

The Impact of Caffeine on Concentration and Performance in Sport Shooting

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Abstract:

This study investigates the effect of caffeine on concentration and performance in the 10 m Air Rifle – Standing position. It focused on measuring total aiming time and performance results under two conditions: without caffeine and after consuming 220 ml of coffee, containing approximately 90 milligrams of caffeine (from 7 g of coffee powder). This method was elected to reflect caffeine intake from coffee while minimizing the risk of unintentional doping violations. Measurements included individual performance assessments and the time taken from aiming to shot release: participants completed 3 sets of 24 shots under the influence of caffeine and 3 sets without caffeine (totaling 864 shots per condition). Thus, we evaluated 864 shots with caffeine and 864 shots without caffeine. The research sample consisted of 12 competitive sport shooters classified in the first and master categories. An ex post facto intra-individual and inter-subject research design was employed to assess differences in mean values of total aiming time with and without caffeine intake. To determine the statistical significance of these differences, the nonparametric Wilcoxon T-test for dependent samples was used. This analysis revealed a significant difference in total aiming time under the influence of caffeine compared to without it. Data were collected using a stopwatch and specialized electronic target systems designed to measure and evaluate shooting performance. The results were recorded in graphs and tables, including graphs showing the individual shot values for visual clarity. The graphs illustrate the difference in the size of shot dispersion with and without caffeine. Based on the individual shot values and their differences across total aiming time, we found an association between caffeine and non-caffeine conditions. A more significant change in total aiming time was observed for shooters who do not normally drink caffeinated coffee. Otherwise, shooting performance values did not change in most shooters. Therefore, the results of this study indicate that caffeine has a highly individual effect on shooting performance and there is no direct impact on shot score values.

Key Words: sport science, air rifle, caffeine effects, muscle tremor, sport performance

Introduction

Caffeine is among the most widely consumed psychoactive stimulants worldwide. It occurs naturally in substances such as coffee, tea, and cocoa, and is also a common additive in energy drinks, gels, and nutritional bars. Owing to its well-documented effects on both physical and cognitive performance, caffeine is widely used by athletes across a broad range of sports disciplines. Its ergogenic effect has been confirmed by studies examining various aspects of physical performance in different sports. However, there are relatively few comparable studies in sport shooting. As indicated by the findings reported in our study, caffeine can have a positive influence on an athlete's shooting performance by enhancing attention, cognitive function, and motor performance; on the other hand, it may also exert a negative impact by increasing heart rate, muscle tremor, postural fluctuation, irritability, headache, and diuretic effects. Regarding anti-doping regulations, previous rules set a limit on the amount of caffeine an athlete could consume prior to competition. Since 2004, however, this restriction has been lifted, though caffeine remains an under-tested substance.

Previous research has demonstrated that acute caffeine supplementation can enhance several aspects of physical performance in team sports, such as increased heart rate, elevated blood glucose levels, and greater movement intensity during match play. However, findings related to technical or fine motor skills remain inconsistent - some studies report no effect or even potential impairments. This underscores the need to investigate caffeine's effects in precision-based sports such as sport shooting, where accuracy and concentration are crucial (Arguedas-Soley, Townsend, Hengist, & Betts, 2022).

High doses of caffeine have also been examined in young elite athletes, with results showing improvements in physical performance measures such as repeated sprint ability and dribbling speed. A randomised, placebo-controlled trial demonstrated that a single 400 mg dose of caffeine administered 60 minutes before intense activity significantly enhanced performance without increasing adverse effects. These results suggest that caffeine may support both endurance and sport-specific skills under certain conditions (Bezuglov, Vakhidov, Morgans, Malyakin, Emanov, Koroleva, Kapralova, & Talibov, 2025).

According to the International Society of Sports Nutrition, caffeine is one of the most effective ergogenic aids for both physical and cognitive performance. When consumed in moderate doses (3–6 mg/kg body mass), it

can improve muscular endurance, strength, sprinting ability, and aerobic capacity. In addition, caffeine enhances attention and vigilance, which may be particularly relevant in sports that require sustained concentration, such as sport shooting. However, responses vary according to individual sensitivity, genetic factors, and habitual caffeine use (Guest, VanDusseldorp, Nelson, Grgic, Schoenfeld, Jenkins, Arent, Antonio. Stout, Trexler, Smith-Ryan, Goldstein, Kalman, & Campbell, 2021).

In the field of sports nutrition, Clarková (2020) described caffeine as one of the most researched and widely used supplements owing to its stimulatory effects on the central nervous system. According to Clarková (2020), its capacity to reduce perceived exertion and enhance focus makes it popular among athletes, although its effects may vary depending on individual sensitivity and sport-specific demands.

Sport shooting encompasses several disciplines, which are categorised by the type of weapon and the shooter's starting position. For our research, we selected the final round of the standing air rifle discipline, which comprises 24 competitive shots. This discipline is one of the primary rifle events and is statistically the most widely practised among sport shooters. It is also among the most demanding. Due to the aforementioned starting position, standing is the least stable and the most susceptible to various influences. All disciplines in sport shooting are governed by the rules of the International Shooting Sport Federation (ISSF) (2022), which sets out the specific rules for each discipline; our research was conducted in accordance with these regulations. The performance of a sport shooter is determined by a multitude of factors, the optimal combination of which produces elite results. Among the most influential are postural stability and the psychological state of the shooter (Vadovičová, 2023).

Performance levels in sport shooting continue to improve globally, highlighting the necessity for ongoing education and the integration of new knowledge into training processes. This continuing development is essential not only for coaches but also for dedicated athletes who seek to deepen their understanding and enhance their performance. Success in shooting sports results from a complex interplay of ideomotor, technical, tactical, psychological, and discipline-specific factors, all of which require long-term, structured preparation. In air rifle events, where results depend largely on shooting accuracy, the quality of sporting equipment and accessories is also critical (Červenka, 2019).

Research has demonstrated that performance-related anxiety and mental fatigue can negatively affect the consistency and accuracy of air rifle shooters. The combined cognitive load arising from stress and fatigue leads to fluctuations in attention and motor execution, ultimately diminishing performance. These findings underline the importance of psychological resilience and mental freshness in precision sports (Ghosh, Das, Chowdhury, Banerjee, & Gangopadhyay, 2022). Elite shooters must master the core technical and mechanical actions, such as body positioning, stance control, reloading, breath regulation, and trigger execution, at a subconscious level. These actions must be performed consistently to form a stable motor pattern. Maintaining a high degree of concentration and attentional control is essential for sustaining postural stability and precise aiming during competition (Brych, 2008).

As Cinko (1979) notes, achieving peak performance in sport shooting requires several key elements: maximum stability of both shooter and weapon, fine neuromuscular coordination during shot execution, complete automatization of technical skills, and exceptional mental focus.

A systematic review of Olympic air rifle and small-bore shooting identified multiple factors influencing performance, including technical skill, stability, psychological state, and environmental conditions. The authors emphasised that consistent, high-level shooting depends not only on physical preparation but also on precise motor control and mental focus—both of which may be affected by substances such as caffeine (Spancken, Steingrebe, & Stein, 2021). From a psychological perspective, sports performance is heavily influenced by mental readiness, emotional regulation, and concentration. According to Gregor (2013), optimal focus and psychological balance are essential in sports where precision and control are critical, such as sport shooting. Distractions, anxiety, or fluctuations in mental state can significantly impair outcomes (Gregor, 2013).

The aim of this work is to introduce new insights and contribute to the ongoing development of sport shooting as a high-performance discipline.

Material & methods

The aim was to investigate the effect of caffeine on sports performance in an observational cohort of shooters competing in the 10m Air Rifle – standing position discipline. We hypothesised a statistically significant negative relationship between caffeine intake and the point value of shooting performance. We also hypothesised a statistically significant difference in total aiming time, predicting that shooters' total aiming time with caffeine would be longer than without caffeine. The objective of the study was to process and evaluate the data on total aiming time using special electronic target devices (SCATT) and to determine the potential negative impact of caffeine on the resulting point value, reflecting sports shooting performance.

Krawczyk-Suszek (2022) states that postural stability plays a critical role in shooting accuracy, particularly when firing from a standing position. A randomised controlled trial found that physical exertion prior to shooting significantly increased centre of pressure movement, suggesting reduced balance and potential performance decline. These findings emphasise how fatigue can negatively influence fine motor tasks such as precision shooting.

In a comprehensive doctoral dissertation, technical aspects such as rifle stability, aiming accuracy, and trigger control were identified as key determinants of performance in competitive rifle shooting. The findings highlight that even minimal disturbances in postural control or timing can significantly impact shooting outcomes, underscoring the high demand for precision and consistency in this sport (Ihalainen, 2018).

We used an ex post facto research design. In the created research situation VS (12) (S1–S4) to, there is a selection of probands (V12) in which we monitored: S1 – average total aiming time with caffeine effect; S2 – average total aiming time without caffeine effect; S3 – shooting performance achieved with caffeine effect; S4 – shooting performance without caffeine effect at time t_0 (Jan - Mar 2023). The group consisted of 12 selected sports shooters (7 male / 5 female) in the first class and championship performance class category, aged 20 - 52 years. All shooters had won at least one Slovak championship title during a minimum eight-year sports career.

Table 1 Basic statistical characteristics

	Body height [cm]	Body weight [kg]	Decimal age [years]	Sports activity [years]
Average	173.5	74.8	33.1	13.8
Maximum value	185	88	52	31
Minimum value	145	60	20	8
Variation margin	40	28	32	23

Recording of study data took place during a three-month training cycle (Jan - Mar 2023). During this period, we measured total aiming time, defined as the interval from the start of aiming at the target to the moment of releasing the shot, and on that basis recorded the resulting point value of each shot. Each shooter then fired 24 competitive shots in accordance with international shooting rules of the ISSF (International Shooting Sport Federation) for the final competition of 10m Air Rifle (4.5 mm / .177 cal) – standing position. The measurements were performed under predetermined conditions: three times without the influence of caffeine and three times under the influence of caffeine, contained in a coffee drink, on each examined shooter individually on separate days.

Upon the command to proceed to the firing line, the athlete assumes position with the air rifle and all required shooting equipment, including the shooting jacket, trousers, footwear, glove, belt, and rifle stand. A preparation period of 15 minutes is provided, during which the athlete may adopt the firing position, conduct position-specific stabilisation exercises, simulate shooting actions, and engage in muscle activation routines without live firing. Following the conclusion of this period, the athlete is granted an additional 15 minutes for sighting shots, in accordance with ISSF rules and regulations (International Shooting Sport Federation, 2022).

Following a total of 30 minutes of preparation, the final round begins, consisting of 24 shots, each with a time limit of 50 seconds. The countdown for each shot is initiated by the Chief Referee's command "Start" and concludes with the command "Stop". If a shooter fails to fire within the allotted 50 seconds, the shot is scored as zero. Time updates are announced during each shot interval with the commands "10 seconds left" and "5 seconds left" (Slovenský strelecký zväz, 2017).

All shooting activities must be carried out in strict accordance with safety regulations and firearm handling procedures. Upon completion, the shooter is required to unload the weapon and secure it by inserting a protective nylon safety device into the barrel. The Chief Referee is responsible for verifying the safety status of all firearms at each shooting station (Slovenský strelecký zväz, 2017).

The maximum possible score in the final is 261.6 points, calculated as the sum of 24 shots, with each shot carrying a maximum value of 10.9 points (International Shooting Sport Federation, 2022).

To evaluate and process the results, we used basic statistical characteristics. During the intra-individual and inter-subject ex post facto research, we determined the significance of differences in mean values between total measured aiming times with and without the caffeine dose using the non-parametric statistical method, the Wilcoxon T-test for dependent samples. The statistical significance of mean value differences was assessed at the level of statistical significance ($p \leq 0.05$) and ($p \leq 0.01$). Data were obtained using a stopwatch and special electronic target devices (SCATT) to evaluate the point performance of shooting activities. The collected data were subjected to logical analysis and synthesis, followed by interpretation leading to the formulation of conclusions and findings. Chráska (2007) emphasises that a well-structured experimental design and appropriate data analysis are key to drawing meaningful conclusions, particularly in applied fields such as sports science.

Results

The monitored outcomes are presented in Tables 1 - 7 and Figures 1 - 5. Analysis of the selected variables indicates relatively consistent performance among the shooters. Table 2 provides the mean values of specific factors observed in the 10m Air Rifle discipline, based on the results of three final competitions for each participant.

Tables 3 - 7 compare the average values recorded for individual shooters during the three-month training cycle (January–March 2023). The average shooting time (AST) per shot with caffeine among the probands ranged from 12.5 (S11) to 19.0 (S7) seconds, while the average shooting time without caffeine ranged from 9.3

(S1) to 17.1 (S7) seconds. Regarding the second factor - the shooting performance of the probands - the average total sports performance (SP) for 24 competition shots with caffeine ranged from 239.3 (S5) to 248.3 (S7) points, and the average sports performance without caffeine ranged from 240.0 (S4) to 250.2 (S7) points. The data indicate that all shooters remained within the time limits prescribed by ISSF regulations.

With respect to average shooting time and overall performance after the completion of three final competitions, the group exhibited relatively consistent results. To provide a more in-depth perspective, a detailed analysis is presented for five selected shooters from the total sample of twelve. Specifically, Shooter 1 (S1), who had the lowest average shooting time without caffeine; Shooter 4 (S4), who achieved a score similar to the average across three competitions; Shooter 6 (S6), who displayed proportional differences in the measured factors within the predicted variances; Shooter 11 (S11), who was affected by the opposite effect of caffeine on sports performance; and Shooter 12 (S12), who had the largest difference in sports performance with and without the influence of caffeine (see Table 2).

Table 2 Mean values of selected factors for shooters after three final competitions in the 10m Air Rifle

Shooters	AST per shot with caffeine [seconds]	AST per shot without caffeine [seconds]	SP with caffeine [points]	SP without caffeine [points]
S1	15.4	9.3	245.7	246.1
S2	13.5	12.9	247.6	247.7
S3	13.3	12.5	246.5	246.5
S4	12.7	10.8	240.0	240.0
S5	14.1	12.5	239.3	241.2
S6	18.7	16.0	241.9	242.6
S7	19.0	17.1	248.3	250.2
S8	12.6	11.7	247.4	246.6
S9	15.5	13.4	246.5	246.6
S10	16.3	12.3	246.0	247.0
S11	12.5	10.9	246.1	245.5
S12	12.7	11.4	243.9	246.1

*S1-12 – Shooter proband number

*AST – Average shooting time

*SP – Sport performance

An evaluation of the performance record sheets for shooters S1, S4, S6, S11, and S12 provided detailed data on individual performance factors, as presented in Tables 3 – 7.

SHOOTER 1

S1 has participated in the sport for 25 years. His maximum final score during measurement in this discipline was 247.3 points. (Table 3) He trains five times a week and does not drink caffeinated coffee at all; he himself reports that caffeine has a negative effect on him. It does not improve his concentration or mood.

Table 3 Individual Shooter 1 – Factor Data

Shooter 1	AST per shot with caffeine [seconds]	AST per shot without caffeine [seconds]	SP with caffeine [points]	SP without caffeine [points]
x	15.4	9.3	245.7	246.1
s	2.4	1.9	0.9	0.1
Xmax	23.0	14.0	246.7	247.3
Xmin	10.0	6.0	245.1	245.4
Vr	13.0	8.0	1.6	1.9

The average performance of S1 was 245.7 points with caffeine and 246.1 points without caffeine. For this shooter, performance without caffeine was 0.18% higher than with caffeine. S1 showed the largest difference in aiming time across all measurements among the shooters. His average aiming time with caffeine was 15.4 seconds, while the average aiming time without caffeine was 9.3 seconds, forming the greatest average difference - 6.1 seconds or 39.57% - among the studied shooters. The minimum aiming time without caffeine was 6 seconds, and the maximum with caffeine was 23 seconds. (Fig. 1).

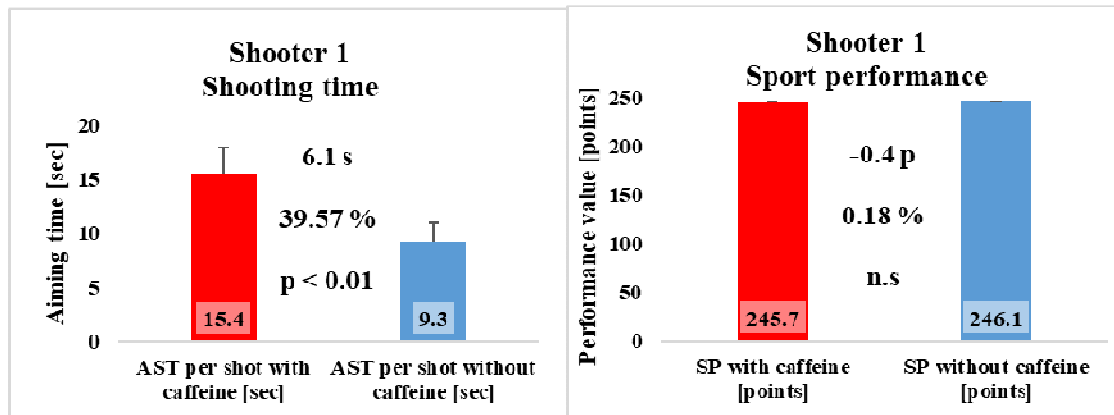


Fig. 1 Selected factors (with and without caffeine) in relation to shooting time and sports performance for S1

S1 exhibited the greatest difference in aiming time among the shooters tested. Therefore, although there was not a significant difference in performance, caffeine had a negative effect on this proband in terms of concentration, specifically by increasing overall aiming time.

SHOOTER 4

S4 has been involved in sport shooting for 13 years. His maximum final performance in the measurement is 241.3 points (Table 4), and he trains twice a week. He drinks coffee for its taste and to overcome fatigue twice a day, including in the morning before competitions. He reports that he does not consciously experience its effect on concentration or any other negative impact, and he also often drinks other caffeinated beverages.

Table 4 Individual Shooter 4 – Factor Data

Shooter 4	AST per shot with caffeine [seconds]	AST per shot without caffeine [seconds]	SP with caffeine [points]	SP without caffeine [points]
x	12.7	10.8	240.0	240.0
s	2.4	2.1	0.7	1.3
Xmax	19.0	15.0	240.8	241.3
Xmin	9.0	6.0	239.4	238.8
Vr	10.0	9.0	1.4	2.5

The average performance of this shooter was balanced under both conditions, scoring 240.0 points in each research situation. Both the lowest and highest performance values were achieved by this shooter without caffeine. S4's average aiming time was 12.7 seconds with caffeine and 10.8 seconds without caffeine, a difference of 1.8 seconds or 14.34%. The minimum aiming time of 6 seconds was without caffeine, and the maximum aiming time of 19 seconds was under the influence of caffeine (Fig. 2).

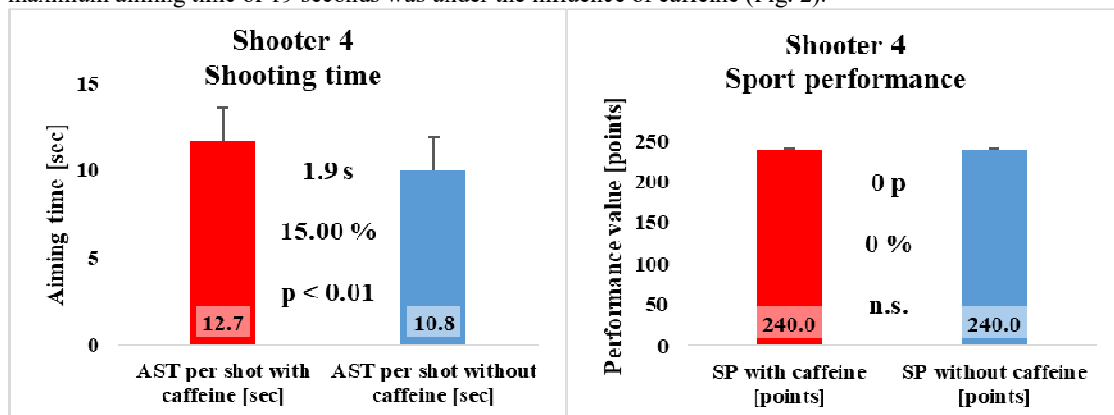


Fig. 2 Selected factors (with and without caffeine) in relation to shooting time and sports performance for S4

For S4, as a daily coffee drinker, there was no significant difference between the means of the measured values. Differences were mainly evident in the times for individual shots.

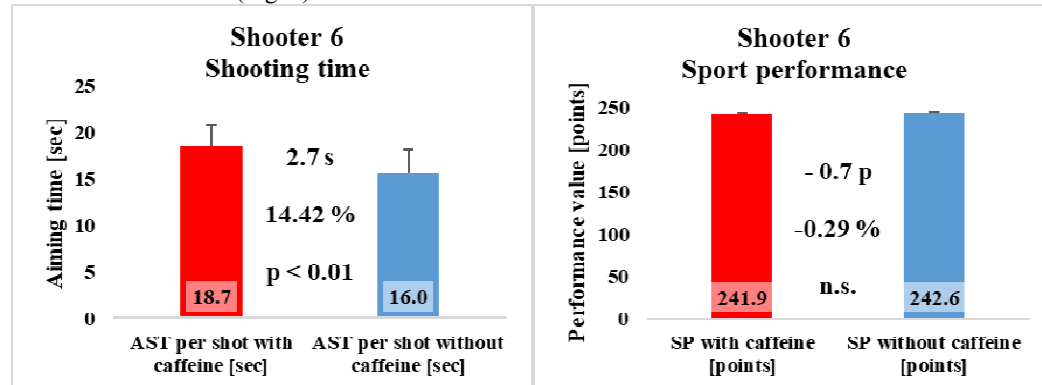
SHOOTER 6

S6 has been shooting for 12 years and trains four times a week. His maximum score in the measurement was 244.3 points (Table 5). He drinks coffee twice a day and always before competitions. He reports that coffee improves his concentration and mood, and he does not perceive any negative effects.

Table 5 Individual Shooter 6 – Factor Data

Shooter 6	AST per shot with caffeine [seconds]	AST per shot without caffeine [seconds]	SP with caffeine [points]	SP without caffeine [points]
x	18.7	16.0	241.9	242.6
s	2.3	2.6	0.9	1.7
Xmax	24.0	24.0	242.6	244.3
Xmin	14.0	11.0	240.9	240.9
Vr	10.0	13.0	1.7	3.4

The average performance of this shooter under the influence of caffeine was 241.9 points, compared to 242.6 points without caffeine—a difference of 0.7 points or -0.29%. The shooter's average aiming time with caffeine was 18.7 seconds; without caffeine, it was 16.0 seconds, a difference of 2.7 seconds or 14.42%. The shortest recorded aiming time without caffeine was 11 seconds, and the longest aiming time—24 seconds—was observed under both conditions (Fig. 3).

**Fig. 3** Selected factors (with and without caffeine) in relation to shooting time and sports performance for S6

For S6, there was no substantial difference in results. However, a slight time lag was recorded for this shooter under the influence of caffeine, with even individual shots being fired after a longer aiming time compared to those without caffeine.

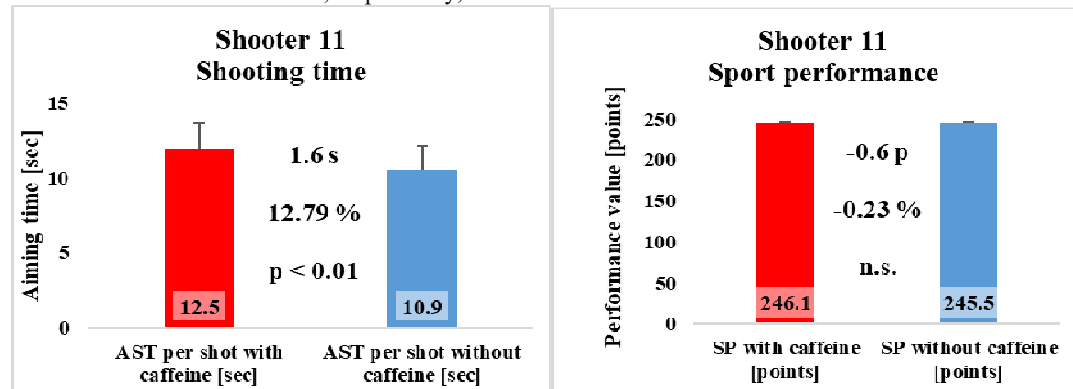
SHOOTER 11

S11 has practised this sport for eight years and trains twice a week. His maximum final score in the measurements was 246.9 points (Table 6). He drinks coffee twice a day out of habit, to overcome fatigue, and for its taste. He drinks the first coffee in the morning and the second before a competition or training. He states that coffee improves his concentration and mood and reports no negative effects of caffeine.

Table 6 Individual Shooter 11 – Factor Data

Shooter 11	AST per shot with caffeine [seconds]	AST per shot without caffeine [seconds]	SP with caffeine [points]	SP without caffeine [points]
x	12.5	10.9	246.1	245.5
s	1.8	1.7	1.1	1.4
Xmax	17.0	17.0	246.9	246.5
Xmin	9.0	7.0	244.9	243.9
Vr	8.0	10.0	2.0	2.6

The caffeinated and decaffeinated performance scores for S11 were 246.1 and 245.5 points, respectively—a difference of 0.6 points or 0.23%. The mean aiming time was 12.5 seconds with caffeine and 10.9 seconds without caffeine, a difference of 1.6 seconds or 12.79%. The minimum and maximum aiming times were 7 seconds and 17 seconds, respectively, without caffeine.

**Fig. 4** Selected factors (with and without caffeine) in relation to shooting time and sports performance for S11
S11, a regular coffee drinker, showed no significant differences in either score or aiming time.

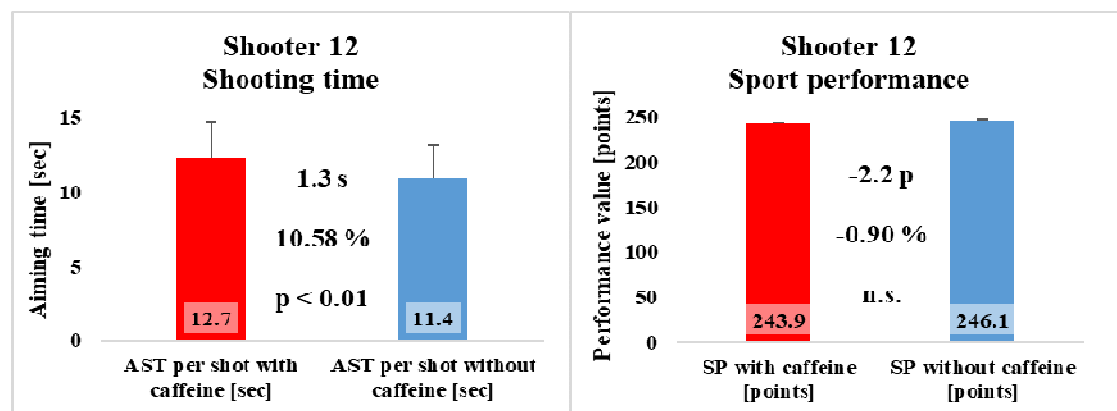
SHOOTER 12

S12 has been shooting for seven years and trains twice a week. The maximum final score for this shooter is 247.5 points (Table 7). He drinks coffee twice a day out of habit, to overcome fatigue, and for its taste. He also drinks coffee in the morning before each competition. S12 reports that coffee has a positive effect and does not cause him any negative effects.

Table 7 Individual Shooter 12 – Factor Data

Shooter 12	AST per shot with caffeine [seconds]	AST per shot without caffeine [seconds]	SP with caffeine [points]	SP without caffeine [points]
x	12.7	11.4	243.9	246.1
s	2.3	2.3	0.3	1.2
Xmax	19.0	22.0	244.2	247.5
Xmin	6.0	8.0	243.6	245.2
Vr	17.0	14.0	0.6	2.3

The average performance for this shooter with caffeine was 243.9 points, compared to 246.1 points without caffeine - a difference of -2.2 points or -0.90%. The average aiming time with caffeine was 12.7 seconds, and without caffeine it was 11.4 seconds, a 10.58% increase. The minimum aiming time with caffeine was 2 seconds, which, given the unusually short duration, was likely the result of an unintentional shot due to shooter error, possibly skewing the measurement. The longest aiming time with caffeine was 22 seconds (Fig. 5).

**Fig. 5** Selected factors (with and without caffeine) in relation to shooting time and sports performance for S12

S12 achieved a slightly higher average score without caffeine; however, no substantial difference was observed in the average aiming time. The single shot fired within 2 seconds can be considered an error due to shooter negligence. As there was only one such error, it cannot be attributed to caffeine.

In precision sports such as air rifle shooting, psychological and physiological states are crucial to performance. Research has shown that poor sleep quality and negative mood states are associated with decreased shooting scores among elite shooters. These findings underscore the importance of cognitive stability and emotional regulation for optimal performance in tasks requiring sustained focus and fine motor control (Lu, An, & Qiu, 2022).

Discussion

The study demonstrates that the impact of caffeine on shooting performance and aiming time in the 10m Air Rifle discipline varies considerably among shooters. The average shooting time with caffeine ranged from 12.5 to 19.0 seconds, compared with 9.3 to 17.1 seconds without caffeine (Table 2). Sports performance scores with caffeine ranged from 239.3 to 248.3 points (Table 2), while scores without caffeine ranged from 240.0 to 250.2 points (Table 2). Detailed analysis of selected shooters revealed diverse responses: S1 (Fig. 1), who does not consume caffeine, exhibited the greatest increase in aiming time with caffeine (6.1 seconds), suggesting a negative impact on concentration, though the difference in performance was minimal (Fig. 1). S4 (Fig. 2), a habitual coffee drinker, showed consistent performance with and without caffeine, with only minor changes in aiming time (1.9 seconds). S6 (Fig. 3) experienced a slight decrease in performance and an increase in aiming time with caffeine, indicating a possible minor negative effect on concentration. S11 (Fig. 4), also a regular coffee drinker, exhibited negligible differences in both performance and aiming time, suggesting minimal impact from caffeine. S12 (Fig. 5) recorded a slight decrease in performance and a minor increase in aiming time with caffeine, with an outlier shot likely due to error rather than the influence of caffeine.

A recent systematic review summarised the immediate effects of caffeine on athletic performance, confirming its overall ergogenic potential across various sports. The review emphasised that caffeine intake can lead to improvements in reaction time, endurance, and focus; however, its effects are influenced by factors such as dosage, timing, individual variability, and type of sport, particularly in tasks requiring precision and control (Lu, & Wang, 2025).

A comprehensive review of caffeine's effects across cognitive, physical, and occupational domains confirmed its ability to enhance alertness, attention, and reaction time—especially in situations involving fatigue or sleep deprivation. However, the authors also noted that individual responses vary, and that overstimulation may impair performance in tasks requiring fine motor control and precision (McLellan, Caldwell, & Lieberman 2016).

A recent meta-analysis confirmed that caffeine intake has a significant positive effect on endurance running performance and time to exhaustion. The ergogenic effect was most notable when caffeine was consumed in moderate doses (3–6 mg/kg) before exercise. These findings reinforce caffeine's role in enhancing sustained physical performance, although its impact may differ depending on the nature of the task (Wang, Qiu, Gao, & Del Coso, 2022).

Caffeine has been described as a substance with both beneficial and potentially adverse effects on the human body. While it can enhance alertness, mood, and physical performance, its impact varies depending on dose, individual sensitivity, and frequency of use. The authors emphasize that caffeine should be used with awareness of possible negative outcomes, particularly when taken in high doses or by individuals with heightened sensitivity (Rodak, Kokot, & Kratz, 2021).

A study on caffeine's effects in a military shooting context found that while caffeine improved target detection and alertness, it did not significantly enhance rifle marksmanship accuracy. This suggests that although caffeine may benefit vigilance, its influence on precision shooting remains limited when fine motor control is essential (Gillingham, Keefe, Keillor, & Tikuisis, 2003).

A systematic review examining the effects of caffeine on marksmanship revealed mixed results. Some studies reported improved reaction time and sustained attention, while others found no significant enhancement in shooting accuracy. These findings suggest that although caffeine may support cognitive alertness, its influence on precision in marksmanship tasks remains inconclusive and context-dependent (Torres & Kim, 2019).

A study examining various caffeine doses found that while moderate intake had no significant effect on shooting accuracy, higher doses were associated with elevated cardiovascular responses, such as increased heart rate, which may impair shooting precision. These results suggest that the physiological arousal induced by caffeine can counteract its potential benefits in fine-motor sports such as shooting (Ebrahimi, Pordanjani, & Ahmadabadi, 2015).

A controlled study investigating the effects of caffeine on competitive rifle shooting found no significant improvement in shooting performance following caffeine ingestion. Although caffeine is known to enhance alertness, the study suggests that its stimulating effects may not necessarily translate into better accuracy in precision-based sports, possibly due to increased physiological arousal or hand tremors (Nygaard, Riksaasen, Hjelmevoll, & Wold, 2019).

The findings of our study indicate that caffeine's effects on performance are highly individual, with habitual users showing minimal changes, while others may experience increased aiming times and slight performance variations. Further research is needed to establish individualized caffeine intake guidelines for competitive shooters, with the aim of optimising performance outcomes.

Conclusion

The objective of this study was to examine the effects of caffeine on athletic performance within an observational cohort of athletes competing in the 10m Air Rifle discipline, specifically in the standing position. The group consisted of 12 selected sports shooters (7 male / 5 female) in the first master class category, with a mean age of 33.1 years. All participants had been actively engaged in sport shooting for a minimum of eight years.

In Hypothesis 1, we anticipated a statistically significant negative relationship between caffeine intake and shooting performance score. In Hypothesis 2, we predicted that total aiming time under the influence of caffeine would be longer than without caffeine. Our research did not confirm Hypothesis 1, as two shooters demonstrated a slight increase in rifle shooting accuracy in the standing position under the influence of caffeine, and two had identical results in both conditions. Conversely, eight shooters recorded slightly lower scores with caffeine; of these, four habitual coffee drinkers had significantly lower scores under the influence of caffeine than without. We advise shooters to consider their caffeine intake prior to shooting and to monitor this factor during training sessions. The second finding of our study was that aiming time increased in all shooters studied. We confirmed Hypothesis 2, with particularly large differences observed among shooters who do not normally drink caffeinated coffee.

In conclusion, our study indicates that caffeine has a greater effect on aiming time than on the performance score of this sample of sports shooters, and that caffeine primarily influences concentration. This leads to the next area of investigation—the impact of caffeine on vision impairment. We acknowledge the limited sample size in our study; further research is necessary to validate these findings.

Conflicts of interest

The authors declare no conflicts of interest.

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