	Mean Power(watt)	446/15±79/72	476/98±77/29	0.017*
	Minimum Power(watt)	342/84±79/86	407/99±63/93	0.004*
	Fatigue Index(w/s)	37/87±12/82	24/91±7/33	0.027*
	Blood Lactate(mmol/dl)	11/42±2/55	12/20±2/60	0.40
placebo	Maximum Power(watt)	561/86 ±99/35	544/85±123/78	0.47
	Mean Power(watt)	463/44±101/71	463/75± 97/71	0.25
	Minimum Power(watt)	378/21± 99/83	351/79±84/37	0.23
	Fatigue Index(w/s)	30/60 ±7/37	27/07±11/03	0.36
	Blood Lactate(mmol/dl)	12/16±4/59	12/61±3/99	0.88

*p < 0.05, significant differences

Table2: The comparison of the means of maximum power, minimum power. Fatigue index, and blood lactate level, before and after test in each group (caffeinated and placebo)

Variables / Statical Index	Variables	Sig.
Comparison of Between Groups in Pretest	Maximum Power(watt)	0.86
	Mean Power(watt)	0.71
	Minimum Power(watt)	0.45
	Fatigue Index(w/s)	0.21
	Blood Lactate(mmol/dl)	0.70
Comparison of Between Groups in Posttest	Maximum Power(watt)	0.30
	Mean Power(watt)	0.02 *
	Minimum Power(watt)	.006 *
	Fatigue Index(w/s)	0.019 *
	Blood Lactate(mmol/dl)	0.91

*p < 0.05, significant differences

DISCUSSION

The purpose of this research was to investigate about the effect of caffeine consumption on the power of non-aerobic activities, the fatigue index, and the blood lactate level within male athlete students. The effective factors on the results of this research can be nutrition habits and the amount of physical activities. Regarding the nutrition habits such as the habit of caffeine consumption may say that it seems that ceasing the exercises within this research period can be interpreted as the period of the exercise modification (Tapering). Thus, it have been shown that further consumption of one kind of a nutritious like caffeine after a long period of interruption can have a useful effect (24). Hence, in this research like Andrew Lorino and his colleagues (2006) it was said to the subjects that avoid making any sudden change on their routine diet and physical activity during the days prior to the test and during the sessions before and after the test. The amount of consumed caffeine by each subject is the other methodological factor that can affect the consequences of the research. For instance, in Collamp and his colleagues' research (1992), each subject have consumed the amount of 250 milligram of caffeine, and in result, the amount of caffeine consumption in lieu of every kilogram of their weight was not equal. However, in this research like Lorino and his colleagues (2006) and Greer and his colleagues (1988), the amount of 6mgkg caffeine or placebo was consumed. I this manner, all of the subjects received the same amounts of caffeine or placebo, so the establishment of outside credibility of the research was enhanced.

The analysis of the out-coming results of this research shows that consuming 6mg/kg of caffeine has a meaningful effect on mean power, minimum power, and fatigue index. These outcomes are similar to Jonathan Bell1 and his colleague's research (2006) who reported that the amount of 5mg/kg caffeine increase the mean power and mean speed in comparison with placebo in 1km time-trail-biking-test (17). In a research, Bell (2001) reported that consuming caffeine in biking test increases the superior time of reaching to the fatigue (4). Also, Doherty and his colleagues (1998) in a research showed that caffeine consumption in the amount of 5mg/kg improve the function of intensive short-term running to 125 vo2max (12). It seems that caffeine has stimulating effect on central nervous system because the small amount of time in these activities is smaller and more limited than of that it can have a meaningful effect on the amount of glycogen in the muscle. Hence, caffeine may increase the function by influencing on the processes that are set for stimulation of the nervous system. The recommended mechanisms for describing the effect of caffeine on increasing minimum power and mean power by stimulating the central nervous system can be the concentration of cyclic AMP through phosphodiesterase inhibition and blocking the competing adenosine receptors (21, 27). This is also probable that caffeine affect the process of the stimulations that enter to the central nervous system from environment like decrease in sensitive consciousness regarding the muscle fatigue. Other observations showed that caffeine affect the process of the stimuli enters the central nervous system from environment. At least, part of these effects can vindicate with the increase of calcium concentration in muscular cells or decrease or lost of potassium in cells during the repetitive contraction. The other probable justification for improvement of minimum and mean power can be the increase in Na-K ATPase activity in the muscular tissue. It have showed that paraxanthine (one of the caffeine metabolites) increase the Na-K ATPase activity (16). On the other hand, the analysis of this research results shows that the consumption of 6mg/kg of caffeine have no meaningful effect on maximum power. This result with the results of the researches of Jay Hafman1 and Andrew Lorino is convergence, while with the research of Scheneiker and his colleagues is not (2, 18, 20). In a research, Jay Hafman and his colleagues (2007) represented that one hour before the test, non-caffeinated coffee have no effect on the maximum power and the entire work in 30-Second-Wingate-test (18). In a research, Andrew Lorino and his colleagues (2006) reached to the consequences that showed consumption of 6mg/kg caffeine for young people who are occasionally active, has no significant effect on output of power when was measured by Wingate test (2). Despite of this, in a research, Scheneiker and his colleagues (2006) demonstrated the consumption of 6mg/kg of caffeine in comparison with placebo in a test was done by an Ergometer Bike that has formed from two half 18*4s pedaling the bike with the most speed and with 2 minutes return to the initial active situation with 35% o2peak between every 4 seconds, he increased the maximum power to 7% in the first effort and to 6/6% in the second effort, and the amount of sprint work to 8/5% in the first effort and to 7/6% in the second effort .It seems that the time and the type of return to the first position between repeats, and also the type of the performed activity is effective on the amount of the maximum power In RAST test the return time was 10 seconds and inactive, while in Scheneiker and his colleagues' test (2006) the return time to the first situation was 2 minutes and active.

Furthermore, according to the result of the test about blood lactate, we are concluding that consuming 6mg/kg caffeine, despite of its increase, has no meaningful effect on the amount of blood lactate of the subjects which is not compatible with the result of Greer research. In a research, Greer (1998) investigated about the effect of caffeine consumption on the blood lactate level of 9 male who have occasional activities during the period of intensive repetitive athletic activities. He reported that consuming 6mg/kg of caffeine have no significant effect on blood lactate (15). Probably a small increase in blood lactate because of caffeine consumption was caused by increasing the discharge of catecholamine (epinephrine, and norepinephrine).

CONCLUSION

Summary, The conclusion of current research is showing that consuming 6mg/kg caffeine has a meaningful effect on mean power, minimum power, and fatigue index, while it has no meaningful effect on maximum power and blood lactate. More researches are necessary in order to investigate the acute effects of different amount of caffeine on non-aerobic power and blood lactate levels. Totally, regarding the result of this research, it seems that people, who have at least three times regular exercise during the week and usually caffeine (tea, coffee…) consumption in their daily diet, may improve their function with consuming 6mg/kg caffeine in the form of gelatin capsules one hour before the athletic activity.

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EFEKTI KONZUMACIJE KAFEINA NA ANAEROBNU SNAGU, INDEX ZAMORA I NIVO LAKTATA U KRVI KOD STUDENATA SPORTISTA

Originalni naučni rad

Sažetak

Cilj ovog istraživanja je bio da se utvrdi efekat konzumacije kafeina na anaerobnu snagu, indeks zamora i nivo laktata u krvi kod studenata sportista. Šesnaest ispitanika (prosječne težine 68,1 +/- 9,1kg, visine 1,73 +/- 7cm i uzrasta 24 +/- 2 godine) su nasumično izabrani među prijavljenim dobrovoljcima te su podijeljeni kao podudarni parovi, na osnovu indeksa zamora dobijenog prije istraživanja, na dvije grupe: kafein (n=8) i placebo (n=8). Od ispitanika je traženo da abstiniraju od bilo kakve intenzivne fizičke aktivnosti 24 sata prije testiranja te izbjegnu konzumaciju jela i pića koje sadržava kafein 48 sati prije testiranja. Prvo je sproveden RAST test i to najmanje 4 sata poslije posljednjeg obroka, a nakon toga, šest minuta po zavrsetku testa su uzeti uzorci nivoa laktata u krvi. Drugi RAST test je sproveden sedam dana kasnije, po istom protokolu kao i prvi. Ispitanici su nastavili konzumaciju kafeina, kao obično, te je prekinuli 48 sati prije narednog testa. Na post testu, jedan sat prije testiranja, ispitanici su uzeli 6mg/kg tjelesne težine kafeina ili placebo u formi želatinoznih kapsula. Analizom rezultata primjenjenog t testa za zavisne uzorke na nivou značajnosti ($p \leq 0.05$) može se vidjeti da konzumacija kafeina ima statistički značajne pozitivne efekte na prosječnu snagu; minimalnu snagu i indeks zamora, dok nema statistički značajnih efekata na maksimalnu snagu i količinu laktata u krvi. Čini se da je konzumacija kafeina efikasna na oporavak kod brzih i kratkotrajnih ponavljajućih sprinterskih dionica.

Ključne riječi:*kafein, anaerobna snaga, indeks zamora, nivo laktata u krvi, studenti sportisti*

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