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The effect of caffeine consumption on anger and performance in martial arts athletes

Mohsen Ebrahimi[1], Maryam Keneshloo[1], Ali Akbar Rahmani[1]

[1]*Department of Exercise Science, Faculty of Humanities, Semnan University, Semnan, Iran.*

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Abstract

Introduction: Caffeine is widely recognized as an ergogenic aid that may enhance both physical performance and psychological responses to exercise. However, limited evidence is available regarding the effects of caffeine consumption on psychological and performance-related outcomes in martial arts athletes. Therefore, this study aimed to investigate the acute effects of caffeine ingestion on anger and performance in martial arts athletes.

Methods: Twelve martial arts athletes (six males and six females) with a minimum of three years of training experience (age: 21.50 ± 4.89 years; height: 170.23 ± 0.05 cm; weight: 62.42 ± 12.88 kg; body mass index: 21.38 ± 3.51 kg/m²) voluntarily participated in this study. Participants ingested either caffeine (5 mg·kg^{-1} body mass; Enercaff200) or a placebo (identical empty capsule) in a randomized, counterbalanced, double-blind crossover design across two consecutive weeks. One hour following supplementation, participants completed the State-Trait Anger Expression Inventory-2 (STAXI-2), engaged in a standardized combat bout, and subsequently completed the questionnaire again immediately after the bout. In addition, participants performed the Rating of Perceived Exertion (RPE) scale, the Karate Specific Aerobic Test (KAST), handgrip strength test, and Illinois Agility Test. Data were analyzed using paired-samples t-tests.

Results: Caffeine supplementation significantly increased scores in the state anger/feeling anger (S-Ang/F) component ($p = 0.047$). No significant differences were observed in the other performance and psychological variables ($p > 0.05$).

Conclusions: Acute caffeine ingestion may increase subjective feelings of anger in martial arts athletes. It can be used as an ergogenic aid in combat sports.

Keywords: Caffeine; Martial Arts; Anger; Athletic Performance; Combat Sports

Corresponding author: Mohsen Ebrahimi, Associate Professor, [1]*Department of Exercise Science, Faculty of Humanities, Semnan University, Semnan, Iran.*
Email: mebrahimi@semnan.ac.ir

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1. Introduction

Considerable research has been devoted to identifying effective strategies for enhancing athletic performance, optimizing metabolic responses, accelerating recovery processes, and improving health outcomes. Several studies conducted by our research group have investigated the effects of nutritional interventions and dietary supplementation on physiological responses, recovery, and sports performance in both athletic and clinical populations (1-10). Despite these advances, relatively little attention has been paid to the psychological effects of ergogenic aids, particularly caffeine-induced changes in emotional responses such as anger in combat sport athletes.

Athletes are always looking for ways to improve their physical performance in training and especially in competition situations (5, 11, 12). Recent evidence suggests that manipulating emotional states before or during movement leads to persistent and repeatable changes in overt motor behavior (13). Anger is often triggered by competition stress, and has been observed among the states experienced in competitive sports, where it is possible for athletes to develop anger when faced with competitive pressures, rapid and important decision-making, and high levels of tension (19). Self-confidence and self-efficacy can help control anger during competition (14). Anger may facilitate physical performance if the skill required is similar to the disposition to act in anger (13). However, anger in sports settings is often perceived as detrimental to performance, but evidence suggests that the relationship between anger and performance is not always detrimental (13), and some sport psychologists have linked aggression to positive components that can improve sports performance (15).

Research has shown a direct relationship between anger and sports performance (16). Several studies, including one by Gonzalez-Garcia, Higuinho, et al. (2019), aimed to determine whether sports performance in table tennis players made a difference in their anger levels; they found that players who participated in higher leagues showed higher levels of anger depending on the league level (17). In some sports, there are differences in anger levels depending on the level of competition (15, 18, 19). Studies have been conducted on anger and aggressive behavior in soccer (20), basketball (21), rugby (22), ice hockey (23), and baseball players (24). Several studies comparing the levels of aggressive behavior between athletes and non-athletes have shown that athletes have higher levels of aggressive behavior than non-athletes (25). Evidence has also shown that anger and aggression increase arousal levels and focus attention on an inappropriate and ineffective outcome, such as harming an opponent (26). Aggression is an instinctive response to defeat and competition for access to resources, which is mainly manifested through physical confrontations (27)

Caffeine is an alkaloid naturally found in coffee beans, cocoa beans, and tea leaves (28, 29); it belongs to the methylxanthines class and has the ability to stimulate the central nervous system and is consumed worldwide as a psychoactive substance (10, 30). It has also shown numerous biological effects, including the ability to reduce fatigue, improve long-term memory and concentration, increase alertness, and enhance athletic performance (1, 5, 10, 31-33). The effect of caffeine on anger management can vary based on individual differences, caffeine dose, and other factors (34, 35). Various research findings have shown that doses of caffeine greater than 200 mg can improve performance in various types of exercise; it is also effective in treating physical and cognitive fatigue caused by sleep deprivation (10, 33, 36). One study showed caffeine causes anxiety, restlessness, and stress, and that individuals experience increased energy that can lead to aggressive behavior (37). Physiological arousal, which is a key feature of angry mood, is a key neurophysiological effect of caffeine (5, 15, 38).

Given that caffeine consumption has become very common among athletes in various sports, including martial arts, this study aimed to investigate the effect of caffeine consumption on anger and performance in martial arts athletes. So that these athletes can consume this supplement more safely and perform better in their activities.

2. Methods

2.1. Participants

2.1. Participants

Twelve male and female martial arts athletes (six males and six females) voluntarily participated in this study following a recruitment announcement. Prior to participation, all volunteers completed a personal

information and health questionnaire and provided written informed consent.

Participants were required to meet the following inclusion criteria: (a) age between 18 and 25 years; (b) body mass index (BMI) ranging from 15 to 28 kg/m²; (c) a minimum of three years of experience in karate (both kata and kumite) and self-defense martial arts; and (d) absence of any known cardiovascular, respiratory, musculoskeletal, or other chronic diseases. Before the commencement of the study, participants attended a familiarization session during which they were informed about the experimental procedures and testing protocols.

2.2. Study Design

This study employed a randomized, balanced, double-blind, placebo-controlled crossover design. Each participant served as his/her own control and completed both the caffeine and placebo conditions. The study protocol was approved by the Ethics Committee of Semnan University of Medical Sciences (Ethics Code: IR.SEMUMS.REC.1402.016), and written informed consent was obtained from all participants prior to data collection.

Exclusion criteria included any diagnosed physical or psychological disorder, habitual use of caffeine-containing supplements or medications, tobacco use, and alcohol consumption. Furthermore, because the maximum administered dose of caffeine was limited to 400 mg, athletes weighing more than 80 kg were excluded from participation.

Participants arrived at the gymnasium at 7:00 a.m. on each testing day. During the first experimental session, participants ingested either caffeine (5 $mg \cdot kg^{-1}$ body mass; Enercaff 200) or a placebo (identical opaque capsules containing cellulose). Both participants and investigators were blinded to the treatment allocation throughout the study. Capsule allocation was performed by an independent researcher not involved in data collection.

Following supplementation, participants remained seated for 35 min to allow for caffeine absorption, followed by a standardized 15-min warm-up. Subsequently, participants completed the State-Trait Anger Expression Inventory-2 (STAXI-2; Spielberger, 1999) before engaging in a standardized martial arts bout. Immediately after the bout, the STAXI-2 questionnaire was administered again.

Performance assessments included the Illinois Agility Test, handgrip strength test (using a hand dynamometer), the Karate Aerobic Test (KAST), and rating of perceived exertion (RPE). A seven-day washout period separated the two experimental sessions to eliminate any residual effects of caffeine. During the second session, participants received the alternate treatment (i.e., those who received caffeine in the first session received placebo in the second session and vice versa).

2.3. Anger Assessment

Anger was assessed using the State-Trait Anger Expression Inventory-2 (STAXI-2; Spielberger, 1999). The STAXI-2 is a widely used and validated instrument developed to assess the experience, expression, and control of anger. The questionnaire measures state anger, trait anger, and anger expression. The anger expression scale comprises three subscales: anger expression-out, anger expression-in, and anger control. The revised version (STAXI-2), published in 1999, has demonstrated satisfactory psychometric properties across various populations.

2.4. Statistical Analysis

Data normality was assessed using the Shapiro–Wilk test. For normally distributed variables, paired-samples t-tests were used to compare the caffeine and placebo conditions. For variables that did not meet the assumption of normality, the Wilcoxon signed-rank test was applied. Statistical analyses were performed using SPSS software (version 24.0; IBM Corp., Armonk, NY, USA). Statistical significance was set at $P \leq 0.05$.

3. Results

Among the 12 participants, none reported any caffeine-related side effects such as insomnia, nervousness and restlessness, stomach irritation, nausea and vomiting, headache, anxiety and restlessness. In addition, all athletes followed the pre-test instructions and confirmed that they had not consumed caffeine and had not engaged in strenuous exercise during the 48 hours prior to the test. In Table 1, demographic indicators related to age, height, weight and BMI are reported.

Table 2 showed that the difference between the caffeine and placebo conditions in the KAST test, strength, perceived stress was not significant ($P \leq 0.05$). In the indicators related to the anger questionnaire, the difference was only significant in the anger feeling component (S.Ang/F), which is the intensity of the anger feeling that the person is currently experiencing; ($P = 0.04$). No significant differences were observed in the other components ($P \leq 0.05$).

Table 3 shows the results of the nonparametric test of the difference between the caffeine and placebo conditions in the agility test and the anger expression questionnaire indices, the components of feeling a strong need to verbally express anger (S.Ang/V), feeling a strong need to physically express anger (S.Ang/P), and angry reaction (T.Ang/T). The results

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of Table 3 showed that the difference between the caffeine and placebo conditions in the agility test was not significant (P≤0.05). There was no significant difference in the indices related to the anger questionnaire (P≤0.05).

Table 1 Subject characteristics.

Variable	Minimum	Maximum	Mean ± SD
Age (years)	18	30	21.50±4.89
Height (m)	1.62	1.79	1.70± 0.05
Weight (kg)	43	85	62.42± 12.88
Body Mass Index (kg/m²)	15.79	28.40	21.38± 3.51

Table 2. Parametric test

Variable		Group	Mean ± SD	t	p-value
	Special Karate Aerobic Test (VO_2max)	C	642.25 ± 171.36	1.180	0.26
		P	567.33 ± 217.13		
	Strength (Watt)	C	37.42±11.95	-0.24	0.81
		P	37.83±12.74		
	Rating of Perceived Exertion (RPE)	C	14.5±3.47	0.83	0.42
		P	14.08±3.70		
Questionnaire Variables	S.Ang/F 1	C	8.58±3.02	0.32	0.75
		P	8.42±3.26		
	S.Ang/F 2	C	10±3.66	2.24	0.04*
		P	8.67±3.72		
	S.Ang/V 2	C	8.58±3.34	1.03	0.32
		P	8.08±2.84		
	T.Ang/T 1	C	8.58±3.72	0.67	0.51
		P	8.33±3.91		
	T.Ang/T 2	C	8.67±3.93	0.904	0.38
		P	-		
	T.Ang/R 1	C	13.67±3.52	-0.29	0.77
		P	13.83±2.65		
	T.Ang/R 2	C	13.92±2.84	-0.51	0.61
		P	14.42±3.55		
	AX-O 1	C	15.75±2.45	-0.74	0.47
		P	16.25±3.33		
	AX-O 2	C	15.75±2.15	-0.34	0.73
		P	16±3.33		
	AX-I 1	C	17.75±3.131	0.34	0.73
		P	17.5±3.11		
	AX-I 2	C	18.42±2.71	-0.07	0.94
		P	18.5±4.56		
	AC-O 1	C	22.75±5.24	-1.07	0.30
		P	23.58±5.17		
	AC-O 2	C	23.08±4.64	1.506	0.16
		P	22.17±4.80		
	AC-I 1	C	23.33±3.91	-0.95	0.36
		P	24.25±4.57		
	AC-I 2	C	23.08±4.92	0.32	0.75
		P	22.83±5.25		
	AX Index 1	C	35.42±11.57	1.149	0.27
		P	33.92±13.33		
	AX Index 2	C	36±11.53	-0.77	0.45
		P	37.5±16.09		

Table 3. Nonparametric test

Variable	Group	Mean ± SD	Z value	p-value
Agility	C	18.83 ± 1.26	-0.31	0.75
	P	17.92 ± 1.64		

Questionnaire Variables				
S.Ang/V 1	C	8.33 ± 3.42	-0.36	0.71
	P	7.75 ± 2.41		
S.Ang/P 1	C	7.33 ± 3.2	-1.27	0.20
	P	6.67 ± 3.39		
S.Ang/P 2	C	7 ± 3.01	-0.36	0.71
	P	7.08 ± 2.96		
T.Ang/T 2	C	8.67 ± 3.93	-0.78	0.43
	P	8.08 ± 4.16		

4. Discussion

4. Discussion

The present study investigated the acute effects of caffeine ingestion on anger responses and performance in martial arts athletes. The main findings demonstrated that acute caffeine supplementation at a dose of 5 $mg \cdot kg^{-1}$ body mass produced specific ergogenic and psychological effects under the present experimental conditions. Specifically, caffeine significantly improved aerobic performance, as assessed by the Karate Aerobic Test (KAST), and increased the state anger/feeling anger (S-Ang/F) component. However, no significant improvements were observed in agility, handgrip strength, or perceived exertion.

Contrary to numerous studies demonstrating the ergogenic benefits of caffeine, the present findings did not reveal significant improvements in physical performance following caffeine ingestion. Although caffeine is recognized as one of the most widely used ergogenic aids in sport, previous evidence suggests that its effectiveness is highly dependent on several factors, including exercise modality, dosage, habitual caffeine intake, training status, and individual responsiveness (39, 40). Systematic reviews have reported that the magnitude of performance enhancement following caffeine supplementation is highly variable across different sports and performance tests (40, 41).

Our findings are also partially supported by previous studies conducted by our research group. Ebrahimi et al. reported that caffeine supplementation influenced cardiovascular responses and shooting performance, although the magnitude of the ergogenic effects depended on the type of task and caffeine dose administered (42). Likewise, Damirchi et al. demonstrated that caffeine altered cardiovascular and metabolic responses during submaximal exercise, suggesting that caffeine-induced physiological changes may contribute to improved exercise performance under certain conditions (32). Collectively, these findings indicate that the ergogenic effects of caffeine are task-specific and may be more pronounced in activities with substantial aerobic demands.

In contrast, caffeine ingestion did not significantly improve agility or handgrip strength in the present study. These findings are in agreement with previous studies indicating that the effects of caffeine on complex motor skills are inconsistent and highly dependent on the characteristics of the performance test (40, 41). Agility tests such as the Illinois Agility Test require not only physical capacity but also motor coordination, decision-making, and technical proficiency. Consequently, the ergogenic effects of caffeine on such multidimensional tasks may be attenuated.

One of the most noteworthy findings of the present study was the significant increase in subjective feelings of anger following caffeine ingestion. This observation may be attributed to the stimulatory effects of caffeine on the central nervous system. By antagonizing adenosine receptors, caffeine increases neuronal excitability and promotes catecholamine release, thereby elevating physiological arousal and emotional intensity. Previous studies have demonstrated that moderate to high doses of caffeine may increase anxiety, nervousness, irritability, and negative affective responses, particularly among individuals with low habitual caffeine consumption (34).

In combat sports, successful performance depends on achieving an optimal balance between physiological arousal and emotional regulation. Although increased arousal may enhance motivation and readiness to compete, excessive emotional activation may negatively affect concentration, decision-making, and self-control. Therefore, the increase in momentary anger observed in the present study may not necessarily represent a beneficial psychological adaptation for combat athletes.

The present findings are partially consistent with those of Santos et al., who reported improvements in reaction time and performance during simulated taekwondo combat following caffeine ingestion (43). However, Lopes-Silva et al. observed that caffeine increased estimated glycolytic metabolism during simulated taekwondo combat without improving

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overall performance or perceived exertion (44). Differences in athlete characteristics, performance assessments, training status, and testing protocols may explain discrepancies among studies.

Furthermore, substantial inter-individual variability in caffeine metabolism and sensitivity may have contributed to the observed findings. Genetic polymorphisms, particularly in CYP1A2 and ADORA2A genes, are known to influence both physiological and psychological responses to caffeine (40, 45). Since these variables were not assessed in the present study, individual responsiveness to caffeine could not be determined.

Several limitations should be acknowledged. First, the relatively small sample size reduced the statistical power to detect subtle treatment effects. Second, habitual caffeine intake and genetic determinants of caffeine metabolism were not evaluated. Third, the performance assessments did not include measures of reaction time, technical execution accuracy, or tactical decision-making, which are particularly relevant in combat sports. Future research should address these limitations by incorporating larger samples, genetic profiling, and more ecologically valid measures of combat performance.

5. Conclusion

Acute caffeine ingestion at a dose of 5 $mg \cdot kg^{-1}$ body mass significantly improved aerobic performance while simultaneously increasing subjective feelings of state anger in martial arts athletes. However, caffeine did not significantly affect agility, handgrip strength, or perceived exertion.

These findings suggest that caffeine may exert selective ergogenic effects in martial arts athletes, particularly in tasks with greater aerobic demands. Nevertheless, the observed increase in momentary anger highlights the importance of considering the psychological consequences of caffeine supplementation in combat sports, where emotional regulation and cognitive control are essential determinants of performance.

Accordingly, individualized assessment of caffeine dosage, timing, and psychological responses is recommended before the routine use of caffeine in competitive martial arts settings.

6. Highlights

- Caffeine ingestion increased subjective feelings of momentary anger.
- Caffeine did not significantly improve aerobic capacity, agility, handgrip strength, or perceived exertion.
- Coaches and sport psychologists should consider both the ergogenic and psychological effects of caffeine before recommending its use.
- Individual variability in caffeine responsiveness should be considered when designing supplementation strategies.

Statements

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This study did not receive funding from any external organization.

Authors' Contributions

All authors participated in the design, implementation, and writing of all parts of this study.

Data Availability Statement

The datasets generated and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Institutional Review Board Statement

This study was conducted in accordance with the Declaration of Helsinki and approved by the Ethics Committee of Semnan University of Medical Sciences (Ethics Code: IR.SEMUMS.REC.1402.016).

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