THE ATHLETE

SPORT MEDICINE COUNCIL OF MANITOBA

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CAFFEINE USE IN SPORT:

Should it be allowed, restricted or banned?

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Let's first set the record straight. Caffeine is a drug. In fact, it is the most widely ingested psychoactive drug in the world. That's right - more than alcohol, more than marijuana, more than valium...more than any other drug that affects the brain. Moreover, it is the world's most abused drug. As many of us know all too well, chronic use of caffeine makes you dependent on it, tolerant to its actions, crave it, and makes you experience unpleasant withdrawal symptoms when its use is stopped. Thus, caffeine fulfills all criteria by which agents are classified as drugs of abuse. Nevertheless, its use is legal and only at high, but readily attainable, levels is it banned from sport.

Is it a food or a drug? Caffeine (1,3,7-trimethylxanthine) is found in coffee, tea, soda's, and 'sold over the counter' medications. The general public uses it, and perhaps not surprisingly, it is used systematically by athletes in an attempt to enhance performance. Most people are familiar with the main pharmacological actions of caffeine; it stimulates the nervous system, increases urine output and, less well known to the general public, it is a well-documented performance-enhancing agent. So, although caffeine is a 'drug of abuse' and is performance enhancing (see below) it has yet to be banned from sport. This should be careful re-considered because among 11 to 18 year old Canadian students, 35% believed it could enhance performance and 25% had actually used caffeine for such a purpose.

Does caffeine enhance athletic performance? Because caffeine is legal, it is one of the few drugs where proper studies could be performed ethically to test whether caffeine improves athletic performance. Nevertheless, it has only been in the past 10 years or so that caffeine's benefits have begun to be well documented. Many of the earlier studies failed to use only highly trained athletes, and individuals who have similar histories of caffeine use who have abstained from caffeine consumption for at least 48 hours prior to being studies. In short-burst power events, caffeine does not appear to provide benefit. However, as summarized in the following Table, the results of studies over the last five years strongly indicate that caffeine is effective at increasing performance in endurance events.

Type of exercise	Outcome
Cycle to exhaustion	↑time to exhaustion
Run to exhaustion	↑time to exhaustion
Tennis	↑winning percentage ↑post-exercise recovery
Intense repeated cycle	↑time to exhaustion
1500 m swim	↓race time by more than 30 s

What happens to caffeine once ingested? Caffeine is well absorbed into blood follow-

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ing oral administration - peak plasma concentrations are reached within 15 to 120 minutes depending mainly on gastric emptying times. The absorption is roughly the same regardless of whether caffeine is drunk, swallowed in capsules or eaten. Absorption may be different if injected subcutaneously, intramuscularly or inserted as a solid suppository. Caffeine is mainly metabolized in the liver, but the kidneys can also be involved in caffeine metabolism. Various things affect caffeine metabolism; metabolism is increased in habituated caffeine users, in people who smoke tobacco, in people who take acetaminophen (eg. Tylenol), in people who exercise, and in people who eat a diet rich in cruciferous vegetables and/or flavenoids. On the other hand, certain drugs (eg. alcohol and the antidepressant fluvoxamine), oral contraceptives by females, and certain spices (capsaicin from hot red peppers) inhibit caffeine metabolism. There are also genetic considerations among North American Caucasians that affects the rate of caffeine metabolism.

Caffeine is excreted mainly in the urine - it takes 3 to 5 hours to excrete 50% of the caffeine ingested, but only 0.5 to 3 % of the caffeine is excreted as such. Caffeine appears to be metabolized equally well in both sexes, but during times of strenuous exercise there is a greater decrease in elimination in women than in men. All of these factors are of concern to athletes using caffeine because they affect the absorption, metabolism, and excretion of caffeine thus changing blood and urine levels.

How does it work? Without getting overly technical and risking losing some of the readership at this point, we point out that research over the past 20 years has gone along way towards figuring out putative mechanisms by which caffeine is thought to enhance endurance performance. The most well understood mechanism of caffeine's action is its ability to block sites of action for the primarily inhibitory substance adenosine that is present throughout the body. The activation of these sites (receptors) by adenosine causes many effects including inhibition of fat metabolism, slowing of heart rate, and general nervous system inhibition. On the basis of these actions, it is easy to understand why caffeine by blocking these receptors results in actions that are largely opposite to those of adenosine. This is particularly important during exercise when adenosine levels rise dramatically because of increased consumption of ATP (the main source of energy to cells) and because oxygen delivery does not meet demand.

The actions of caffeine are summarized as follows. Caffeine can:

- Increase free fatty acid levels and delays the use of the body's carbohydrate stores during times of strenuous activity particularly during the first 15 minutes of endurance exercise.
- Increase the release of adrenaline from adrenal glands, but it is now recognized that this is not the most important mechanism of caffeine's actions, especially in explaining the actions of caffeine during exercise.
- Increase plasma levels of the stress hormones cortisol and ACTH. Cortisol has been regarded as the primary peripheral effector of overall improved athletic efficiency so it is surprising that the role of caffeine in altering cortisol and ACTH levels has been largely overlooked as a major mechanism of caffeine-induced increases in endurance performance.
- Increase levels of intracellular calcium in skeletal muscle, and via this action it can facilitate excitation-contraction coupling and increase muscle efficiency.
- Decrease levels of extracellular potassium and inhibits the activity of the enzyme cyclic AMP phosphodiesterase, but these do not appear to mediate the exercise-related effects of caffeine.

How might caffeine be performance enhancing? "Winning is 90% mental and 10% physical". That should give you the first clue as to how caffeine might be working. Numerous studies have shown that caffeine is capable of decreasing the perceived level of exertion especially in endurance athletes. These effects are likely due to caffeine-induced changes to the chemicals in the brain, neurotransmitters, which help transmit signals between nerves. These changes likely lead to increased excitability and alertness.

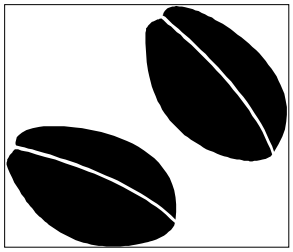
The transmitters implicated in these actions include:

- Adenosine, an inhibitory neuromodulator,

which is capable of decreasing synaptic transmission. Blockade of adenosine receptors by caffeine increases the release of excitatory neurotransmitters and results in increased neuronal excitability.

- Dopamine, a neurotransmitter important in controlling locomotor function and emotions has been implicated in athletic performance.
- Caffeine has also been shown to decrease, albeit weakly, the actions of the inhibitory neurotransmitter GABA.
- The levels of the neurotransmitter serotonin may be lowered by caffeine and as a result increase endurance capacity by removing a fatigue factor.

Other mechanisms that might help explain the performance enhancement of caffeine include increasing VO_2 max under conditions of strenuous exercise and acting as an antioxidant whereby it might reduce free radical-induced muscle damage and potentially decrease the recovery time required between strenuous exercise regiments. Thus, the effects of caffeine in the CNS are numerous and complex, but poorly understood. In spite of this it is apparent that caffeine is producing effects which may lead to enhancement of athletic endurance.



So what is the downside?

- Withdrawal from caffeine can cause headache, fatigue and decreased vigor. Anxiety, nausea/vomiting and craving occur with lesser frequency. While these symptoms might make an athlete feel 'out of sorts', they do not significantly affect performance.
- Caffeine can increase heart rate during exercise and increases heart rate and blood pressure in mildly hypertensive individuals. Although the full range of effects of caffeine on the cardiovascular system in response to exercise has not been fully characterized, the effects on heart rate and blood pressure would be detrimental to an athlete.
- Caffeine has a diuretic effect such that under normal condition urine output is increased. However, during exercise, caffeine did not increase diuresis.
- Caffeine has a negative effect on endurance events because of increased loss of calcium, which may lead to decreased muscle contraction, and loss of magnesium that may lead to muscle cramping.
- Caffeine prolongs wakefulness and causes disturbances in sleep patterns. Such actions during training or prior to competition may have a negative impact on athletic performance.
- Caffeine can cause anxiety and panic disorder
- Caffeine through its actions on adenosine receptors may decrease the body's production of erythropoietin, the hormone that signals for production of red blood cells thus decreasing the body's ability to carry oxygen.
- Caffeine can also counteract the ergogenic effect of creatine loading.

How much is too much? Caffeine is a restricted substance with an allowable limit in urine of 12 mg/ml. The Australian view is that the 12 mg/ml limit is too low as this limit may be exceeded by 3-6 cups of coffee per day. The Canadian view is that the 12 mg/ml limit is too high because caffeine has enhancing properties at levels lower than the allowable limits.

To reach the 12 mg/ml level in urine, individuals need drink 3-6 cups of strong coffee (95-150 mg caffeine/ 250 ml) in a short period of time. The IOC rules state that any compound (natural or synthetic), that produces an elevation of corticotrophin or growth hormone, is banned. As caffeine has been reported to increase the levels of both of these hormones, it would seem logical that caffeine should be banned at least during competition.

Conclusion: Over the past ten years, it has become readily apparent that caffeine is an effective agent for increasing endurance performance in athletics. Athletes continue to take advantage of this agent so as not to be left behind by their competitors. Caffeine in combination with ASA and ephedrine is a current trend in sports training. Thus, the question of caffeine use/misuse in sports will likely remain a topic of importance worthy of careful consideration and debate.

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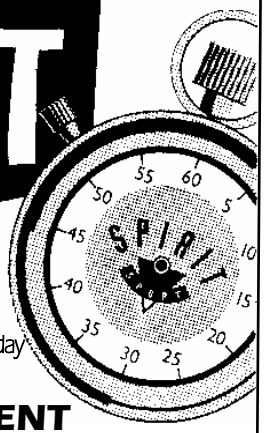
PERFORMANCE ENHANCEMENT WORKSHOP



A Drug Free Athletic Performance Enhancement Workshop

A two day workshop to help athletes and coaches maximize performance through advanced training techniques

DRUG FREE PERFORMANCE ENHANCEMENT

Manitoba Athletes and Coaches are invited to explore new opportunities for maximum performance without the use of steroids and other performance enhancing substance. This two day workshop will show you how to apply the latest performance enhancement training techniques to your sport and includes education and materials on drug use in sport.

Both theory and practical sessions are provided for each of the topics: Sport Physiology, Sport Nutrition, Sport Medicine, Sport Psychology and Drugs in Sport. There is also a presentation by an elite athlete or coach on their experiences in sport, training techniques and the spirit of sport. Other presentations can be included as the host requests.

What the Host Provides

- Workshop Facility – that includes gym space, weight area, classroom space and audio-visual equipment.
- Lunch – provided for all participants and presenters on both days
- Help with promoting the event locally. Materials can be produced by the SMCM.
- A Guarantee of at least 25 participants, one week prior to the seminar.
- A liaison to work as the main contact with the SMCM for suggesting accommodations and activities.

What the SMCM Provides

- Presenters in each of the areas of: Sport Physiology, Sport Nutrition, Sport Medicine, Sport Psychology, and Drugs in Sport. As well, an elite Manitoban athlete or coach will speak on the Spirit of Sport and their experiences in life and competition.
- Accommodations, meals and transportation for all presenters.
- Materials for each participant: A Performance Enhancement Manual, A SNAC workbook, CCES drug books, an athlete training diary, and a t-shirt.
- Registration brochures, press releases, posters and other promotional materials where needed.
- Collection of registration.

Contact the Sport Medicine Council of Manitoba at (204) 925-5750 for more information.
Feel free to copy the Enhancer.
Any comments, suggestions or ideas for future issues are welcome.

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