

# The Role Of Caffeine In Enhancing Physical Performance And Reducing Muscular Fatigue In Handball Players

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## Abstract

This study aims to identify the role of caffeine as a dietary supplement in improving physical performance and reducing muscle fatigue in handball players, under performance demands. The high intensity imposed by the nature of this sport, which relies on repeated high-intensity physical exertion over short periods of time.

Caffeine is one of the most widely used substances in sports, due to its direct effects. On the central nervous system, it inhibits adenosine receptors, leading to a reduction in fatigue and an increase in alertness and concentration. It also contributes to increased secretion. Catecholamines, which promote the use of fat as an energy source and reduce glycogen depletion within muscles, positively impacting endurance and physical performance. The study adopted the experimental method on a sample of handball players, who were divided into two groups (experimental and control), where the experimental group took a specific dose of Caffeine was given to the participants before physical exertion, while the control group received no dietary intervention. Physical performance was measured using an endurance test, in addition to measuring lactate concentration as an indicator of muscle fatigue. The results showed statistically significant differences favoring the experimental group, which recorded a decrease in lactate accumulation and an improvement in physical performance. These results indicate The effectiveness of caffeine in improving physical performance and delaying muscle fatigue in handball players.

**Keywords:** Caffeine, physical performance, muscle fatigue, handball players, endurance, lactate

## 1. Introduction

Handball is a team sport that requires high levels of physical fitness, combining aerobic and anaerobic effort, and demanding the repetitive performance of rapid movements. Intense activities, such as running, sudden changes of direction, and shooting, lead to a rapid depletion of energy reserves within the muscles, increasing the likelihood of muscle fatigue during various periods of play. Muscle fatigue is one of the most important factors limiting athletic performance, as it is associated with increased lactate accumulation and decreased energy production efficiency, in addition to depletion. Glycogen is stored within muscles. Hence, the need arose for effective nutritional strategies that contribute to delaying fatigue and improving physical performance.

Caffeine is one of the most common nutritional supplements in the sports field, due to its direct effect on the central nervous system, where it works to reduce sensation. It causes fatigue and increases alertness. It also contributes to improved energy utilization by increasing reliance on fat and reducing glycogen consumption. Numerous studies have shown that caffeine can improve physical performance and increase endurance, but studies examining its effects on handball players are limited. The research remains limited, necessitating further investigation in this area.

### 1.2 Research Problem

Handball is a sport that requires high-intensity and repetitive physical performance, leading to This leads to a rapid depletion of energy resources and the onset of muscle fatigue during different periods of play. Despite significant advancements in training methods, the problem of fatigue persists. Muscularity remains one of the most prominent factors that limit the efficiency of physical performance among players, especially in the advanced stages of the match.

Muscle fatigue is linked to increased lactate accumulation within the muscles, in addition to glycogen depletion, leading to a decreased ability to sustain performance. In this context. In this context, the importance of using nutritional supplements has emerged, including caffeine, which is believed to contribute to reducing feelings of fatigue and improving physical performance. However, studies examining the effects of caffeine on handball

players are still limited, and their results are inconclusive, raising scientific questions about its effectiveness in improving performance.

Physical efficiency and reduced muscle fatigue in this group.

The research problem is addressed in the following question:

Does caffeine contribute to improved physical performance and reduced muscle fatigue in handball players?

### 1.3 Research Objectives:

Identifying the effect of caffeine on improving physical performance and reducing muscle fatigue in handball players.

To determine the effect of caffeine on physical performance.

To identify the effect of caffeine on lactate concentration.

To evaluate the role of caffeine in delaying the onset of muscle fatigue.

### 1.4 Research hypotheses:

There are statistically significant differences between the two groups in physical performance in favor of the experimental group.

There are significant differences in lactate levels favoring the experimental group.

## 2. Research Design

The researcher adopted the experimental method using an experimental-control design, as it was suitable for the nature of the study. It aims to reveal the effect of an independent variable (caffeine intake) on dependent variables (physical efficiency and muscle fatigue).

This design is considered one of the most accurate designs in applied studies, as it allows comparison between two groups, one of which is exposed to the experimental variable, and the other is not. It is exposed to it, while controlling the influencing factors as much as possible, which contributes to increasing the validity of the results.

Second: The research population and sample

The research population consisted of handball players registered in sports clubs, A sample of (30) players was selected in a simple random manner, ranging in age from (20–25) years, and enjoying a similar level of physical fitness and training experience.

The sample was divided into two equal groups:

- Experimental group: (15 players) who consumed caffeine
- Control group: (15 players) who did not consume any supplement
- Third: Equivalence and homogeneity between the two groups
- The equivalence of the two groups in the basic variables was verified before the experiment was conducted. Using the independent samples t-test, to ensure that there are no differences affecting the results.

Table (1): Equivalence between the two groups for the pre-tests

| Variable    | Experimental Group | Control Group | T    | Sig  |
|-------------|--------------------|---------------|------|------|
|             | (Mean ± SD)        | (Mean ± SD)   |      |      |
| Age (years) | 1.4 ± 22.1         | 1.2 ± 22.3    | 0.39 | 0.69 |
| Height (cm) | 3.8 ± 181.5        | 4.0 ± 180.9   | 0.41 | 0.68 |
| Weight (kg) | 4.6 ± 75.2         | 4.9 ± 74.8    | 0.33 | 0.74 |

Table (1) shows that the values (Sig > 0.05) indicate no significant differences, which shows that the two groups are

statistically equivalent and homogeneous.

Fourth: Experimental Variables

Independent Variable: Caffeine Intake

Dependent Variables:

Physical Performance (Endurance)

Muscle Fatigue (Lactate)

Fifth: Experimental Design

Table (2): Experimental design (integrated)

| Item               | Experimental Group             | Control Group |
|--------------------|--------------------------------|---------------|
| Dietary Supplement | Caffeine                       | None          |
| Dosage             | 5 mg/kg of body weight         | —             |
| Timing of Intake   | 60 minutes before exercise     | —             |
| Type of Test       | Yo-Yo Test                     | Yo-Yo Test    |
| Measured Variables | Physical Performance – Lactate |               |

Sixth: Measurement Tools

Table (3): Measurement Tools

| Variable             | Instrument Used         | Instrument Used |
|----------------------|-------------------------|-----------------|
| Physical Performance | Yo-Yo Test              | Meter           |
| Lactate              | Lactate Analyzer Device | mmol/L          |

Seventh: Field Procedures

The experiment was conducted according to the following steps

*1. Preparatory Phase:*

- Introducing the players to the study objectives
- Obtaining consent
- Standardizing conditions (diet, sleep, training)
- Prohibiting stimulants before the experiment

*2. Pre-workout measurements:*

- Height, weight, and age measurement
- Physical performance test
- Pre-exercise lactate measurement

*3. Experimental Application:*

- Administer caffeine to the experimental group 60 minutes prior to the test.
- Do not administer any supplement to the control group.
- Perform the tolerance test.

*4. Post-exercise measurements:*

- Physical performance measurement (distance covered)
- Lactate measurement immediately after exertion
- Eighth: Controlling Variables
- The following were controlled:
- Test timing
- Exercise intensity
- Environment (temperature)
- Diet

- Rest before the test
- Ninth: Statistical Analysis
- The SPSS software was used to analyze the data through:
- Arithmetic Mean
- Standard Deviation
- Independent Samples t-test
- Significance level (0.05)
- First: Presentation of results (integrated table)

Table (4): Post-test results between the two groups

| Variable                    | Experimental Group<br>(Mean+SD) | Control Group<br>(Mean+SD) | T    | Sig   |
|-----------------------------|---------------------------------|----------------------------|------|-------|
| Physical Performance meters | 120 ± 1780                      | 135 ± 1605                 | 3.42 | 0.002 |
| Lactate (mmol/L)            | 0.9 ± 6.8                       | 1.1 ± 8.1                  | 3.15 | 0.004 |

### 3. Results

Table (3) shows that there are statistically significant differences between the experimental and control groups in all variables under study, where the value reached (Sig) is less than (0.05), indicating a significant effect of caffeine on physical performance and muscle fatigue.

In the physical performance variable, the experimental group achieved a higher average of (1780 meters) compared to the control group (1605 meters), indicating an improvement in endurance among the players who consumed caffeine.

In the lactate variable, the experimental group recorded a lower level (6.8 mmol/L) compared to the control group (8.1 mmol/L), which indicates This leads to a reduction in muscle fatigue and a delay in the accumulation of anaerobic metabolic byproducts.

### 4. Discussion

The study results indicate that caffeine consumption led to a significant improvement in Physical efficiency and reduction of muscle fatigue in handball players, which can be explained by the multiple physiological effects of caffeine on the body. Caffeine works by inhibiting adenosine receptors in the central nervous system, which leads to a reduction in feelings of fatigue and an increase in alertness and concentration.

This has a positive impact on physical performance (Spriet, 2014). It also leads to increased secretion of catecholamines, such as adrenaline, which contributes to improving the body's response to physical exertion and increasing energy availability.

The lower lactate levels in the experimental group can also be explained by the fact that caffeine contributes to improved energy utilization by increasing Relying on fat and reducing muscle glycogen depletion, which delays the onset of muscle fatigue (Graham, 2001).

These results are consistent with the findings of several studies, with Spriet (2014) indicating that caffeine improves performance in activities that require Endurance, as shown in the study (Ganio et al., 2009), is that caffeine reduces the feeling of fatigue and increases the ability to continue performing.

Improved physical performance can also be explained by increased efficiency of the neuromuscular system, as caffeine contributes to improved recruitment of motor units, which It leads to improved strength and speed during performance.

Therefore, it can be said that caffeine is an effective way to enhance performance. Physical fitness and delayed muscle fatigue in handball players, especially in activities that require repetitive and high-intensity effort.

## 5. Conclusion

Caffeine improves physical performance in handball players. Caffeine reduces lactate buildup and thus delays muscle fatigue. There are statistically significant differences favoring the experimental group in all variables.

## 6. Recommendations

Use caffeine in controlled doses before competitions. Incorporating caffeine into training programs under the supervision of specialists. Conducting future studies on different sports categories

## References

- [1] Burke, L. M. (2008). Caffeine and sports performance. *Applied Physiology, Nutrition, and Metabolism*, 33(6), 1319–1334.
- [2] Ganio, M. S., Klau, J. F., Casa, D. J., Armstrong, L. E., & Maresh, C. M. (2009). Effect of caffeine on sport-specific endurance performance: A systematic review. *Journal of Strength and Conditioning Research*, 23(1), 315–324.
- [3] Graham, T. E. (2001). Caffeine and exercise: Metabolism, endurance and performance. *Sports Medicine*, 31(11), 785–807.
- [4] Jeukendrup, A. E. (2017). Training the gut for athletes. *Sports Medicine*, 47(Suppl 1), 101–110.
- [5] Spriet, L. L. (2014). Exercise and sport performance with low doses of caffeine. *Sports Medicine*, 44(Suppl 2), S175–S184.
- [6] Thomas, J. R., Nelson, J. K., & Silverman, S. J. (2015). *Research methods in physical activity* (7th ed.). Human Kinetics.
- [7] McArdle, W. D., Katch, F. I., & Katch, V. L. (2015). *Exercise physiology: Nutrition, energy, and human performance* (8th ed.). Lippincott Williams & Wilkins.