Article

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Infographic. Wake up and smell the coffee

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Caffeine has been used as a performance-enhancing aid by athletes for many years. The first known study to explore the effects of caffeine ingestion on exercise performance dates back to 1907.[1] Until recently, however, findings on this topic remained equivocal, despite a large number of published studies over the last 30 to 40 years.[2] There are many possible reasons for the discrepant results between these studies, but one likely issue could be a common use of relatively small samples. To reconcile the equivocal evidence on this topic and overcome the low statistical power of individual studies, researchers have started to use meta-analytical methods. Meta-analysis is a statistical method that allows pooling of results from studies that address a similar research question.[3]

Given that meta-analytical findings may yield more conclusive statements than individual studies, the recent International Olympic Committee consensus statement placed meta-analyses at top of the hierarchy of evidence pyramid.[3] However, even meta-analyses may produce misleading conclusions. Methods used in a given review, such as the comprehensiveness of the search strategy (*eg*, number of databases searched) and how the data was analysed may impact the overall robustness of these findings. Umbrella reviews (*ie*, reviews that include the synthesis of available meta-analyses) allow better recognition of the uncertainties, biases, and knowledge gaps and therefore may provide a better understanding of the credibility of results from different meta-analyses.[4]

In our recent umbrella review, published in the *British Journal of Sports Medicine*, we synthesised results of the current meta-analyses that explored the effects of caffeine ingestion on exercise performance.[2] We included 11 reviews with a total of 21 meta-analyses. As assessed using Assessing the Methodological Quality of Systematic Reviews 2 checklist, all of the included reviews were categorised as being of moderate or high methodological

quality. The included meta-analyses explored the effects of caffeine vs placebo on different exercise tasks, including aerobic endurance, muscle strength, muscle endurance, anaerobic power, jumping performance, and exercise speed. Moderate-to-high quality systematic reviews that provided a moderate quality of evidence (assessed using the Grading of Recommendations Assessment, Development and Evaluation [GRADE] criteria) support the ergogenic effects of caffeine on muscle endurance, muscle strength, anaerobic power, and aerobic endurance.[5-8] For other outcomes, namely, jumping performance, and exercise speed, we found moderate quality reviews that provided evidence categorised as of low or very low quality on the GRADE assessment. The majority of primary studies were conducted in young men, which highlights the need for future studies in women and older age groups.

Across the primary studies, caffeine was most often provided as caffeine anhydrous (concentrated caffeine powder). However, ingestion of caffeine through coffee also has the potential to be ergogenic.[9] For a 70-kg individual, approximately two cups of coffee should generally be ergogenic as this dose would provide around 3 mg of caffeine per kg of body mass—which seems to be sufficient for acute improvements in exercise performance. However, the content of caffeine in coffee may vary depending on the coffee bean type, preparation method, as well as coffee brands and flavours, which needs to be taken into account when prescribing caffeine supplementation.[10-12]

In summary, this umbrella review highlights that the effects of caffeine on exercise performance are well-established and well-replicated, appearing consistent across a broad range of exercise modalities. Therefore, individuals interested in acute performance-enhancement may consider the use of caffeine.

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