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Effect of different dosages caffeine gum ingestion on mid-endurance performance

Hassan Farhadi[1], Hamdollah Hadi[1]

[1]*Department of Physical Education and Sport Sciences, Ahar branch, Islamic Azad University, Ahar, Iran*

ABSTRACT

Caffeine is a substance that is found naturally in many plants and is often found in many of the drinks and foods we consume. The widespread use of caffeine is continually on the rise as we can easily find caffeine in coffee, tea, soda, chocolate, energy drinks and gels, gum, and pharmaceutical drugs. Caffeine is recognized as the World's most commonly used drug and is frequently used by athletes as a nutritional ergogenic aid during training and competition. Caffeine is often administered as a liquid or in a capsule, but new research has shown that caffeine gum has a faster absorption rate and a higher relative bioavailability. The purpose of this study is to determine the effect of different dosages caffeine gum ingestion on blood lactate and glucose during 1500-m running. **.** *Fifteen well-trained male runners completed a double-blind, placebo controlled experiment. The runners [mean±SD] weight, height, age, and percentage body fat were 64.7±4.91 kg, 174.5±2.73 c m, 21.7±4.76 years, and 13.7±5.08 %, respectively. Chewing gum [3,4,5 mg.kg-1 of caffeine] or a placebo was administered at three time points [Thirty-five minutes pre-exercise, 5 minutes pre-exercise, and immediately following exercise]. The participants were instructed to chew for five minutes. Participants raced 1500-m distance. Blood glucose and lactate were measured via a finger prick in any four stages, 5 minutes pre-1500-m running, and immediately following 1500-m running. The rest Interval between any measurement stages was one week. The results indicated no significantly different between that blood glucose [p<0.05] and blood lactate [p<0.05] levels over time with the different dosages caffeine and versus the placebo. This was one of the first exercise studies conducted that administered caffeine gum and should be used as a starting point for future research on caffeine gum and exercise.*

Keywords: Caffeine gum, 1500-m running, mid-endurance

INTRODUCTION

Caffeine, or 1,3,7-trimethylxanthine, is a widely used substance present in habitual beverages and chocolate-based foods and is also used for therapeutic purposes, being present in a wide variety of fixed combination prescription drugs. Moreover, caffeine is used as an ergogenic aid.

The ergogenic aids can be classified as nutritional, mechanical, pharmacological, physical and psychological, including legal and safe procedures as carbohydrate supplementation, or even illicit and unsafe ones like anabolic steroids and blood infusion [1, 18-22].

For many years caffeine has been one of the most widely consumed drugs in the world [2, 3, 4]. Caffeine [1,3,7- trimethyl-xanthine] is a methyl derivative of xanthine, one of the readily available stimulants consumed daily by more than 80% of the world.s population, making it the most widely consumed drug in history [5]. Several potential mechanisms exist to explain caffeine's performing enhancement effects during exercise. These mechanisms have been extensively reviewed for both aerobic [11] and more recently anaerobic activities [18].

The ability of caffeine and other xanthines to aid sport performance is based on both the direct and indirect action on the heart or skeletal muscles, mediated through the nervous system, altered hormonal activities or shift in mobilization of substances [free fatty acid mobilization and glycogen sparing]. There is also the possibility that the drug may alter the release, binding or activity of neurotransmitter in the brain, thereby affecting the perception of work intensity [5].

The focus of caffeine research has been on the ergogenic effect of the liquid and capsule delivery methods. In order to determine the mechanism by which caffeine elicits this ergogenic effect, the metabolic effects are often studied during exercise. Cox et al. studied the effects of 6 mg/kg of caffeine in capsule form and Coca-Cola on metabolism and endurance performance in twelve highly trained male cyclists or triathletes [6]. Researchers found that the 6 mg/kg of caffeine enhanced performance during a time trial at the end of a prolonged cycling bout. Researchers also found that the Coca-Cola enhanced exercise performance despite having a low level of caffeine. A study by Van Soeren and Graham examined the effects of caffeine on exercise metabolism after withdrawal. This study delivered caffeine in the form of a capsule to recreational athletes. The results indicated that caffeine increased exercise time in all exercise trials when compared to the placebo [7].

The problem with administering caffeine as a liquid or in a capsule is the timing. Gum is one of the more recent items caffeine has been added to. Caffeine gum has proven to be a successful aid for those who need to stay awake especially for a prolonged period [8, 9].

The major difference between the gum and a liquid/capsule is the amount of time it takes to be absorbed. Caffeine gum has a much quicker absorption time and a higher relative bioavailability [10]. Eighty-five percent of the caffeine in the gum is absorbed sublingually within five minutes [11]. Absorption via the buccal cavity will allow caffeine to bypass the gastrointestinal system and be released directly into the bloodstream. This fast absorption rate and relative bioavailability could mean more of an ergogenic effect during exercise.

Given the limited and inconsistent findings in the literature regarding the effects of caffeine on mid-endurance performance, the purpose of this study is to determine if caffeine gum will have more of an effect on blood glucose and blood lactate levels during 1500-m running. The results of this study could prove to be beneficial for athletes who want to ingest a legal supplement before exercise or competition. Athletes often have tight schedules, and since caffeine gum is quickly absorbed and readily available, there would be no need to worry about ingesting the caffeine 45 to 60 minutes prior to exercise. This would greatly benefit athletes.

MATERIALS AND METHODS

Subjects

Fifteen well-trained male runners completed this study. The runners [mean ± SD] weight, height, age, and percentage body fat were 64.7±4.91 kg, 174.5±2.73 cm, 21.7±4.76 years, and 13.7±5.08 %, respectively. All subjects were informed of the purpose and risks associated with participation before giving their written informed consent. Participants were excluded from the study if they had a history of smoking, signs or symptoms of cardiovascular, metabolic, or respiratory disease, or if they are known to have any cardiovascular, metabolic, or respiratory disease as determined via a health history questionnaire.

Experimental protocol

First day of study, height, weight and percentage body fat and baseline blood glucose and lactate was measured in subjects. Also blood glucose and lactate were measured in any four stages, 5 minutes pre-1500-m running, and immediately following 1500-m running. Blood glucose was measured via a glucometer [Roche Diagnostics, Accu Chek Active, Indianapolis, IN] and blood lactate was measured using a lactate pro analyzer [Arkray, Inc., Lactate Pro Analyzer, Tokyo, Japan]. Both blood glucose and blood lactate measurements were taken using a finger prick. Chewing gum [3,4,5 $mg.kg_{-1}$ of caffeine] or a placebo was administered at three time points [35 minutes pre-exercise, 5 minutes pre-exercise, and immediately following exercise]. The participants were instructed to chew for five minutes. The gum was administered in a randomized, counterbalanced, double blind manner. Interval between any measurement stages was one week.

Statistical analysis:

Standard descriptive statistics were used to report means and standard deviation for baseline characteristics. [$P \leq 0.05$]. A repeated measure ANOVA and Tukey post-hoc test used to analyze the data. All data was analyzed by using SPSS for windows software version 16.0[SPSS Inc, Chicago, IL]

RESULTS

Table 1 shows mean and standard deviation of age, height, weight and percentage body fat in subjects.

Table 1: Personal Characteristics of subjects

Variable	N	Mean	SD
[Age[years	**15**	21.7	4.76
[Height[cm	**15**	174.5	2.73
[Weight[kg	**15**	64.7	4.91
Percentage body fat [%]	**15**	13.7	5.08

The results of repeated measure ANOVA showed that blood glucose significantly would not change in before and after 1500-m running with different dosages caffeine gum ingestion and placebo [$F=0.531$, $p= 0.485$] [Table 2].

Table2: Blood Glucose levels with different dosages caffeine gum ingestion pre and post 1500m running

	placebo	3 mg.kg-1 of gumcaffeine	4 mg.kg-1 of gum caffeine	5 mg.kg-1 of gum caffeine
Pre-1500m running	99/6 ± 5/39	113/2 ±18/52	± 12/66 109/3	113 ± 10/39
Post-1550m running	± 14/15 112/80	± 15/25 116/80	± 19/20 117/7	112/30 ± 18/50

Also the results of this study showed significant change in blood lactate in before 1500-m running with after 1500-m running [F=6.86, p= 0.028; F=5.61, p= 0.042], while it does not show significant difference between different dosages caffeine gum ingestion and placebo [Table 3].

Table3: Blood Lactate levels with different dosages caffeine gum ingestion pre and post 1500m running

	placebo	3 mg.kg-1 of gumcaffeine	4 mg.kg-1 of caffeine gum	5 mg.kg-1 of gum caffeine
Pre-1500m running	3/5 ± 1/90[a]	4/5 ±2/53[a]	± 2/94[a] 4/06	4/86 ± 2/29[a]
Post-1550m running	15/99 ± 3/93	14/89 ± 3/90	± 3/98 14/60	12/42 ± 3/32

a: significant different between pre and post-1500m running

Also the results of this study does not show significant difference in time of 1500m running between different dosages caffeine gum ingestion and placebo[F=4.168 , P=0.072] [Table 4].

Table4: the time of 1500m running

	placebo	3 mg.kg-1 of gumcaffein	4 mg.kg-1 of caffeine gum	5 mg.kg-1 of gum caffeine
Time(min)	5/52 ± 0/29	5/37 ± 0/14	± 0/24 5/38	5/42 ± 0/34

DISCUSSION

The purpose of present study was to determine of the effects of caffeine gum [3,4,5 mg.kg-1] and placebo on blood glucose and lactate levels during 1500-m running. The results of this study showed that blood glucose does not change with caffeine gum. The findings of present study are similar to results found in Van Soeren and Graham, Battram et al nd Bagsbo et al [7, 12, 13]. Van Soeren and Graham studied six recreational athletes who were habitual caffeine users and found that caffeine had no effect on blood glucose levels after withdrawal during exercise to exhaustion [7]. Another study by Battram et al observed the effect of caffeine on glucose kinetics in twelve recreationally active males and found that caffeine did not have an effect on endogenous glucose production [12].

Bangsbo et al observed the acute and chronic responses to caffeine and exercise in healthy adults. They found that blood glucose levels were not altered with the caffeine [13]. However, there have been studies that have found caffeine to cause a rise in blood glucose [14, 15]. Graham and Spriet examined the exercise responses to various doses of caffeine in well trained endurance athletes and the results indicated that during exercise the blood glucose concentration rose [16].The reason blood glucose did not show any statistical significance with the caffeine gum in the present study could be due to the nature of exercise used in this study. For example, the study by Graham and Spriet, which found an increase in blood glucose levels, used endurance activity, while in present study; we used mid-endurance activity [1500-m running]. Also another reason could be due the small dose of caffeine the participants received.

The dose given may not have been large enough to cause a significant change in blood glucose during running, even though a larger amount of caffeine may have been absorbed through mastication of the gum. The study by Graham and Spriet, which found an increase in blood glucose levels, used larger doses of caffeine than the present study.

The results of this study showed that blood lactate does not change with different dosages caffeine gum. The findings of present study are similar to results found in Kovacs *et al.* [1998], using 150, 225, and 320 mg caffeine/L supplying amounts of caffeine of 2.1, 3.2, and 4.5 mg/kg [body weight], respectively, observed ergogenic benefits on the performance, however, the highest dosage of 320 mg/L caffeine did not result in a further improvement compared with the 225 mg/L dosage[21]. Research on caffeine's effect on blood lactate during exercise is not often discussed and when it is, the findings are conflicting with the theory that caffeine is glycogen sparing. Most research shows that blood lactate concentration increases after the ingestion of caffeine. An increase in lactate could indicate that there was an increased production by the active muscle or a decreased blood clearance [17]. Our findings conflict with findings of Van Soeren and Graham, Jackman et al and Graham and Spriet [7, 17, 16].Van Soeren and Graham observed the metabolic effects of caffeine after withdrawal reported that blood lactate increased in response to exercise[7]. Jackman et al. examined caffeine's effect during brief, intense exercise and found that blood lactate concentrations increased during exercise in which caffeine was ingested [17]. Graham and Spriet examined the metabolic and exercise responses to various doses of caffeine. Researchers found that during exercise blood lactate rose moderately with exercise [16]. The studies that report an increase in blood lactate conflict with the theory that caffeine is glycogen sparing. If glycogen sparing occurs, then lactate concentrations should not increase due to FFAs being the source of fuel during exercise. The reasons of this conflict could be due to a few reasons. The first is the small dose of caffeine. The second is the fitness level of the participants and the third is the nature of exercise used in this study.

The results of this investigation need to be further studied since this is one of the first exercise study using caffeinated gum and mid-endurance exercise. This investigation is a starting point for future research to be conducted. While the results of this study did not show any significance, this study provides researchers with the opportunity to repeat the study using more controlled variables, such as caffeine dose, number of subjects, and the fitness level of the subjects.

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