The Acute Effects of Caffeine Consumption on Muscle Performance of a 1 Rep Max Bench Press Exercise: A Critically Appraised Topic

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Abstract

Background: Caffeine supplementation has become popular in sports settings with the assumption that caffeine causes acute effects to improve muscle performance. Currently there is a wide variety of clinical studies based off this assumption. With the focus of these studies being on a strength-based population, it is important to recognize what the studies are concluding. **Methods**: Using SPORTDiscus, CINAHL Plus, and MedLine Ultimate 144 studies were retrieved and 3 of those were included. The PEDRO scale was then used to determine the validity of each study. **Results:** The studies concluded that there may be a positive acute effect of caffeine on muscle performance when ingesting a 3mg/kg/bm or 6mg/kg/bm dose of caffeine prior to working out. **Conclusions:** In events where maximal strength or power are needed, a caffeine dose intake of either 3mg/kg/bm or 6mg/kg/bm might be beneficial to active individuals.

Clinical Scenario

Caffeine supplementation has become popular in sports settings with the assumption that caffeine causes acute effects to improve muscle performance. Caffeine is widely consumed across sports and exercise for its reputed ergogenic properties, including central nervous stimulation and enhanced muscular force development.[1] A mass variety of clinical studies have focused on the expectancy and physiological significance caffeine causes in the active population with results ranging from no effect at all to slight improvement among exercises which ultimately leaves clinicians wondering what the true effect within the human body is. Specifically in the anaerobic-focused population, there has been an increase in the use of caffeinated supplements to improve the output of performance.[2] Recent studies on caffeinated supplements have shown an increase in the number of successful repetitions during resistance training, greater peak power, increased choice reaction time, increased lower body muscular endurance, and reduced fatigue, along with an increase in perceived alertness, focus, and energy levels.[3] Within the active population, most studies of caffeine consumption have primarily centered the attention on the effects that occur in endurance athletes which leads to the question of how caffeine reacts to anaerobic-specific activities and specifically with a one rep max of a bench press.

Summary of Search Strategy

An extensive online search was conducted in October 2023, the results of the search are shown in Figure 1.

***Terms used to Guide Search Strategy*:**
Patient/Client Group: Athletes
Intervention/Assessment: Caffeine intake or caffeine use or caffeine consumption
Comparison: Power output or force or strength or power
Outcome: Effects on bench one rep max

***Inclusion Criteria*:**
- Studies that were written in English and in the last 10 years
- Studies that included muscular strength
- Inclusion of bench press exercise
- Involved with caffeine

***Exclusion Criteria*:**
- Studies that included non-active participants
- Studies that included participants that suffered an injury
- Patients who took medications, dietary supplements, and/or ergogenic aids that could potentially affect the outcome of the study
- Patients who were unable to perform the exercise protocol at the maximal effort

Table 1 Characteristics of Included Studies

	Grgic et al.[3]	Filip-Stachnik et al.[4]	Wilk et al.[5]
Title	Caffeine ingestion acutely enhances muscular strength and power but not muscular endurance in resistance-trained men	The effects of different doses of caffeine on maximal strength and strength-endurance in women habituated to caffeine	Acute Caffeine Intake Enhances Mean Power Output and Bar Velocity during the Bench Press Throw in Athletes Habituated to Caffeine
Study Design	Randomized, Double Crossed-Over Study	Randomized, Double Crossed-Over Study	A randomized, double-blind, PLAC-controlled crossover design
Participants	Twenty resistance-trained men aged 18–45 years	Twenty-one healthy and strength-trained females (23.0 ± 0.9 years, body mass: 59.0 ± 6.6 kg)	Twelve healthy strength-trained male athletes (age: 25.3 ± 1.7 years., body mass: 88.4 ± 16.5 kg, body mass index (BMI)
Inclusion and Exclusion Criteria	Inclusion: free from neuromuscular and musculoskeletal disorders, aged 18–45 years; (b) the participants were able to perform successful back squat and bench press exercises with load corresponding to 125% and 100% of their current body mass, respectively; and (c) the participants had a minimum of 12 months of experience in resistance training and were actively involved in resistance training at least 3 times per week over the last 6 months. Exclusion: suffered from any pathology or injury or if they were using any medications, dietary supplements or ergogenic aids which could potentially affect the study outcomes	Inclusion: free from neuromuscular and musculoskeletal disorders, (b) habitual daily CAF intake ≥ 3 mg/kg/bm/day [Citation41] (c) minimum 2 years of resistance training experience (to avoid the potential interference of the learning effect of the bench press exercise technique on the results of the investigation) and participation in resistance training at least 3 days per week for the 6-month prior to enrollment in this study Exclusion: suffered from any pathology or injury or if they were using any medications, dietary supplements or ergogenic aids which could potentially affect the study outcomes	Inclusion: free from neuromuscular and musculoskeletal disorders, (b) 1 RM bench press performance with a load of at least 120% body mass, (c) habitual CAF intake in the range of 4–6 mg/day/kg/b.m Exclusion: suffered from any pathology or injury or when they were unable to perform the exercise protocol at the maximum effort.
Interventions Investigated	Examine the effects of anhydrous caffeine ingestion (6 mg kg−1) on muscular strength and power, muscular endurance, rating of perceived exertion (RPE), and pain perception (PP) in resistance-trained men. Caffeine intake would enhance muscular strength and power as well as muscular endurance, and reduce RPE and PP.	Assess the acute effects of different doses of CAF (3 and 6 mg/kg/b.m.) on maximal strength (1RM) and local strength-endurance during the bench press exercise in women habituated to CAF.	Each participant performed three identical experimental sessions 60 min after the intake of a placebo, 3, and 6 mg/kg/b.m. of caffeine. In each experimental session, the participants performed 5 sets of 2 repetitions of the bench press throw (with a load equivalent to 30% repetition maximum (RM), measured in a familiarization trial) on a Smith machine, while bar velocity and power output were registered with a rotatory encoder.
Outcomes Measures	A 5-min rest interval was employed between performance tests. A series of one-way repeated measures analysis of variance (ANOVA), provided in a computer software SPSS version 20 (Chicago, IL, USA), was used to compare the differences between conditions (caffeine, placebo) for all measures. Other measures included vertical jump, seated medicine ball throw, 1 RM back squat, Back squat repetition until failure, 1 RM bench press, and bench press until failure.	Each participant performed three experimental sessions after ingesting either a placebo (PLAC) or 3 mg/kg/b.m. (CAF-3) and 6 mg/kg/b.m. (CAF-6) of caffeine. In each experimental session, the participants underwent a 1RM test and a strength-endurance test at 50 %1RM in the bench press exercise. Maximal load was measured in the 1RM test and the time under tension, number of preformed repetitions, power output and bar velocity were registered in the strength-endurance test.	Participants performed a familiarization session with the experimental protocols that included a 1 RM measurement for the bench press exercise. Afterwards, they performed 3 different experimental sessions with a one-week interval between sessions to allow for complete recovery and a wash-out of ingested substances. During the 3 experimental sessions, the study participants either ingested a PLAC, 3 mg/kg/b.m. of CAF (CAF-3) or 6 mg/kg/b.m. of CAF (CAF-6). One hour after ingestion of CAF or PLAC, they performed 5 sets of 2 repetitions of the BPT exercise at 30% 1 RM. Both CAF and PLAC were administered orally to allow for peak blood CAF concentration during the training session and at least 2 h after the last meal to avoid any interference of the diet with the absorption of the experimental substances. CAF supplementation was provided to participants in the form of unidentifiable capsules (Caffeine Kick®, Olimp Laboratories, Debica, Poland).
Main Findings	6 mg kg−1 of caffeine acutely enhances lower- but not upper-body strength in resistance-trained men. Findings indicating enhanced strength performance following caffeine ingestion are in contrast with the current data.	Compared to the ingestion of PLAC, the acute intake of CAF-3 and CAF-6 provided an ergogenic effect on the 1RM bench press performance. There was also a significant increase in 1RM values when comparing CAF-6 to CAF-3 ($p < 0.01$), suggesting a dose-response effect of caffeine on maximal strength in women habituated to caffeine.	Acute CAF intake has a positive effect on MP and MV during a training session of the BPT performed at 30% 1 RM. Interestingly, both 3 and 6 mg/kg/bm. doses of CAF had similar effectiveness in enhancing performance when compared to PLAC. Additionally, the ergogenic effect of CAF on MP and MV was evident in most of participants, as all of them responded by improving performance with either CAF-3 or CAF-6, even when they were cataloged as individuals habituated to CAF.
Level of Evidence	Level 1	Level 1	Level 1
Conclusion	May be suggested that trained individuals competing in events in which maximal strength and power are important performance-related factors (e.g., powerlifting, strongman, weightlifting, etc.) might consider taking 6 mg kg−1 of caffeine pre-training/competition for performance enhancement.	An acute dose of CAF between 3 and 6 mg/kg ingested 60 min before resistance exercise increased 1RM strength and TUT during the bench press exercise performed to concentric failure with 50 % 1RM in females habituated to CAF. In contrast, no significant changes were observed in the number of performed REP, power output and bar velocity during the strength-endurance test at 50 % of 1RM.	The acute doses of caffeine before resistance exercise may increase mean power output and mean bar velocity during the bench press throw training session in a group of habitual caffeine users. Thus, caffeine prior to ballistic exercises enhances performance during a power-specific resistance training session.

Abbreviations: CAF, caffeine; PLAC, placebo; RM, rep max; TUT, time under tension; MP, mean power output; MV, mean bar velocity

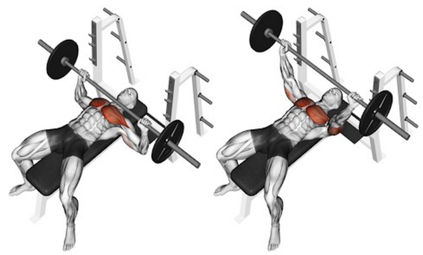
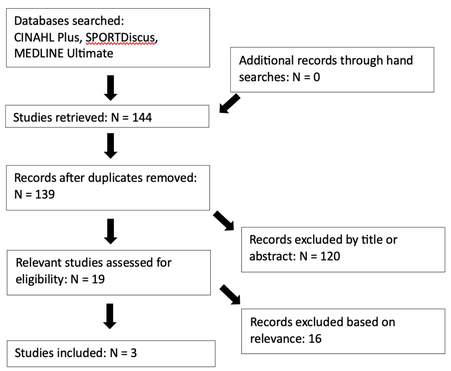


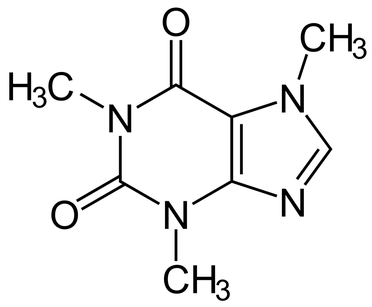
Table 2: Results of PEDro Scale for Each Article

	Grgic et al.[3]	Filip-Stachnik et al.[4]	Wilk et al.[5]
1.Eligibility criteria specified (yes/no)	yes	yes	yes
2. Subjects randomly allocated to groups (yes/no)	yes	yes	yes
3. Allocation was concealed (yes/no)	no	no	no
4. Groups similar at baseline (yes/no)	yes	yes	yes
5. Subjects were blinded to group (yes/no)	yes	yes	yes
6. Therapists who administered therapy were blinded (yes/no)	yes	yes	yes
7. Assessors were blinded (yes/no)	yes	yes	yes
8. Minimum 85% follow-up (yes/no)	yes	yes	yes
9. Intent to treat analysis for at least 1 key variable (yes/no)	yes	yes	yes
10. Results of statistical analysis between groups reported (yes/no)	yes	yes	yes
11. Point measurements and variability reported (yes/no)	yes	yes	yes
Overall Score (out of 10)	9/10	9/10	9/10

Note: Item 1 was not included in overall score
Abbreviations: PEDro: Physiotherapy Evidence Database score

Figure 1 – Search Strategy Flow Chart





Results, Discussions, and Conclusions

The researchers of the three studies examined in this critically appraised topic found that ingesting caffeine before activities where maximal strength and power is needed, may be beneficial to muscle performance. In the study with the highest-quality, researchers randomized 21 healthy and strength trained females. Each participant acted as their own control during the experiment. A pre-experimental training session was conducted to perform a 1 rep max bench press as well as one set of 50% of max to failure. After statistical analysis, they reported a statistically significant effect of a caffeine substance for a 1RM and time under tension.[4] It was concluded that, in comparison to the ingestion of the placebo, the intake of CAF-3 and CAF-6 supplied an ergogenic effect on the 1RM bench press performance.[4] The other two studies showed that there may be a significant effect of caffeine on muscle power output and strength. One of the studies concluded a positive effect on mean power output and mean bar velocity.[5] These results suggest that CAF can be effectively used to acutely improve this power specific training routine even with individuals habituated to CAF, although long term training effects with CAF should be further investigated.[5]

Since there are such conflicting results of the numerous amounts of research that has been conducted on the way caffeine effects muscle performance, the comparison of the effects is difficult. Each of the three studied used a different method to conduct their research. Two of the studies used strictly males, while the other utilized strictly females. These data could have been skewed based on the gender of the participants. Also, the age range of the participants in each study was varied, as well as the height and weight of each participant was not clearly documented. Gender, age, height, and weight all influence the body in how it manages daily intake of substances. They are important factors to consider in every experiment conducted including any ingested substance.

Implications for Clinical Practice and Future Research

1. Additional findings on caffeine and the effect it has on different exercises
2. Energy drink consumption and how different ingredients affect heart rate
3. What are the long-term effects of caffeine on student-athletes?

References and Acknowledgments

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