

EFFECTS OF CAFFEINE ON ATHLETIC PERFORMANCE AND ON THE HUMAN BODY

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ABSTRACT. The effect of caffeine on the human body has been known for thousand years ago by society. In our study we tried to explore all the physiological effects of this agent. We were interested in how it influences the different forms of effort, the forms of speed, and the muscle strength. We tried to process more practical research in order to draw a correct conclusion.

We want to present the side effects what can be expected, and the World Anti-Doping Agency statement about this agent.

The amount of caffeine commonly shown to improve endurance performance is between 3 and 6 mg per kg of body weight.

Our aim is to write an overall study which provides the most basic information to the reader about the effect of caffeine on sport performance.

Keywords: caffeine, athletic performance, effects, strategies, intake

REZUMAT. Efectele cafeinei asupra performanța sportivă și asupra organismului uman. Efectul cafeinei asupra organismului uman este știut de mii de ani în urmă. În acest studiu dorim să prezentăm cât mai multe dintre efectele fiziologice, care apar în timpul investigației de cafeină. Am fost interesați de modul și măsura în care aceasta influențează diferitele forme ale efortului, formele vitezei și forța musculară. Am încercat să procesăm cât mai multe experimente pentru o concluzie corectă. Prezentăm efectele secundare, dar și afirmația Agenției Internaționale de Anti-doping.

O cantitate de cafeină indicată pentru îmbunătățirea performanței este între 3 și 6 mg/kg de greutate corporală.

Scopul nostru era scrierea unui studiu sumar, care oferă informații de bază (și nu numai) cititorilor despre efectul cafeinei asupra performanței sportive.

Cuvinte cheie: cafeină, performanța sportivă, efecte, strategii de utilizare, admisie

Study Objectives

With this study we want to find answers for the following questions and to present some essential information about the correct use of caffeine.

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- I. How does the caffeine work in the human body?
- II. Can we improve our athletic performance with the use of caffeine? If yes, to what extent?
- III. Can it reduce the athletic performance and are there any side effects?
- IV. Using strategies, and caffeine as a banned substance.

Facts About Caffeine

The origin of caffeine and occurrence

Humans have consumed caffeine since the Stone Age. Many legends from different cultures have been speaking about the discovery of miracle plants including the coffee. The caffeine it spread through Europe from Turkey and Arabia. It began to show popularity in the 17th century in the European territories for their beneficial effects. (Grazian, R.,2008), (Escotado, A., Symington, K., 1999) At the first time it was discovered and analyzed by a German chemist, Friedrich Ferdinand Runge, in 1819. (Fitbuilder, 2010)

It is found in many plant species. Common sources are coffee, tea, and to a lesser extent chocolate from cocoa beans. Less commonly used sources of caffeine include yerba mate and guarana plants, which are sometimes used in the preparation of teas and energy drinks. Mateine and guaranine are the caffeine's alternative names, derived from the names of these plants. (EDinformatics, 2010)

Presence in drinks and foods

We can find a lot of sources which show us the content of caffeine on different foods and drinks. We would like to present in this paper the most frequently used products with their caffeine content.

Table 1. - Caffeine content of common foods and drinks (AIS, 2009)

Food or Drink	Serve	Caffeine Content (mg)
Instant coffee	250 ml cup	60 (12-169) ^a
Brewed coffee	250 ml cup	80 (40-110) ^a
Short black coffee/espresso	1 standard serve	107 (25-214) ^b
Starbucks Breakfast Blend brewed coffee	600 ml (Venti size)	415 (300-564) ^c
Iced coffee - Commercial Brands	500 ml bottle	30-200
Frappuccino	375 ml cup	90
Tea	250 ml cup	27 (9-51)
Iced Tea	600 ml bottle	20-40
Hot chocolate	250 ml cup	5-10
Chocolate -milk	60 g	5-15
Chocolate - dark	60 g	10-50

Food or Drink	Serve	Caffeine Content (mg)
Viking chocolate bar	60 g	58
Coca Cola	375 ml can	49
Pepsi Cola	375 ml can	40
Jolt soft drink	375 ml can	75
Red Bull energy drink	250 ml can	80
Red Eye Power energy drink	250 ml can	50
V Energy drink	250 ml can	50
Smart Drink - Brain fuel	250 ml can	80
Lift Plus energy drink	250 ml can	36
Lipovitan energy drink	250 ml can	50
Mother energy drink	500 ml can	160
Spike Shotgun energy drink (USA)	500 ml can	350
Fixx Extreme Ultra shot	5 ml shot	400
PowerBar caffeinated sports gel	40 g sachet	25
PowerBar double caffeinated sports gel	40 g sachet	50
PowerBar caffeinated gel blasts	60 g pouch (~9)	75
Gu caffeinated sports gel	32 g sachet	20
Carboshotz caffeinated sports gel	50 g sachet	80
PB speed sports gels	35 g sachet	40
PowerBar Performance bar with Acticaf	65 g bar	50
Extreme Sports beans - caffeine	28 g packet	50
Jolt caffeinated gum (USA)	1 stick	33
No Doz	1 tablet - Australia	100
	1 1 tablet - USA	200
Excedrin Extra strength (USA)	1 tablet	65

The caffeine content varies widely, depending on the brand, the way that the individual makes their beverage and the size of their cup. Various manufactures produce caffeine tablets (Ex: No Doz), claiming that using as pharmaceutical quality improves mental alertness. These tablets are commonly used by students, athletes, workers, and are available for everyone.

The effects of caffeine in the body

Caffeine has a wide range of actions in the human body, including hormonal, metabolic, muscular, cardiovascular, kidney, and respiratory effects. Also works on the central nervous system. It functions as a stimulant by interfering with the binding of adenosine to adenosine receptors.

Promotes the increase of dopamine and adrenalin, both stimulatory chemicals that increase energy and a sense of well being. These parallel effects allow it to function as an ergogenic aid. Simply it allows the users to do more as normal mental physical effort. (Jensen, C., 2011), (Moberly, T., 2011)

Is **absorbed** by the stomach and small intestine **within 45 to 60 minutes** of investigation and then distributed throughout all tissues of the body. The time required for the body to eliminate one-half of the total amounts of caffeine varies widely among individuals, but in a case of a healthy adult, caffeine's half-life is approximately 4.9 hours. (Teller, R., 2011)

Decreases the body's reliance on muscle glycogen, the storage form of carbohydrate, and increases its use of fat stored within the muscle for energy production. When is consumed with carbohydrate during exercises, it increases the body's absorption and use of consumed carbohydrates rather relying on use of glycogen. Both are important for sustaining endurance and for increased work production, as the body have finite carbohydrate stores but plenty of fat for energy utilization by contracting muscles. (Braun, M., 2010)

There are a number of physiological effects: the stomach acid production, the blood pressure and the pulse rate are increased, fat stores are broken down, and fatty acids are released into the blood stream. These effects can last from a few hours to as long as 12. (Jenkins, M. A., 2002)

Caffeine increases the blood flow in the kidney and at the same time inhibits the re-absorption of sodium and water. Occurring to the kidneys known as **the diuretic effect**, which provokes the need to urinate. Some specialist are saying that this diuretic effect have a negligible importance. Combined with other aspects such as dehydration and abdominal cramping, not only dehydrate the body, they can cause bowel movements and gastric distress which would obviously be detrimental to the athlete. (Clark, N., 2006), (Hartley, J., 2000)

"The caffeine may help **reduce the muscle pain**, which can impinge on performance during the exercise", says Gliottoni, based on their experiment. A caffeine ingestion of 5mg/kg body weight has been found to reduce the muscle pain in a group of subjects carrying out 30 minutes of high intensity cycling, compared to another group who had not consumed. (Gliottoni, R.C. et al., 2009)

How Caffeine Impacts Athletic Performance?

There are a lot of studies on the use of caffeine for both endurance exercise and short term, higher intensity exercise. The vast majority of the studies conclude that caffeine does indeed enhance performance and makes the effort seem easier, by about 6%. More benefits noticed during endurance exercise than with shorter exercise (8 to 20 minutes) and a negligible amount for sprinters. More benefits are also noticed in athletes who rarely drink coffee. (Clark, N., 2006)

Caffeine and performance in endurance (aerobic) exercises

The researches have shown us that caffeine improves performance in individuals taking part in aerobic exercises.

In a recent review in which subjects had to run, cycle or row a set distance saw faster times recorded over the distance in individuals who consumed caffeine. This effect was seen with a moderate quantities of caffeine before and/or after during exercises. (The Institute for Scientific Information on Coffee)

A study explained individual who performed 2 hours of cycle exercises after caffeine ingestion. The caffeinated athletes generated 7.3% greater total power output. (Caffeine Aids Athlete Recovery, 2008)

The European Food Safety Authority (EFSA) recently stated that a cause and effect relationship has been established for caffeine intake and increased endurance performance, endurance capacity, and a reduction in perceived exertion. (EFSA, 2011)

Endurance in short term, intense exercise

One study showed that exercise resulted in rapid exhaustion within 6 minutes and caffeine had no effect. Two other studies demonstrated participants exercising for 15 to 20 minutes had a small increase in endurance (20 to 30 seconds) after consuming. Caffeine either has positive effects or causes no significant improvement to short term, intense exercise (McDaniel, L. et al., 2010)

Beck et al. examined the acute effects of caffeine supplementation on strength, muscular endurance, and anaerobic capacity. Resistance trained males consumed caffeine (201 mg) one hour prior to testing. A low dose of 2.1 -3.0 mg/kg of caffeine was effective for increasing bench press (2.1%). Significant changes in performance enhancement were not found for lower body strength or muscular endurance. (Beck T. W., et al., 2006) Results of the Beck et al. investigation are in contrast to a recent publication by Astorino et al. in which twenty-two resistance trained men were supplemented with 6 mg/kg of caffeine and tested on the bench press and leg press. Their findings revealed no significant increase for either bench or leg press 1RM. Astorino et al. did report a non-significant increase in repetitions and weight lifted at 60% 1RM for both the bench and leg press. (Astorino T. A., Rohmann, R. L. & Firth, K., 2008)

High-intensity and team sport exercise

Based on different researches it is apparent that moderate caffeine supplementation in the range of 4-6 mg/kg can be advantageous to either short term or intermittent/prolonged duration high-intensity performance, but only in trained athletes.

Studies revealed that acute caffeine ingestion can significantly enhance performance of prolonged, intermittent-sprint ability in competitive, team-sport athletes. (Schneiker K.T. et al., 2006), (Goldstein, E.R. et al., 2010), (Stuart G.R. et al., 2005)

Tolerance, withdrawal and side effects

In a case of a new caffeine consumer probably experience a noticeable buzz or jolt at the first time after intake a moderate dose. But if you consume that same amount of caffeine every day, after a few days (5-6), **the stimulant effects are much less obvious**, and more caffeine is necessary to achieve the same effects. It is because your body develops a tolerance or diminished response to caffeine with repeated doses. A consistent usage may lead to dependence in the body.

The withdrawal **symptoms** are present when the used certain daily intake is stopping abruptly. The most commonly reported withdrawal symptoms are: headache, fatigue, sleepiness/drowsiness, difficulty concentrating, work difficulty, irritability, depression, anxiety, flu-like symptoms, impairment in psychomotor, vigilance and cognitive performance. Dehydration is a potential concern because caffeine is a mild diuretic. (Johns Hopkins BAYWIEW Medical Center, 2003)

Withdrawal also can have a less obvious, but **detrimental impact on athletic performance**. To avoid negative effects on training, the dose should gradually reduce over 3-4 days. The symptoms peak in a day or two, and are usually completely gone within a week. If you resume caffeine intake; the symptoms usually disappear pretty quickly. (Jensen, C. D., 2010), (Moberly, T., 2011), (Colpo, A., 2010)

Strategies

Before using caffeine to improve your ability, important to talk with caregiver or nutritionist, if you do not usually drink coffee or other things with caffeine.

The amount of caffeine commonly shown to improve performance is between 3 and 6 mg/kg body mass. These amounts are equally effective when combined with carbohydrate/electrolyte solution or water. Performance improvements with caffeine are maximized with amount up to 6 mg/kg and are not generally improved with 9 mg/kg. (Colpo, A., 2010)

Louise M. Burke of the Australian Institute of Sport found that dosages as low as 1 mg/kg resulted in enhanced performance. (AIS, 2009)

According to the American College of Sports Medicine, consuming low to moderate doses of caffeine before an athletic event maximizes the benefits and minimizes the side effects. Optimal dosage is 3 to 6 milligrams per kilogram body weight. (American College of Sport Medicine) Consuming 10 to 15 mg/kg results in more pronounced side effects, which could be detrimental to athletic performance.

Timing:

- Ingest 60-75 minutes before event.
- Ingest small amount during event (if carbonated, should be flat).
- Ingest small amount late in endurance event (if carbonated, should be flat).

Good to know (Hammond A. L., 2011)

- The researches found that not everyone responds in the same manner to the substance.
- The impact to strength events and short sprints is unclear.
- Drinking more coffee or taking more caffeine pill does not translate into better performance.
- Anhydrous sources of caffeine, such as caffeine pills, were found more effective than coffee.
- Habitual caffeine users will not see any ergogenic effects from caffeine prior to a race.
- Caffeine is the most commonly used drug in the world.

Caffeine and doping

It has been shown that caffeine supplementation can significantly enhance performance in trained athletes. The International Olympic Committee mandates an allowable limit of 12 µg of caffeine per ml of urine. The World Anti-Doping Agency does **not deem caffeine to be a banned substance**, but has instead included it as part of the **monitoring program**. The agency removed from their list of banned substances in January 2004. (World Anti-Doping Agency, 2012)

Conclusions

- ✓ Caffeine is a substance that is found in many organic compounds and is consumed in coffee, drinks, tea, tablets, and foods.
- ✓ Caffeine has a wide range of actions in the human body, including hormonal, metabolic, muscular, cardiovascular, kidney, and respiratory effects. Also works on the central nervous system.
- ✓ The studies showed clear that the caffeine has a positive effect on maximal endurance exercise and short term, higher intensity exercise, also has been shown to be very effective for enhancing time trials.
- ✓ The impact to strength events and short sprints is unclear.
- ✓ Caffeine its use as an ergogenic aid has been proven to increase physical endurance but has many side effects and precautions.
- ✓ Caffeine exerts a greater ergogenic effect when consumed in an anhydrous state (in capsule, tablet, powder form) as compared to coffee.
- ✓ Caffeine supplementation is beneficial for high-intensity exercise, including team sports.

- ✓ The scientific literature does not support caffeine-induced diuresis during exercises, or any harmful change in fluid balance that would negatively affect performance, in case of moderate doses.
- ✓ The amount of caffeine commonly shown to improve endurance performance is between 3 and 6 mg per kg of body weight.

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