DOI: https://doi.org/10.53350/pjmhs22162648

ORIGINAL ARTICLE

The Effect of Caffeine use at Different Times on Vertical Jump and Long Jump Performance in Elite Male Athletes

HÜSEYİN NASİP ÖZALTAŞ[1], EMRE SERİN[2]
[1]Department of Physical Education and Sport, Dicle University, Diyarbakir, Turkey.
[2]Faculty of Sport Sciences, Mersin University, Mersin, Turkey ORCID: 0000-0001-9596-2912
Correspondence to: Hüseyin Nasip Özaltaş, Email:huseyinozaltas@gmail.com, ORCID: 0000-0002-9184-115X Tel: +907767772

ABSTRACT
Aim: This study was designed to determine whether caffeine supplementation applied at different times has an effect on vertical jump and long jump performance.
Method: The study group consists of a total of 30 healthy and volunteer elite male athletes. Caffeine supplementation was applied to the elite athletes participating in the study in two separate periods, and three groups were randomly formed as the first group (Experiment 1), the second group (Experiment 2), and the no application (Placebo) group. Athletes in the (Experimental 1) group were given caffeine supplementation, 60 minutes before the measurements, and the athletes in the (Experiment 2) group were given 6 mg/kg powdered caffeine supplement, mixed with 250 ml of water, 120 minutes before the measurements. Only water was administered to the (placebo) group. In the study, the smart speed lite system was used to determine the vertical jump, and the standing long jump test protocols were used to determine the long jump. Differences between groups were determined by using a post-hoc LSD test together with the one-way analysis of variance in (One-Way-ANOVA-post-hoc LSD) in accordance with the experimental design of the study.
Results: Considering the vertical jump and long jump pre-test post-test performances of the participants, there was a general increase in all groups. There was no statistically significant difference between the posttest-pretest difference scores of vertical jump and standing long jump performance values (p>0.05).
Conclusion: Both results were found to have low effect size values.
Keywords: Caffeine, Vertical Jump, Long Jump, Athletic Performance

INTRODUCTION

Caffeine is prevalently used by athletes to increase physical and mental performance during exercise. Particularly after the removal of caffeine from the list of banned substances by the World Anti-Doping Agency (WADA) in 2004, there has been a great increase in studies examining the effect of caffeine on sports performance [1].

However, there are a limited number of studies that focus on the effects of caffeine intake on short-term and high-intensity anaerobic performance and the results differ from each other. It is reported that such differences are caused by the training status of the test participants, the differences in the daily caffeine intakes of the participants, the tested muscle mass, different caffeine doses, and caffeine forms [2].

The daily dose range of caffeine (approximately 50-300 mg) provides the ability to stay awake and energized and increase concentration though caffeine overdose (300-800 mg and over) is reported to cause health problems in individuals including sleep disorder, nervous temperament, anxiety, insomnia, and panic attacks as well as involuntary contractions. It is observed that people who consume high amounts of caffeine experience health problems such as bone mineralization, metal absorption, dental diseases, kidney and intestinal reabsorption problems, iron deficiency, and bone resorption [3].

Another factor that determines the ergogenic effect of caffeine intake is the amount of dose. Studies have reported that caffeine doses in the range of 2-9 mg/kg have positive effects on aerobic endurance, muscular strength, muscular endurance, and repeated sprint performance. As the amount of dose goes near 9 mg/kg, which is classified as a high-dose amount, the ergogenic effect of caffeine decreases due to the side effects (headache, tension, focusing problem, gastrointestinal discomfort) caused by high-dose intake. In the literature, studies comparing the ergogenic effects of caffeine taken at different doses report that there is no significant difference between doses of 3 and 6 mg/kg, and the use of a caffeine dose of 3 mg/kg is recommended [4,5].

The positive or negative effect of caffeine varies depending on the dose taken and the time of intake. This effect of caffeine intake is said to be related to the secretion of adrenal hormones. It has been observed that when caffeine is taken, the contraction of the heart muscles increases as a reaction to the change in the body. Caffeine increases heart rate and the number of heartbeats. However, the effect on heart rate did not persist. It is concluded that this is mostly due to its effect on increasing blood pressure increasing. When caffeinated beverages are consumed, first blood pressure increases, then an increase is observed in pulse, and 2 hours later, the pulse and blood pressure return to normal [6].

It is claimed that energy drinks containing caffeine significantly improve reaction time, increase aerobic and anaerobic endurance time, and reduce the time spent in sleeplessness by drivers. There are studies on the ergogenic effect of caffeine intake before moderate-intensity exercise. Moderate caffeine intake (~ 75 mg) appears to improve cognitive performance such as visual interest, attention, psychomotor speed, reaction time, alertness, and memory [7,8]. The literature reveals that the duration of caffeine in the blood continues to be seen, generally 1 hour after the application and 2-3-4-5-6 hours after the ingestion while the effect of caffeine in the blood gradually decreases. There are different opinions and studies on this subject. As a result, it is well-understood that the athletes tend to continuously improve their performance in order to gain superiority over each other and to beat the rival players and teams in training and competitions. Therefore, jumps and bounds that require sudden explosive power in some branches of sport are important in terms of gaining and superiority at the moment of performance. Vertical jump and long jump are among the important parameters. Special training and warm-up methods are also being developed to improve these characteristics and performance parameters of the athletes with particular attention [9,10,11,12,13,14]. These characteristics of athletes can be affected positively or negatively by supplements such as caffeine. In consideration of the foregoing, this study has been designed to shed light on the effect of caffeine supplementation applied at different times on vertical jump and long jump performance in elite male athletes.

MATERIAL AND METHOD

Study Group: A total of 30 healthy elite male athletes volunteered to participate in this study. Before conducting the study, it was approved by Dicle University Ethics Committee with the "Ethics Committee Permission (numbered 236433) dated 21.02.2022. (Placebo group; age: 20.20±0.91 years, height: 1.81± 0.04 cm, bodyweight: 72.00±8.74 kg, Body Mass Index: 22.74±1.90 kg/m2, Experiment1 group: age: 20.60±1.50 years, height: 1 .76±0.07 cm, bodyweight: 72.00±8.74 kg, Body Mass Index: 23.00±1.73 kg/m2, Experiment2 group: age: 20.70±1.06 years, height: 1.78±0.05 cm, bodyweight: 75.70±6.80 kg, Body Mass Index: 23.84±2.32 kg/m2). The participants were comprised of elite athletes who move on in nutrition and habits and have had no experience of any serious injury problems over the last six months.

Caffeine Intake: The athletes included in the study were included in the study in 3 groups by random method, including the two groups in which caffeine supplement was applied at 2 different times (60 min and 120 min) and the placebo group. Placebo participants were given only 250 ml of water. Caffeine supplementation was applied at certain intervals (60 minutes (experiment1) and 120 minutes before (experiment2) measurements). Participants were supplemented with caffeine (Sigma-Aldrich) in powder form of 6 mg/kg per body weight, mixed with 250 ml of water. Participants in the placebo group were not told whether they were taking the caffeine or placebo supplements.

Vertical Jump Test: The vertical jump performances of the athletes were measured with the electronic smart speed lite system. The vertical jump test was performed after 15 minutes of active warm-up, 5 minutes of jogging, 5 minutes of short bursts, 5 minutes of stretching. As soon as the athletes felt ready, they jumped to the highest point they could jump. The jump distances of the athletes were measured electronically in cm and the best of 3 trials was recorded [15].

Standing Long Jump Test (Broad Jump): The standing long jump test measures the power output of the leg muscles [16]. The toes of the athlete participants were placed just behind the line with feet placed in the normal period and parallel to the ground, with arms in front and knees bent, and they jumped as far as they could jump forward with the swinging of the arms, and after having jumped, the heel of both feet touched the ground at the same time while landing. The measurement was repeated twice, and the best distance of the athletes was recorded in cm [17].

Statistical Analysis: Data analysis was done in SPSS 22.0 statistical package program for Windows. Arithmetic means (X), standard deviation (Ss.), maximum (Max.), and minimum (Min.) values were determined for the parameters obtained from the data collection tools. Differences between groups were determined by using a post-hoc LSD test together with the one-way analysis of variance (One-Way-ANOVA-post-hoc LSD) in accordance with the experimental design of the study [18]. The LSD (least significant difference) method applies standard t-tests to all possible pairs of group means. LSD test is an inconvenient post-hoc statistic, which is preferred if the number of groups (k means) for which the difference will be determined is more than 3 [19]. Mathematically, it is highly vulnerable to type I error as although the type I error level (α) is chosen as 5%, the amount of error per group increases as the number of groups increases. Therefore, LSD multiple comparison statistics should not be used if the number of groups compared is large or more than 3 [20,21]. In addition to these, the statistical significance level in the study was accepted as $p<0.05$, and eta-square (η^2) values were calculated as the effect size coefficient [21,22,23,24].

RESULTS

All the findings of the research are given in detail in Table 1, Table 2, Table 3, Table 4, and Table 5, respectively.

Table 1: Descriptive Data of Subjects

Parameter/(Unit)	Group	n	Min.	Max.	X̄±Sd.
Ager(year)	Placebo	10	19,00	22,00	20,20±0,91
	Experimet 1	10	19,00	24,00	20,60±1,50
	Experiment 2	10	19,00	22,00	20,70±1,06
Height(cm)	Placebo	10	1,74	1,87	1,81±0,04
	Experiment 1	10	1,63	1,86	1,76±0,07
	Experiment 2	10	1,70	1,84	1,78±0,05
Bodyweight(kg)	Placebo	10	63,00	96,00	77,40±10,05
	Experiment 1	10	56,00	82,00	72,00±8,74
	Experiment 2	10	62,00	88,00	75,70±6,80
Body Mass Index(kg/m²)	Placebo	10	19,88	26,59	22,74±1,90
	Experiment 1	10	20,48	25,31	23,00±1,73
	Experiment 2	10	18,51	26,30	23,84±2,32

X̄: Mean, Sd.: Standard Deviation.

Table 1 highlights that for the placebo group, the mean age is 20.20±0.91 years, the mean height is 1.81±0.04 m, the mean body weight is 77.40±10.05 kg, mean body mass index is 22,74±1.90 kg/m², for the Experiment 1 group, the mean age is 20.60±1.50 years, the mean height is 1.76±0.07 m, the mean body weight is 72.00±8.74 kg, the mean body mass index is 23.00±1.73 kg/m², and for the Experiment 2 group, the mean age is 20.70±0.91 years, the mean height is 1.78±0.05 m, the mean body weight is 75.70±6.80 kg, and the mean body mass index is 23.84±2.32 kg/m², respectively.

Table 2: Comparison of the subjects' age, height, body weight, and body mass index values

Parameters	Group	n	X̄±Sd.	Df.	F	p	η²
Age	Placebo	10	20,20±0,91	2	,496	,614	,04
	Experimet 1	10	20,60±1,50				
	Experimen2	10	20,70±1,06				
Height	Placebo	10	1,81±0,04	2	1,637	,213	,11
	Experimen1	10	1,76±0,07				
	Experimen2	10	1,78±0,05				
Bodyweight	Placebo	10	77,40±10,05	2	1,023	,373	,07
	Experiment 1	10	72,00±8,74				
	Experiment 2	10	75,70±6,80				
Body Mass Index	Placebo	10	22,74±1,90	2	,862	,434	,06
	Experiment 1	10	23,00±1,73				
	Experiment 2	10	23,84±2,32				

*p<0.05, X̄: Mean, Sd.: Standard Deviation, Df.: Degree of Freedom.

According to Table 2, no significant difference was found in the age, height, body weight, and body mass index values of the subjects (p>0.05). In addition, it was determined that all of these results had low effect size values.

Table 3: Pre-test values of vertical jump and standing long jump performance of subjects

Parameter/(Unit)	Group	n	Min.	Max.	X̄±Sd.
Vertical Jump(cm)	Placebo	10	35,49	48,98	41,40±4,30
	Experiment 1	10	35,23	53,58	43,78±4,79
	Experiment 2	10	31,97	45,87	40,22±4,96
Standing Long jump(cm)	Placebo	10	105,00	167,00	141,90±17,66
	Experiment 1	10	123,00	188,00	146,60±20,16
	Experiment 2	10	104,00	154,00	130,70±16,72

X̄: Mean, Sd.: Standard Deviation.

Table 3 highlights that in the pre-tests for the placebo group, the mean vertical jump performance values are 41.40±4.30 cm and the mean standing long jump performance values are 141.90±17.66 cm, for the Experiment 1 group, the mean vertical jump performance values are 43.78 ±4.79 cm and the mean standing long jump performance values are 146.60±20.16 cm, for the Experiment 2 group, the mean vertical jump performance values are 40.22±4.96 cm and the mean standing long jump performance values are 130.70±16.72 cm, respectively.

Table 4: Post-test values of vertical jump and standing long jump performance of subjects

Parameter/(Unit)	Group	n	Min.	Max.	X̄±Sd.
Vertical Jump(cm)	Placebo	10	37,76	51,18	45,61±4,08
	Experiment 1	10	39,01	49,76	45,15±4,07
	Experiment 2	10	34,14	53,58	44,87±5,43
Standing Long jump(cm)	Placebo	10	134,00	165,00	144,80±11,57
	Experiment 1	10	116,00	165,00	148,50±16,96
	Experiment 2	10	108,00	181,00	148,90±20,67

X̄: Mean, Sd.: Standard Deviation.

Table 4 highlights that in the post-tests for the placebo group, the mean vertical jump performance values are 45,61±4,08 cm and the mean standing long jump performance values are 144,80±11,57 cm, for the Experiment 1 group, the mean vertical jump performance values are 45,15±4,07 cm and the mean standing long jump performance values are 148,50±16,96 cm, for the Experiment 2 group, the mean vertical jump performance values are 44,87±5,43 cm and the mean standing long jump performance values are 148,90±20,67 cm, respectively.

Table 5: Comparison of the vertical jump and standing long jump performance posttest-pretest difference scores of the subjects

Parameter	Group	n	X̄±Sd.	Df.	F	p	η²
Vertical Jump	Placebo	10	4,21±4,63	2	1,457	,251	,09
	Experiment 1	10	1,37±4,83				
	Experiment 2	10	4,65±4,51				
Standing Long Jump	Placebo	10	2,90±11,90	2	2,194	,131	,14
	Experiment 1	10	1,90±20,60				
	Experiment 2	10	1,20±23,00				

*p<0.05, X̄: Mean, Sd.: Standard Deviation, Df.: Degree of Freedom.

According to Table 5, no significant difference was found between the posttest-pretest difference scores of the subjects' vertical jump and standing long jump performance values ($p>0.05$). In addition, both results were found to have low effect size values.

DISCUSSION AND CONCLUSION

The main purpose of this study was to examine the effects of moderate doses of caffeine supplementation administered at different times on anaerobic power performances, namely vertical jump and long jump performance, in elite male athletes. As a result of the study, no significant difference was found between the posttest-pretest difference scores of the vertical jump and standing long jump performance values of the participants ($p>0.05$). In addition, both results were found to have low effect size values.

In fact, the core purpose of the study was to monitor when the use of caffeine at different times had an effect on athletic performance and when it was possible to achieve improvement. Another purpose was to reveal the kind of effects on explosive power. However, the findings of this study indicate that caffeine supplementation and the time of caffeine intake have no effect on vertical jump and standing long jump performance. Studies in the literature show that some scholars have found a positive effect of the use of caffeine on explosive power while some studies show that it releases adrenaline in people whose blood flow accelerates and that it creates a desire to move quickly. Apart from this, different studies can be designed with different participants to discover when caffeine is absorbed by the athletes' bodies and converted into energy, and whether it affects sports performance or not.

Skinner et al. [25] and Bell and McLellan [26] examined the effect of caffeine supplementation at different times before short-term high-intensity activities. Research findings indicated that caffeine supplementation 60 minutes and 120 minutes before short-term high-intensity activities does not affect performance.

Greer et al [27] and Pereira et al [28] report that caffeine does not have a significant effect on muscle strength and blood lactate level in short-term maximal exercises. It is also reported that the main reasons for this difference can be related to the physical performance levels as well as exercise duration and intensity of the athletes.

Contrary to the results of this study, Foskett et al [29], who conducted a study with the addition of moderate caffeine dose (6 mg/kg), examined the passing the ball technicality and ball control technique of the football player to conclude that the accurate pass rate and ball control technique of the football player increased, which shows the positive effect of caffeine on the realization of fine motor skills.

As a result of the study by Leski and Terrell [30], it was observed that caffeine intake (6 mg) had a positive effect on the overall sprint training compared to placebo. In particular, caffeine was observed to increase the overall sprint performance 8.5% more in the first half of the match, and 7.6% more in the second half of the match. In the study, positive effects of caffeine supplementation on anaerobic power, anaerobic capacity, and muscular endurance were determined. A positive effect on short-term and high-intensity performance was determined in professional athletes who received moderate caffeine supplementation between 4-6 mg.

A myriad of studies, the majority of which are generally related to the effects of athletic endurance, have investigated the effect of caffeine on athletic performance. At the same time, many articles have shown that theoretically caffeine increases the adrenaline level and accelerates the body. Thus, this study was aimed at examining whether caffeine affects vertical jump performance and long jump performance, which are important in that they give the athletes an advantage over each other in many branches of sport. As a result, according to the findings of this study, caffeine supplementation performed 60 minutes and 120 minutes before the tests did not significantly increase vertical jump and long jump performance in active male athletes, and a result with a low effect size was obtained. In future research, the effects of different doses of caffeine intake at different times can be studied. Likewise, since caffeine increases the basal metabolic rate, as shown in literature, together with a planned training program, creating an epoch effect in athletes, whether caffeine has effects on fat burning in the body can also be investigated.

Conflicts of interest: The authors declare that there is no conflict of interest in this manuscript.

REFERENCES

1. Ganio SM, Klau FJ, et all. (2009): Effect of Caffeine on Sport-Specific Endurance Performance: A Systematic Review. Sports medicine, 23(1), 315-324.
2. Davis JK, Green, JM (2009): Caffeine and anaerobic performance: ergogenic value and mechanisms of action. Sports Med, 39 (10), 813-832.
3. Benowitz, N.L., Peng, M., Jacob, P. (2003). Clinical Pharmacology & Therapeutics Effects Of Cigarette Smoking And Carbon Monoxide On Chlorzoxazone And Caffeine Metabolism., S. 74, 5, 468, 474.
4. Sökmen B, ve ark. (2008): Caffeine Use in Sports: Considerations For The Athlete. Journal of Strength and Conditioning Research, 22(3): 978-986.
5. Desbrow B, ve ark. (2012): The Effects of Different Doses of Caffeine on Endurance Cycling Time Trial Performance. Journal of Sports Sciences, 30(2): 115-120.
6. Mellion, M.B., Walsh, W.M., Madden, C., Putukian, M., Shelton, G.L, (2002). The Team Nutrition And Physical Performance: A Century Of Pennay AE, Lubman DI. Energy Drinks: Health Risks And Toxicity. Med J Aust 2012, 196 (7), 442, 7.
7. Babu, K.M., Church, R., Lewander, W. (2008). Energy Drinks: The New EyeOpener For Adolescents. Clinical Pediatric Emergency Medicine, S, 9,35.
8. Curry, K., Stasio, M. (2009). The Effects Of Energy Drinks Alone And With Alcohol On Neuropsychological Functioning. Human Psychopharmacology Clinical Experimental, 24, 473.
9. Özdemir, M., Tanır, H., Ilkım, M., & Özmaden, M. (2017). The effects of 8 week exercise program on reaction time performance of hearing impaired students at 11–14 years of age. In SHS Web of Conferences (Vol. 37, p. 01031). EDP Sciences.
10. Ilkım, M., Canpolat, B., & Akyol, B. (2018). The effects of eight-week regular training in amateur amputee football team athletes' body composition. Turkish Journal of Sport and Exercise, 20(3), 199-206.
11. Eken, Ö., Bayer, R. (2022). Acute effects of proprioceptive neuromuscular facilitation stretching, massage and combine protocols on flexibility, vertical jump and hand grip strength performance in kickboxers. Pedagogy of Physical Culture and Sports, 26(1), 4-12.

12. Eken, Ö., Bayer, R. Bayrakdaroğlu, S. (2022). The Acute Effect of High-Intensity Functional Exercises on Circadian Rhythm and Anaerobic Performance Parameters . Gümüshane Üniversitesi Sağlık Bilimleri Dergisi, 11 (1) , 279-286 . DOI: 10.37989/gumussagbil.1049921
13. Bayer, R., Eken, Ö. (2021). The acute effect of different massage durations on squat jump, countermovement jump and flexibility performance in muay thai athletes. Physical education of students, 25(6), 353-358.
14. Eken, Ö. (2021). The acute effect of different specific warm-up intensity on one repeat maximum squat performance on basketball players. Pedagogy of Physical Culture and Sports, 25(5), 313-318.
15. Serin, E., & Taşkin, H. (2016). Anaerobik Dayanıklılık İle Dikey Sıçrama Arasındaki İlişki. Spor Ve Performans Araştırmaları Dergisi, 7(1), 37-43.
16. Yücel, S. B. (Ed.). (2020). Hareket ve Antrenman Bilimleri II. Eskişehir: Anadolu Üniversitesi Basımevi, 148 - 235.
17. Işıldak, K. (2020). Plyometrik Antrenmanların Çabukluk, Dikey Sıçrama ve Durarak Uzun Atlama Performansı Üzerine Etkisi. Akdeniz Spor Bilimleri Dergisi, 3(1), 36 - 44.
18. Kalaycı, Ş. (2009), SPSS Uygulamalı Çok Değişkenli İstatistik Teknikleri, Ankara: Asil Yayın Dağıtım
19. Efe, E., Bek & Y., Şahin, M. (2000). Spss'te Çözümleri ile İstatistik Yöntemler II. Kahramanmaraş: Kahramanmaraş Sütçü İmam Üniversitesi Rektörlüğü, Yayın No:10.
20. Kayri, M. (2009). Araştırmalarda gruplar arası farkın belirlenmesine yönelik çoklu karşılaştırma (post-hoc) teknikleri. Journal of Social Science, 55.
21. Gravetter, J. F. ve Forzano, L. B. (2012). Research methods for the behavioral sciences (4. Baskı). USA: Linda Schreiber-Ganster.
22. Büyüköztürk, Ş. (2001). Deneysel desenler: Öntest sontest kontrol gruplu desen ve veri analizi. Ankara: Pegem Yayınları.
23. Alpar, R. (2014). Uygulamalı istatistik ve geçerlik-güvenirlik: spor, sağlık ve eğitim bilimlerinden örneklerle (3. Baskı). Ankara: Detay Yayıncılık.
24. Karasar, N. (2018). Bilimsel Araştırma Yöntemi: Kavramlar, İlkeler, Teknikler. Ankara: Nobel Yayınevi.
25. Skinner TL, Jenkins DG, Folling J, Leveritt MD, Coombes JS, Taaffe DR. Influence of carbohydrate on serum caffeine concentrations following caffeine ingestion. J Sci Med Sport, 2013; 16 (4): 343-7. doi: 10.1016/j.jsams.2012.08.004.
26. McArdle WD, Katch FI, Katch VL. Exercise physiology. Energy, nutrition, & human performance. Baltimore: Lippincott, Williams & Wilkins; 2007.
27. Greer, F., Morales, J., Coles, M., (2006). Wingate Performance And Surface EMG Frequency Variables Are Not Affected By Caffeine İngestion. Appl Physiol Nutr Metab, S, 31, 597, 603.
28. Pereira, L.A, Curti, J.O, Camata, T.V., Gonçalves, E.M., Leite, S.T, Costa, T.G., Gulak, A., Maia, G.B.M., Moraes, A.C., Altimari, L.R, (2010). Caffeine Does Not Change The Anaerobic Performance And Rate Of Muscle Fatigue İn Young Men And Women, Medicina Sportiva, S. 14,67,72
29. Foskett, A., Ali, A., Gant, N. (2009). Caffeine Enhances Cognitive Function And Skill Performance During Simulated Soccer Activity. Int J Of Sport Nutr Exerc Meta, S. 19, 410, 23.
30. Leski, M.I., Terrell, T.R. (2002). Philadelphia: Nutrition And Ergogenicaids. In Textbook Of Family Practice, Edn 6. Editedby Rakel RE. WB Saunders, 856.