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EDITORIAL COMMENT

Keep an eye on the impact of caffeine on the recovery of the cardiovascular system after exercise

Vigiar o impacto da cafeína na recuperação do sistema cardiovascular após o exercício

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Caffeine (CAF) is a methylxanthine and is one of the most frequently consumed psychostimulant substances.[1] It occurs naturally in coffee beans, tea leaves, cocoa beans, and kola nuts, and is also added to foods and beverages, including caffeinated soda (cola-type) and energy drinks.[2] North America had the highest average country annual total volume sales of caffeine-per capita (348 L/capita), followed by Europe (200 L/capita), Latin America and the Caribbean (153 L/capita), Asia and the Pacific (126 L/capita), and Africa (90 L/capita) in 2017 according to the Euromonitor Passport Global Market Information Database.[2,3]

Caffeine-containing products have a range of doses per serving, from 1 mg in milk chocolate up to >300 mg in some dietary supplements.[3] It is argued that up to 400 mg CAF/day in healthy adults is not associated with adverse effects.[4] However, this should be reassessed. Importantly, caffeine-containing food supplements are marketed for weight loss and sports performance.[5] Moreover, the International Olympic Committee in its consensus statement on dietary supplements confirmed the ergogenic properties of CAF across a broad range of exercise modalities.[5,6] Caffeine was a banned substance in sports and its use was prohibited in competition between 1984 and 2004. However, the World Anti-Doping Agency decided to remove CAF from the list of banned substances with effect from January 1, 2004, and moved it to the monitoring program. Despite the fact that the scientific evidence for CAF ergogenic properties has been increasing over the years, there are still many unanswered questions regarding the use of CAF in sports including the effects of CAF on post-exercise recovery.[7] It is noteworthy that the recovery of cardiovascular system after exercise occurs across a period of minutes to hours, during which many characteristics of the system, even how it is controlled, change over time.[8] This cardiovascular recovery includes hemodynamic adjustments (e.g., regional vascular changes), autonomic contributions (e.g., baroreflex resetting) and histamine signaling pathway, about which very little is known. Although some of these changes may be necessary for long-term adaptation to exercise training, some can lead to cardiovascular instability during recovery. These

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changes are not as well documented following resistance exercise as they are for aerobic exercise.[8]

The impact of CAF on recovery of the cardiovascular system after exercise has been under the spotlight as CAF has well established cardiovascular effects.[9] At low CAF concentrations, positive chronotropic and ionotropic effects appear to result from inhibition of presynaptic adenosine receptors in sympathetic nerves increasing catecholamine release at nerve endings.[9] Higher concentrations (>10 μM, 2 mg/ml), which are associated with phosphodiesterase inhibition and increase in cAMP, may result in increased calcium influx. Moreover, at even higher concentrations (>100 μM) the sequestration of calcium by the sarcoplasmic reticulum is impaired. Therefore, ordinary consumption of coffee and caffeine-containing beverages usually produces slight tachycardia, an increase in cardiac output and an increase in peripheral resistance, raising blood pressure slightly. In sensitive individuals, consumption of a few cups of coffee may result in arrhythmias. In large doses, CAF may also relax vascular smooth muscle with the exception of cerebral blood vessels. Importantly, caffeine acts as a sympathetic stimulus during exercise.[10] However, research findings are mixed on the impact of CAF on the autonomic recovery post-exercise. For example, it was recently shown that CAF increases resting cardiac autonomic modulation and accelerates post-exercise autonomic recovery after a bout of anaerobic exercise in recreationally active young men.[10] No differences were observed between CAF doses on cardiac autonomic reactivity.[10] However, Benjamim et al. (2021) published a manuscript entitled ''Caffeine slows heart rate autonomic recovery following strength exercise in healthy subjects'' showing that CAF delayed recovery of heart rate, blood pressure and heart rate variability indices following strength exercise. This suggests that CAF delayed parasympathetic cardiac control following exercise. It is not always straightforward to compare results across studies because of differences between CAF dosages, physical exercise protocols and the physical status of the subjects. Nonetheless, Benjamim et al. (2021)[11] shed further light on the impact of CAF on cardiac autonomic control in physically active individuals, which needs to be further analyzed within active or athletic populations. This paper also highlights the importance of assessing the benefits of cardiovascular recovery after exercise, or minimizing the vulnerabilities of this state.[8] In fact, recovery from exercise can be envisioned as a vulnerable period in which individuals are at increased risk of adverse cardiovascular events, or a window of opportunity in which the positive adaptations to training can be potentially augmented.[8] Finally, it is of utmost importance to continuously monitor the cardiovascular safety of CAF intake in the context of physical activity and sports.

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Conflicts of interest

The authors have no conflicts of interest to declare.

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