



Beat the heat: How to become a gold medalist at the Tokyo Olympics

“Faster, higher, stronger” is the official Olympic motto and illustrates that participating athletes are expected to deliver extraordinary performances to entertain spectators and achieve the highest possible ranking. For this purpose, every athlete spent multiple years of hard training and intense preparations to succeed in their Olympic dream: become a gold medalist. The stakes are high. From fame and financial prosperity to the happiness of fulfilling a successful career. But the competition is tough and the difference between winning and losing is small, and seems to become smaller in every Olympic cycle. Therefore, Olympic performances are no longer a one (wo)man show, but a team effort instead.

Athletes and coaches will develop the best possible training schedules to optimize endurance capacity, muscle strength, and sport-specific skills. But so does every Olympic competitor, making it difficult to be a step ahead on this level. Therefore, insights to enhance performance from neighboring disciplines gained significant attention in the past decade, such as providing mental support (psychologist), improve sleep quality (neurobiologist), consume sport-specific diets and supplements (dietician), and monitor training load and associated recovery (data scientist). Also, technological advancement and innovation in sports gear and apparel are now common strategies to boost performance, as was recently illustrated by the introduction of shoes with carbon fiber plates for track and field athletes. Such garment is exclusively available to athletes and teams affiliated with the producer, which may outrank competitors. Successful collaboration and interplay between athletes, coaches, and these embedded scientists is, therefore, key to deliver optimal performance.

The Tokyo Olympics have an additional challenge compared to previous editions of the Summer Olympics. Tokyo’s local climate is extremely harsh with expected ambient air temperatures of $>30^{\circ}\text{C}$ and relative humidity of $\pm 70\%$. This combination will presumably result in the most challenging environmental conditions ever observed during the Olympic Games [1], leading to significant heat stress for athletes competing in outdoor disciplines. Hence, significant performance decrements can be expected and athletes are at increased risk for the development of heat-related illnesses [2]. That these heat stress induced consequences are not purely theoretical became clear during the 2019 IAAF World Championships in Doha, Qatar. Despite the female marathon race was scheduled for a mid-night start in an attempt to alleviate some of the heat stress, environmental conditions remained challenging (air temperature: 33°C , relative humidity: 73%) and comparable to the Tokyo summer climate. Importantly, only 40 of the 68 entrants (58%) finished the race, in the slowest winning time (2:32.43) in the history of the World Championships. These observations highlight a large window of opportunity to improve exercise performance in the heat but also underline the need for athletes to prepare for the challenging environmental conditions of Tokyo 2020.

There is good evidence available about the efficacy of heat mitigation measures. Heat acclimation and acclimatization are known to induce beneficial physiological adaptations that increase heat tolerance at rest and during exercise [3]. Pre-cooling and per-cooling interventions attenuate core temperature during exercise and are known to improve exercise performance in the heat [4]. And a planned hydration strategy can prevent the occurrence of dehydration and associated performance loss [2]. Outcomes of these scientific studies are translated to various practical advices for athletes and coaches. The problem, however, is that such

recommendations are often too generic (i.e. “acclimatize for at least 2 weeks,” “use pre-cooling during warm-up,” etc.), which hinders an effective implementation in the elite sports environment.

An embedded thermo-physiologist should fill this gap and can translate scientific findings into practical and personalized solutions. To achieve this mission, the first step is to raise awareness among athletes and coaches and to educate them about the challenges of exercise under heat stress. Exercise in high ambient air temperatures is something that most elite athletes experienced previously during their career, but the impact of a high air temperature in combination with high humidity is often underestimated and may even be neglected if they are not informed about, and preferably exercise in such a climate.

Second, heat mitigation measures should be tailored to the individual athlete as much as possible. Large variations in the magnitude of exercise-induced elevations in core temperature have been observed [5]. These differences partially depend on factors such as age, sex, body mass and morphology, fitness, exercise intensity, and hydration status. However, within-athlete elevations of core temperature following exercise are remarkable reproducible [6], suggesting that every athlete has a typical response to exercise in the heat. Hence, we recommend to test, test, test! Extensive data collection to assess core temperature and performance measures during standardized exercise tests, training sessions and competition allow the embedded scientist to build a personalized temperature profile of athletes. The Thermo Tokyo study is an example of how such an approach could be implemented in sports practice, and the rationale and design of this project were recently described in *Temperature* [7]. Such information gives important insight in how the individual athlete responds to exercise in the heat, and how core temperature and performance outcomes deviate from benchmark data. Athletes with abnormal responses, such as excessive performance loss or very high peak core temperature, may subsequently benefit from intensified mitigation measures, such as prolonged heat acclimation or additional cooling/hydration strategies.


Third, protocols for the use of heat mitigation measures should be developed bottom-up instead of top-down. All relevant stakeholders, including coaches, team doctors, physiotherapists and embedded scientists, should be involved so that all mitigation measures are adopted to training regimens, are incorporated into extensive pilot and practice sessions, and comply with sport-specific rules and regulations. This way, acclimatization, cooling strategies, and hydration plans will become common practice for athletes and their support team, which maximizes the success rate without disrupting the athlete’s focus on the Tokyo Olympics.


Becoming a gold medalist at the Tokyo Olympics is the ultimate goal of every athlete. Apart from innate talent, years of exercise training, a dedicated lifestyle, support from a multidisciplinary team, and access to sports garment with the latest technological advancements, the Olympic athlete also need to beat the heat beyond fellow competitors! A committed thermophysiological approach allows Olympic teams to develop, optimize, and implement heat mitigation strategies and tailor these solutions to the individual athlete and sports discipline. Such an approach contributes to a safe and maximal exercise performance during the challenging environmental conditions of the upcoming Tokyo Olympics. To paraphrase the chairman of the International Olympic Committee, the new Olympic motto should, therefore, be “*faster, higher, stronger – together, with science*”.


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