

An ergogenic approach to enhancing performance in archery: the acute effects of caffeine

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Abstract

Background and Study Aim Ergogenic aids are widely used to enhance exercise performance and training adaptations. Among these, caffeine is recognized for its stimulatory effects on the central nervous system and neuromuscular function. Despite their widespread use, the relative effectiveness of such aids in improving performance in precision-based target sports such as archery remains a matter of practical interest. This study aimed to examine the effects of acute caffeine supplementation on shooting performance in university-level archers.

Material and Methods A total of 12 licensed university archers (mean age: 22.92 ± 2.11 years) participated in this study. A single-group pretest–posttest experimental design was employed. Participants completed two laboratory sessions separated by 72 hours under standardized conditions. In each session, anthropometric and hearing assessments were conducted. This was followed by the ingestion of 200 mg of caffeine. After a 60-minute absorption period, archers performed shooting tests at 18 meters. The protocol included practice trials and 10 sets of scoring shots. Data were analyzed using paired-samples t-tests and repeated-measures ANOVA. These methods accounted for within-subject variability across sets. Statistical significance was set at $p < .05$.

Results Posttest scores were consistently higher than pretest scores across most sets. Statistically significant improvements were observed in Sets 2, 3, 4, 6, 8, 9, and 10 ($p < .05$). Sets 1, 5, and 7 showed non-significant differences. Overall performance increased significantly from 6.61 ± 1.20 to 8.33 ± 0.39 ($p < .001$), with a large effect size (Cohen's $d = 1.90$; $\eta^2 = .50$). Repeated-measures ANOVA revealed a significant main effect of condition ($p < .001$). No significant set or interaction effects were found. This indicates that performance improvements were consistent across shooting sets.

Conclusions Acute caffeine supplementation was associated with improved shooting performance in university-level archers. The findings suggest that caffeine may have potential as an ergogenic aid in precision-oriented sports requiring sustained attention and performance consistency. However, the results should be interpreted with caution due to methodological limitations. These include the absence of a control condition and the small sample size. Further randomized placebo-controlled studies are needed to confirm and extend these findings.

Keywords: acute effects, archery performance, attention and concentration, caffeine supplementation, cognitive performance

Introduction

Performance optimization in sport involves the integration of physiological, cognitive, and technical factors that collectively influence competitive outcomes. In precision-based disciplines such as archery, success depends not only on physical stability but also on sustained attention, fine motor control, and the ability to regulate arousal under competitive conditions. The interaction between neuromuscular function and cognitive processes plays a critical role in maintaining shooting accuracy across repeated attempts. In this context, interventions that influence central nervous system

activity and alertness may affect both execution quality and performance consistency.

Ergogenic aids are defined as psychological techniques, mechanical devices, nutritional supplements, or pharmacological approaches aimed at enhancing training adaptations or improving exercise performance capacity [1]. Among these, nutritional ergogenic aids refer to orally administered substances containing dietary components intended to support sports performance. In addition to performance-related effects, such products may contribute to the prevention of conditions including excessive fatigue, dehydration, and reduced physical capacity [2]. The use of dietary supplements is widespread among athletes [3].

The American College of Sports Medicine (ACSM), the International Olympic Committee (IOC), and

the International Society of Sports Nutrition (ISSN) classify ergogenic aids into three primary categories: sports foods, medical supplements, and performance-enhancing supplements [4]. Within the category of performance-enhancing supplements, caffeine is one of the most widely used ergogenic aids due to its stimulant properties and its ability to improve exercise efficiency [5]. Caffeine has been shown to exert effects in endurance-based sports requiring prolonged effort. It also demonstrates stimulatory effects during short-duration and repeated high-intensity activities [1].

In aerobic exercise, the ergogenic effects of caffeine are primarily attributed to increased catecholamine release and enhanced fat metabolism, which contribute to glycogen sparing. In contrast, during anaerobic exercise, caffeine exerts more direct effects on the muscular system [6]. For instance, it may enhance neuromuscular transmission and excitation–contraction coupling by increasing intracellular calcium availability [7]. Furthermore, caffeine is involved in several physiological mechanisms. These include the inhibition of adenosine receptors, increased activity of the sodium–potassium ATPase enzyme, and more efficient mobilization of intracellular calcium [8]. In addition to these physiological effects, caffeine may reduce perceived exertion and muscle pain. This may contribute to improved overall exercise performance [9].

Evidence indicates that caffeine influences physical performance parameters such as gross motor skills and endurance capacity. It also affects cognitive functions, including attention, focus, and motivation. This has contributed to a growing body of research examining the relationship between caffeine and performance [10]. Caffeine is recognized as an ergogenic aid with stimulatory effects on the central nervous system (CNS). The primary mechanism underlying its effects on cognitive performance is explained by its antagonistic action on adenosine receptors in the brain [11]. Under normal physiological conditions, adenosine contributes to fatigue and sleepiness by suppressing neural activity. Caffeine binds to adenosine receptors and blocks this inhibitory effect. This leads to increased central nervous system activity. As a result, the release of excitatory neurotransmitters such as dopamine, norepinephrine, and acetylcholine increases [12]. Consequently, improvements may be observed in cognitive functions, including alertness, attention, information processing speed, and psychomotor performance (David McLellan et al., 2016). Caffeine is widely used as an ergogenic stimulant affecting both physical and cognitive aspects of performance [5].

The neuromuscular and muscular effects of caffeine are related to its pharmacokinetic profile.

Peak plasma concentrations are typically reached approximately one hour after ingestion. Consuming caffeine about 60 minutes prior to training or competition is considered appropriate [13]. This timing is linked to its absorption characteristics. Caffeine is a moderately water-soluble compound. It is absorbed through the gastrointestinal tract within approximately 15 to 45 minutes following ingestion. It is then distributed throughout body tissues over time [14].

When consumed during the warm-up phase, plasma caffeine levels may be maintained during the competition [8]. Caffeine intake in the range of 3–9 mg·kg⁻¹, consumed 30–90 minutes prior to exercise, is considered an ergogenic strategy for influencing exercise performance [8, 9, 13]. Due to its effects on motor functions and the central nervous system (CNS), caffeine may be a relevant factor in sports where attention and focus are important, such as archery [9, 11].

Achieving successful shooting performance in archery requires the development of a range of physical and technical skills. Archery is a predominantly static sport that emphasizes the strength and endurance of the shoulder musculature. It also requires high levels of attention and concentration [15]. It is an Olympic sport that requires sustained attentional focus, precise mental control, and the use of cognitive abilities during shot execution [16].

Caffeine supplementation may help maintain these parameters in target-based sports such as archery, where attention and focus are important determinants of performance [17]. A number of studies have reported that caffeine supplementation influences cognitive performance parameters. These include attention, memory, concentration, focus, and psychomotor performance [18, 19, 20, 21].

Caffeine supplementation has been shown to influence cognitive and performance-related parameters in archery. Evidence indicates improvements in attention, focus, and shooting accuracy under controlled conditions. Experimental and randomized studies show that moderate caffeine intake may influence archery performance outcomes. These effects are associated with its action on the central nervous system and related cognitive functions, particularly in athletes with low habitual caffeine consumption [22, 23, 24].

Analysis of research findings has shown that caffeine influences both physiological and cognitive components of performance, including neuromuscular function, attention, and psychomotor processes. Researchers emphasize that in precision-based sports such as archery, performance outcomes depend on the interaction between physical stability, cognitive control, and sustained attentional focus. At the same time, variability in individual responses, differences in

supplementation protocols, and the specificity of task demands complicate the interpretation of these effects within applied settings. These aspects continue to limit the consistent application of caffeine supplementation strategies in precision-oriented sports contexts.

Considering the available evidence, the effects of acute caffeine supplementation on shooting performance in archery require further clarification within applied sport settings. Variability in study designs, performance metrics, and supplementation protocols complicates the interpretation of outcomes related to precision-based tasks. These aspects indicate the need for structured evaluation of shooting performance under controlled and repeatable conditions.

The present study aimed to investigate the effects of acute caffeine supplementation on the shooting performance of actively competing, licensed university-level archers. It was also intended to examine changes in performance outcomes under standardized conditions and to quantify the magnitude of the observed effects. Based on existing evidence, it was hypothesized that acute caffeine supplementation would be associated with an improvement in shooting performance compared to baseline measurements.

Materials and Methods

Participants

The study included 12 volunteer university-level archers (2 females and 10 males) with a mean age of 22.92 ± 2.11 years, a mean sport experience of 6.50 ± 1.78 years, a mean height of 175.83 ± 7.46 cm, and a mean body mass of 74.58 ± 7.22 kg. All participants were actively training archers who regularly engaged in structured training routines. Regarding visual and motor dominance, 83.3% ($n = 10$) used the right eye and right drawing arm, while 16.7% ($n = 2$) used the left side. Inclusion criteria required participants to be free from musculoskeletal injuries, cardiovascular conditions, metabolic diseases, recent surgical procedures, and adverse reactions to caffeine. Participants were instructed to abstain from caffeine for at least 24 hours prior to each session and to maintain consistent sleep and dietary habits; compliance was not objectively verified.

Sample Size Estimation. A priori sample size estimation was conducted using G*Power 3.1 for a paired-samples t-test. Assuming a two-tailed test, $\alpha = .05$, statistical power $(1-\beta) = .80$, and a large effect size ($d_z = 0.80$), the required minimum sample size was calculated as 15 participants. The final sample consisted of 12 participants, which is considered a limitation; therefore, the findings should be interpreted with caution in relation to the observed effect size.

Ethical Considerations. Ethical approval for this study was obtained from the Ethics Committee of the Faculty of Sport Sciences at Atatürk University (Decision No: E-70400699-050.02.04-2600019255; Date: 20 January 2026). All procedures were conducted in accordance with the ethical standards of the 1964 Declaration of Helsinki and its subsequent amendments. Data were collected, analyzed, and reported in accordance with established ethical principles.

Research Design

A single-group pretest–posttest experimental design was employed. Participants completed two laboratory sessions separated by 72 hours under standardized conditions. Anthropometric and hearing assessments were conducted prior to testing. Pure tone audiometry was used to confirm normal hearing thresholds within the range of -10 to 25 dB HL across frequencies from 500 to 8000 Hz. Testing conditions were controlled in accordance with established audiometric standards. Participants were instructed to maintain their usual training routines and to avoid intense physical activity prior to testing; compliance was not objectively monitored.

The design was used to evaluate the effects of acute caffeine supplementation on shooting performance in university-level archers. The independent variable was applied to the sample group, and measurements were obtained before (pretest) and after (posttest) the intervention [26, 27]. The study was conducted under standardized procedures reflecting typical training conditions.

Study Organization

Participants visited the laboratory on two separate occasions. During the first visit, participants were informed about the study procedures and signed an informed consent form. Anthropometric measurements were then obtained. Body height was measured using a stadiometer (Holtain, UK) with a precision of ± 0.01 mm. Body mass was assessed using a Tanita BC-418 A (Japan) device with a precision of ± 0.1 kg. Measurements were conducted with participants wearing standard sports clothing and without shoes. Hearing thresholds were assessed using a clinical audiometer.

Following these assessments, participants consumed a standardized breakfast at 09:00. No caffeine was administered during the first session. At 12:00, archers performed shooting trials from a distance of 18 meters. Participants used their personal recurve bows ($66''-70''$; draw weight: #34–#42 lbs). They first completed three sets of practice shots with three arrows per set. After adjustments, participants performed 10 sets of scoring shots, each consisting of three arrows (total: 30 arrows; maximum score: 300 points).

The second session was conducted 72 hours

later and followed the same protocol. Participants consumed a standardized breakfast at 09:00 and ingested 200 mg of caffeine at 11:00. This dose corresponded to approximately 3 mg·kg⁻¹ based on average body mass. After a 60-minute period, participants completed a 10-minute general warm-up followed by sport-specific warm-up activities. The same shooting protocol was then repeated.

All sessions were conducted under standardized conditions. Equipment, shooting distance, and environmental settings were kept constant. Shooting procedures followed World Archery

guidelines. Each set consisted of three arrows and was completed within 2 minutes. A total of 10 sets were performed. Trials were conducted in an indoor range with consistent lighting and no external distractions. Auditory signals were used to regulate the shooting process.

Short transition intervals were allowed between sets to maintain a consistent sequence. Scoring was performed using official target faces, and results were recorded after each set using a consistent procedure. All data were entered into IBM SPSS (version 27) for analysis (Figure 1). No randomization

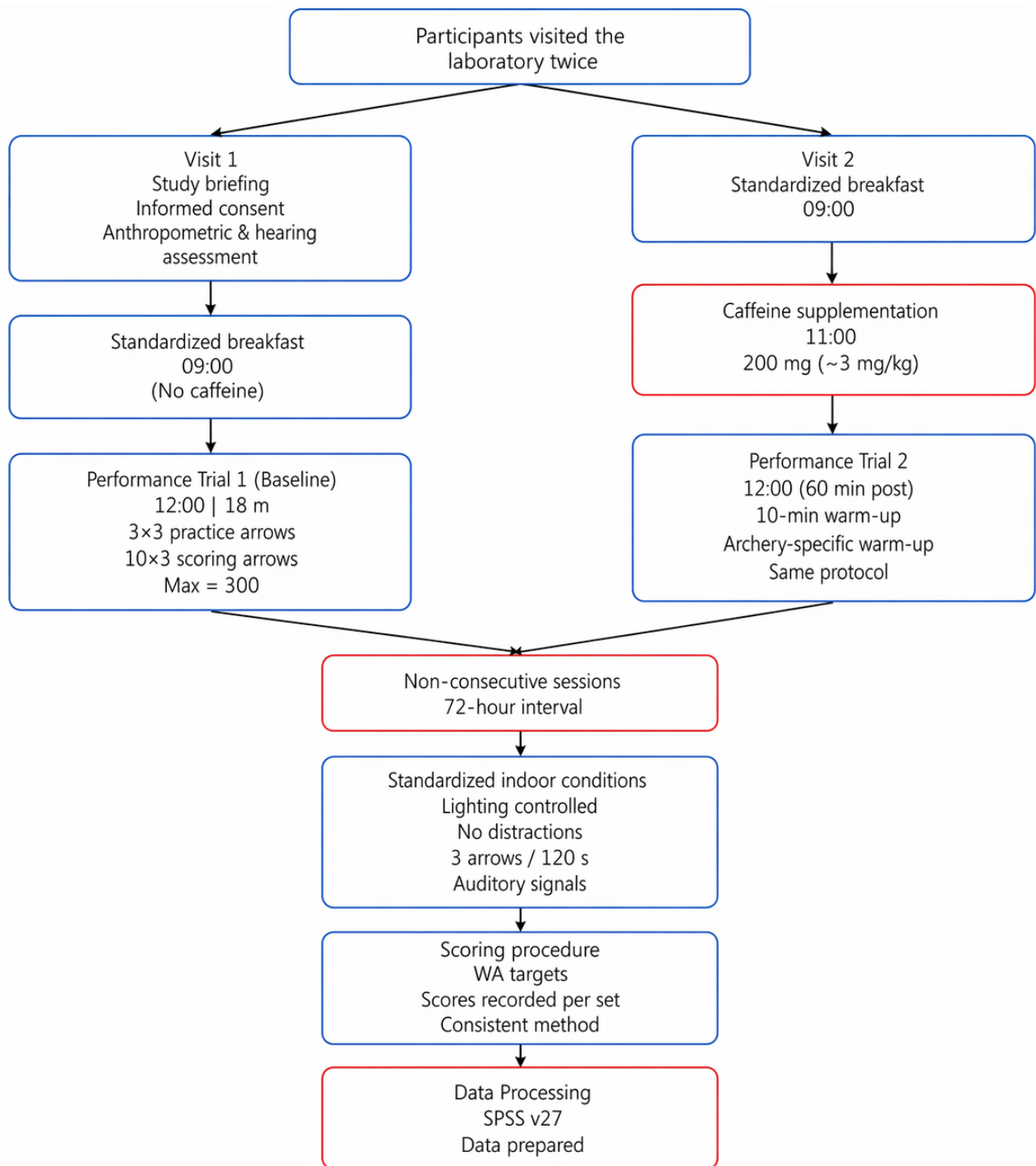


Figure 1. Flowchart of the Experimental Design and Data Collection Procedure

or counterbalancing procedure was implemented, which may have introduced order effects.

Instruments

Anthropometric Measurements. Body height was measured using a stadiometer (Holtain, UK), a portable device with a precision scale providing measurements with millimetric accuracy. Body mass was assessed using a Tanita BC-418 A (Japan) analyzer. Measurements were conducted with participants wearing standard sports clothing and without shoes.

Hearing Assessment. Hearing thresholds were evaluated using a clinical audiometer (Interacoustics AC40, Denmark).

Caffeine Supplementation. Caffeine was administered in the form of a commercially available supplement (Nature's Supreme, 200 mg). Each participant consumed one capsule, corresponding approximately to the caffeine content of two cups of coffee. The supplement contained pharmaceutical-grade caffeine produced under standardized manufacturing conditions and approved by relevant regulatory authorities.

Archery Equipment and Testing Protocol. During the trials, participants used their personal competition equipment. Recurve bows (HOYT) with lengths ranging from 66" to 70" and draw weights between #34 and #42 lbs were used. Arrows (Easton X10) were selected according to individual anthropometric characteristics, particularly arm length. Shooting performance was assessed in accordance with World Archery standards using indoor target faces (3-spot, 5-ring targets for recurve bow).

Statistical Analysis

All statistical procedures were performed using IBM SPSS Statistics (version 27) following standard analytical practices. The normality of the data distribution was assessed using the Shapiro–Wilk test [28]. Skewness and kurtosis values were also evaluated [29]. Given that the sample size was fewer than 50 participants, the Shapiro–Wilk test was used as the primary criterion for normality assessment, with the level of significance set at $p = .05$ [30]. Skewness and kurtosis values within the range of ± 1.5 were accepted as indicative of normal distribution [29]. Data were screened for potential outliers using standardized z-scores. No extreme values (± 3 SD) were detected. Based on the study design and sample size, paired-samples t-tests were used to compare pretest and posttest measurements. A repeated-measures analysis of variance (ANOVA) was also conducted to account for within-subject variability across multiple sets and to reduce the risk of Type I error. The assumptions of normality and sphericity were evaluated prior

to analysis. Appropriate corrections were applied when necessary. Effect sizes were calculated to assess the magnitude of differences. Cohen's d was interpreted according to conventional thresholds (small: 0.20, medium: 0.50, large: 0.80) [31]. The level of statistical significance for all analyses was set at $p < .05$.

Results

To ensure analytical coherence, a repeated-measures ANOVA was used as the primary statistical approach to evaluate overall performance changes across conditions and sets. Paired-samples t-tests were used as supplementary analyses to examine set-by-set differences. Pretest and posttest performance scores were compared. Descriptive statistics and inferential results are reported, taking into account statistical significance and effect size estimates.

The comparison of shooting performance across test conditions is presented in Table 1.

The comparison of pretest and posttest scores across the 10 sets is presented in Table 1. Posttest scores were generally higher than pretest scores, indicating an overall improvement in shooting performance.

Statistical analysis showed that differences were not significant in several sets, while significant differences were observed in others. The direction of the differences indicated higher posttest values. As illustrated in Figure 2, this pattern was generally consistent across sets, with some variability in the magnitude of change.

The analysis of total mean scores is presented in Table 2. Posttest values were higher than pretest values, indicating an improvement in shooting performance under the caffeine condition. A statistically significant main effect was observed. The reduction in variability in the posttest condition suggests a more consistent performance pattern following caffeine ingestion. Effect size estimates indicate a substantial magnitude of change.

A repeated-measures ANOVA was conducted to examine the effects of condition (pretest vs posttest) and set (1–10) on shooting performance. A significant main effect of condition was observed, indicating improved performance following caffeine supplementation. The main effect of set was not significant after Greenhouse–Geisser correction, suggesting that performance remained relatively stable across sets. The condition \times set interaction was also not significant (Table 3). This indicates that the improvement in performance was consistent across sets and not dependent on specific shooting phases.

Table 1. Comparison of shooting performance across test conditions

Shooting Sets	Test	Mean \pm SD	Md.	r	t	p
Set 1	Pre	6.33 \pm 2.28	-1.41	.296	-2.120	.058
	Post	7.75 \pm 1.45				
Set 2	Pre	5.50 \pm 2.21	-2.01	.167	-2.923	.014
	Post	7.50 \pm 1.28				
Set 3	Pre	6.01 \pm 2.83	-2.52	-.422	-2.682	.021
	Post	8.52 \pm 0.81				
Set 4	Pre	6.63 \pm 1.79	-1.80	.219	-3.541	.005
	Post	8.44 \pm 0.62				
Set 5	Pre	7.13 \pm 1.68	-1.19	-.007	-2.149	.055
	Post	8.33 \pm 0.92				
Set 6	Pre	7.11 \pm 1.64	-1.38	.099	-2.694	.021
	Post	8.50 \pm 0.87				
Set 7	Pre	7.16 \pm 2.10	-1.13	.058	-1.809	.098
	Post	8.30 \pm 0.70				
Set 8	Pre	7.02 \pm 1.45	-1.72	.008	-3.488	.005
	Post	8.72 \pm 0.90				
Set 9	Pre	6.55 \pm 2.08	-2.05	.085	-3.326	.007
	Post	8.61 \pm 0.70				
Set 10	Pre	6.75 \pm 2.23	-1.91	-.189	-2.728	.020
	Post	8.66 \pm 0.61				
Average score (10 sets)	Pre	6.61 \pm 1.20	-1.71	.481	-5.557	< .001
	Post	8.33 \pm 0.39				
Total score (10 sets)	Pre	198.58 \pm 36.09	-51.50			
	Post	250.08 \pm 11.96				

Note. SD – standard deviation; Md. – mean difference; r – effect size (correlation coefficient); t – t-value from paired-samples t-test; p – significance level. Pre – pretest; Post – posttest. Statistical significance was set at $p < .05$.

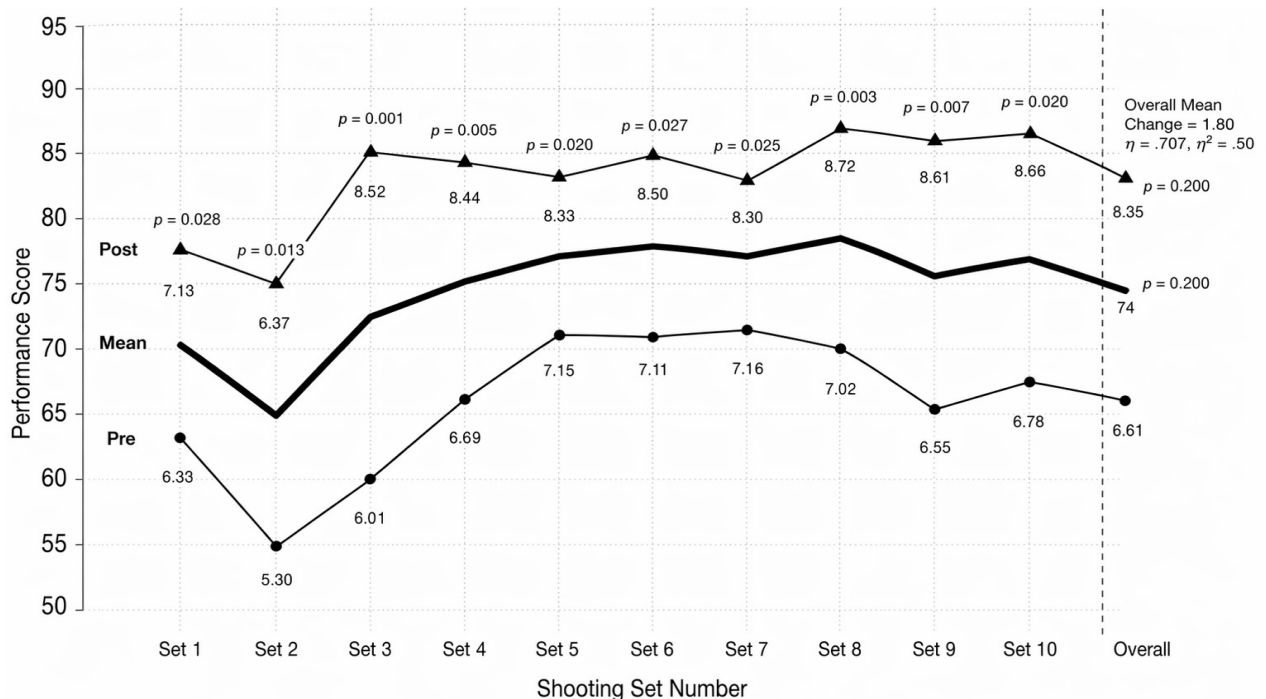


Figure 2. Effects of acute caffeine supplementation on archery performance: a set-by-set pre–post analysis

Table 2. Pre–post differences in shooting performance and associated effect sizes in archery

Test	n	Mean ± SD	F	p	η	η ²	Cohen's d
Pre	12	6.61 ± 1.20	22.01	< .001	.707	.50	1.90
Post		8.33 ± 0.39					

Note. SD – standard deviation; F – F-value from repeated-measures ANOVA; p – significance level; η – effect size (eta); η² – eta squared; Cohen's d – standardized effect size. Pre – pretest (caffeine-free); Post – posttest (caffeine condition). Statistical significance was set at p < .05.

Table 3. Descriptive statistics and repeated-measures ANOVA results for shooting performance

Variable	Pretest (Mean ± SD)	Posttest (Mean ± SD)	F (df)	p	Partial η ²
Condition	6.62 ± 1.20	8.33 ± 0.39	30.88 (1, 11)	< .001	.737
Set (1–10)			2.44 (4.41, 48.51)*	.054	.182
Condition × Set			0.53 (5.71, 62.80)*	.773	.046

Note. SD – standard deviation; F – F-value from repeated-measures ANOVA; df – degrees of freedom; p – significance level; Partial η² – effect size. *Greenhouse–Geisser correction applied. Statistical significance was set at p < .05.

Discussion

In this study, the effects of acute caffeine supplementation on shooting performance in university-level archers were evaluated. The findings indicated higher performance scores under the caffeine condition in both set-based averages and total shooting scores. Effect size estimates indicated a large magnitude of difference [31]. Repeated-measures ANOVA showed a significant main effect of condition, indicating an overall increase in performance. The non-significant condition × set interaction indicates that this effect was consistent across sets.

A review of the literature reveals studies with designs comparable to the present research. Aghadewa and Sumartiningsih investigated the acute effects of coffee containing 2 g/100 mL caffeine at different temperatures on archery shooting performance and concentration. Improvements were reported in both variables regardless of beverage temperature [22]. In contrast, a study examining the effects of 300 mg of caffeine on shooting performance and reaction time in traditional archery found no statistically significant effects of supplementation on either variable [24].

Similarly, in precision-based sports such as rifle shooting, caffeine supplementation at doses of 2 mg/kg and 4 mg/kg did not produce significant changes in shooting performance or reaction time among elite athletes. No significant differences were observed between low-dose caffeine, high-dose caffeine, and placebo conditions (p > .05) [32]. In contrast, a study conducted on female athletes reported that caffeine intake at doses of 3 mg/kg and 6 mg/kg improved reaction time and attention performance. The largest effect was observed at the 3 mg/kg dose. No improvements were observed at a

dose of 9 mg/kg, which was associated with a higher incidence of side effects [23].

These differences may be related to variations in caffeine dosage, participant characteristics, and the cognitive–motor demands of the sport. In precision-based disciplines such as archery, which require fine motor control and sustained attention, the effects of caffeine may differ from those observed in strength- or endurance-based activities.

The potential effects of caffeine on performance are often explained by its action on the central nervous system. As an adenosine receptor antagonist, caffeine may increase neural activation and the release of excitatory neurotransmitters. This may contribute to changes in cognitive processes such as attention and reaction time [5, 11]. However, these mechanisms were not directly measured in the present study. Therefore, their contribution to the observed performance outcomes should be interpreted with caution.

In a study conducted by Doyle et al. [35] with university-level fencers, caffeine ingestion at doses of 4.5–6.0 mg/kg improved reaction time and overall performance. At a dose of 7.5 mg/kg, performance declined. These findings are consistent with a dose-dependent pattern described as an “inverted U-shaped” model. Similarly, Karaalp and Taşkiran [36] reported that supplementation with Turkish coffee providing 7 mg/kg of caffeine over a 6-week period improved anaerobic power, agility, and coordination in male athletes.

In another study, the consumption of 200 mg of caffeine influenced cognitive processing by suppressing EEG delta wave activity following central fatigue. No changes were observed in Taekwondo-specific physical performance [37]. In contrast, Toktaş et al. [38] found that caffeine administered via mouth rinsing did not produce differences in attention or hand–eye coordination.

These findings indicate that the effects of caffeine on sports performance depend on multiple factors. These include the mode of administration, dosage, individual tolerance, sport-specific skill requirements, and the physiological or fatigue state of the athlete.

These findings should be considered in relation to existing literature on caffeine, which has primarily examined endurance and strength-based performance outcomes. The results indicate that caffeine may also be associated with performance changes in precision-oriented sports such as archery, where performance depends on both physical execution and attentional control. The use of a fixed-dose protocol provides an applied perspective, suggesting that moderate caffeine intake may produce consistent effects across repeated trials. Individual variability related to body mass and caffeine sensitivity may influence responses. These aspects contribute to the interpretation of sport-specific effects of caffeine and the role of cognitive and motor factors in performance.

Limitations and Future Research Directions

The study sample consisted of university-level archers, representing a relatively homogeneous group in terms of training background and performance level. This may limit the generalizability of the findings. Subgroup analyses, including sex differences, training experience, and habitual caffeine consumption, were not conducted. The study design did not include a placebo or control condition, randomization, or blinding. These factors may increase susceptibility to learning, repetition, and expectancy effects. The relatively small sample size and the assessment of only acute effects also limit the strength of the conclusions.

Additional factors were not controlled, including habitual caffeine intake, individual tolerance, prior dietary intake, hydration status, and sleep patterns. These variables may have influenced performance outcomes. The use of a fixed caffeine dose does not account for differences in body mass. Participants were limited to recurve archers, which restricts generalization to other archery disciplines. Cognitive and neuromuscular mechanisms were not directly measured, and interpretations related to these factors should be made with caution.

Future studies should include larger and more diverse samples to improve generalizability. Randomized placebo-controlled designs are required to strengthen internal validity. Individualized caffeine dosing strategies based on body mass should be considered. Subgroup analyses based on

sex, training experience, and caffeine habituation are needed. Direct assessment of cognitive and neuromuscular variables would allow a more precise interpretation of underlying mechanisms. These approaches would improve the evaluation of caffeine effects in precision-based sports contexts.

Conclusions

The findings of the present study indicate that caffeine supplementation is associated with improved shooting performance in university-level archers under the tested conditions. Paired comparisons and repeated-measures ANOVA demonstrated an overall increase in performance following caffeine ingestion. Improvements were observed across multiple sets, indicating a consistent effect throughout the shooting series.

These results support the view that caffeine may have a role as an ergogenic aid in precision-oriented target sports that require sustained attention and performance consistency. The findings should be interpreted with caution due to methodological limitations, including the absence of a control condition, lack of randomization, and the relatively small sample size. Cognitive and neuromuscular mechanisms were not directly assessed, and interpretations regarding underlying processes remain indirect.

The present findings should be considered as preliminary evidence rather than confirmation of causality.

Practical Applications

The findings of the present study indicate that caffeine supplementation may be associated with improved shooting performance in archery when consumed approximately 60 minutes prior to activity. These results should be interpreted with caution due to methodological limitations, including the absence of a control condition. Moderate doses (e.g., $\sim 3\text{--}6\text{ mg}\cdot\text{kg}^{-1}$ or $\sim 200\text{ mg}$) may represent a practical intake range. Individual responses may vary. Athletes and coaches are encouraged to evaluate caffeine use in training settings and to consider factors such as individual tolerance, nutritional status, and potential side effects.

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Conflicts of Interest

The authors declare no conflict of interest.

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