"Nicotine, Exercise and Heat Stress: Performance Benefits, Health Risks and Implications for the Prohibited List"

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Project Overview

In 2011 a study reported that of 2185 urine samples from professional athletes (spanning 43 different sport disciplines), 'active' consumption (not passive environmental exposure) of nicotine and/or tobacco-related alkaloids were detected in 15% immediately prior to and during sport practice. That same year WADA added nicotine to its Monitoring Program. Taken together, this highlights the extensive and alarming use of nicotine in professional sport.

Inclusion on the Monitoring Program implies nicotine satisfied three criteria of potentially i) enhancing performance, ii) representing a health threat for athletes and, iii) altering the spirit of sport. However, whilst evidence for the latter two criteria features in abundance the former criterion suffers from a lack of evidence or examination. To date, only two studies have investigated the effects of nicotine on sporting/exercise performance, with one showing an endurance improvement of 17% whilst the other found no effect.

However, evidence from similarly acting drugs such as bupropion and methylphenidate suggests that any performance improvements only occur at warmer ambient temperatures, when their action as central stimulants becomes more obvious. These substances also cause body temperature and heart rate to be pushed closer to the limit of safety.

Many competitive sporting events, especially endurance, take place during the summer period or in warm climates. Nicotine is known to reduce skin blood flow. When combined with exercise this raises a serious concern over the safety of its use during exercise/sport in a warm environment, where increasing skin blood flow and sweating are the primary routes of heat loss, possibly placing an athlete at greater risk of developing a heat illness.

This project will extend the limited data on whether nicotine does improve endurance performance, and determine whether at higher ambient temperatures nicotine may lead to developing heat illness, increasing an athlete's health risk.

Result and Conclusion:

Nicotine was added to the 2012 WADA Monitoring Program after it was found that 15% of professional athletes actively consume it. Previous research has demonstrated that transdermal nicotine administration improves cycling time

to exhaustion but does not influence 1h cycling time-trial performance in a moderate (~20°C) ambient temperature. However, evidence from similarly acting drugs suggests that any performance improvements only occur at warmer ambient temperatures, when they also cause body temperature and cardiovascular function to be pushed closer to the limit of safety.

Many competitive sporting events take place during the summer period or in warm climates. Nicotine is known to reduce skin blood flow and when combined with exercise this raises a serious concern over the safety of its use during exercise in a warm environment, where increasing skin blood flow and sweating are the primary routes of heat loss, possibly placing an athlete at greater risk of developing a heat illness.

Therefore, this project extended the limited data on whether nicotine does improve endurance performance, and whether at higher ambient temperatures it may lead to developing heat illness, increasing an athlete's health risk. A final aim was to determine whether measurement of nicotine's major metabolite, cotinine, should be performed using blood (serum) or urine. Ten trained, male cyclists cycled for 60 min at 55% of their maximum power output followed by a work-dependent time-trial at 75% of their maximum power output (~30 min) on four occasions. Twice trials were conducted in 18°C and twice in 30°C and in each environment they were administered placebo and nicotine via transdermal patch (7 mg·24hr-1) the evening before.

Ambient temperature affected time-trial performance, such that both time to complete the set work was faster (4±1min) and mean power output was higher (24±8W) in 18°C than 30°C. Forearm blood flow (venous occlusion plethysmography) values increased from 18°C to 30°C (6±1ml·100ml·min-1) and decreased from placebo to nicotine (3±1ml·100ml·min-1). Mean weighted (12-site) skin temperature values were lower in 18°C than 30°C (3.7±0.3°C) and higher with nicotine than placebo (0.5±0.2°C). Core (gastro-intestinal) temperature values were lower in 18°C than 30°C (0.4 ± 0.1°C) and higher with nicotine than placebo (0.2±0.1°C). Total sweat loss and % body weight loss were lower in 18°C than 30°C (0.6±0.1L and 0.7±0.2%). Heart rate was lower in 18°C than 30°C (8±1 beats·min-1). Cotinine concentrations immediately before exercise were higher in urine (140 ± 127 ng/ml-1) than serum (31 ± 29 ng/ml-1).

On the basis of these results, i) under these conditions, nicotine is neither ergogenic nor ergolytic, ii) nicotine does increase the risk for heat illness when administered during exercise coupled with heat stress, and iii) anti-doping efforts should concentrate on athlete urine sampling.