**Menthol mouth rinsing: an applied perspective**

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With the Tokyo Olympics rapidly approaching, and increasing global temperatures, applied nutrition practitioners and supporting scientists are looking for ways to physiologically cool their athletes, but the value of perceptual cooling is also gaining a profile; menthol mouth swilling is one such strategy. This article provides a brief synopsis of menthol research to date, followed by a reflection of how we have used menthol mouth rinsing to complement an Ironman™ triathlete's event nutrition strategy, and concludes by highlighting ethical concerns with menthol mouth rinsing.

Research to date has focused upon endurance sports taking place in hot environments (28 - 35°C) [1,2], tending to adopt variations on time to exhaustion (TTE) protocols, yet Chris Stevens' work has shown improvements in time trial performance in runners, over distances as short as 5km [3]. Time trial improvements have also been shown in cyclists and triathletes in tropical conditions, when menthol has been combined with other ingested cooling strategies [4,5]. The researched range of time to task completion is ~20 to 70 minutes, with application typically spaced evenly throughout exercise. However, a recent paper by Owen Jeffries showed that a single menthol mouth swill applied at 85% of TTE can extend TTE in the heat, when compared to placebo, and performs as well as ice applied at the same time point [6]. Here, menthol presents a novel thermal stimulus which challenges the athlete's interpretation of their perceived thermal state – refreshing athletes and allowing more work to be performed, suggesting that a more tactical approach to the use of menthol may be required.

Currently there is no evidence that menthol benefits intermittent activity [7]. This may be due to the work rest ratio that typically characterises intermittent sports, or that performance can also be assessed by skill success rates, which have an element of innate variability too. Similarly, menthol may not show performance improvements in events that are comprised of a blend of aerobic and anaerobic work such as a 1500m, especially in tactical races that aren't limited by thermoregulatory ability *per se*. Although, strength or power athletes may benefit from the pleasant refreshing sensation of menthol[8], making the wait time between attempts when competing in the heat more bearable e.g. shot-putt or discus. Equally, there may be a unique role for menthol swilling in equestrian sports, especially in Tokyo, as an athlete's horse also produces a considerable amount of heat, thus imparting another thermal load upon the athlete.

From an applied perspective, we have used menthol swilling as part of an athlete's nutrition strategy at Kona, specifically in conjunction with on course nutrition whilst completing the bike component of her Ironman™ performance. This strategy consisted of 0.1% menthol solution in 750ml drinks bottles, coloured blue to maximise perceptual cooling[9]. The athlete aimed for ~30ml per swill, taking place every 10 - 15 minutes alongside food intake and the sports drinks available on the bike course. The athlete reported improved thermal comfort and sensation and reduced flavour fatigue from carbohydrate drinks. The timing was self-selected, and had been trialled in heat acclimation sessions and long training rides before heading to Kona. The 0.1% concentration was adopted from our paper in *Beverages*[9], but can be tailored to personal preference quite easily. One way to assess which menthol concentration to trial with an athlete, is to ask 'How frequently you use strong minty products?'. In habitual menthol consumers, opt for a higher concentration such as 0.1%, if menthol use is infrequent, a 0.01% may be more appropriate.

Aside from concentration preference, the risk of a mismatch between an athlete's heat perception and core temperature also needs to be considered. For this reason, trial menthol in training before using it in competition, and be aware that menthol is just one way to perceptually cool an athlete, not the only way. Evaluating menthol use alongside physiological cooling strategies may also lessen the risk of a physiological and perceptual mismatch. Similarly, menthol swilling has not yet been studied in repeated rounds of competition that are typical of many multi-sport games or multi-day events. This risk may be inherently low as most events in which menthol may produce an ergogenic effect are likely to be contested over two rounds (heat and final), with ample recovery time between. Employing physiological cooling strategies post-exercise, if appropriate, may reduce the risk imposed by an elevated core temperature prior to a second round of competition.

In conclusion, menthol mouth rinsing has been researched predominantly in endurance events to date, with no benefit seen in intermittent sports. Other sports that either impart an additional heat load upon the athlete or have periods of passive recovery in the heat may stand to benefit from menthol containing strategies, due to their perceived freshness[8]. Menthol use needs to be evaluated on a per athlete basis with menthol preference and a potential mismatch between an athlete's thermal sensation and an elevated core temperature considered; employing physiological cooling alongside menthol containing strategies may attenuate this risk to athlete health and performance.

Originally from North Yorkshire, Russ Best is a Senior Academic Staff Member at Wintec, New Zealand, where he leads the Environmental Ergogenic Strategies and Polo Science research groups, alongside coordinating the Centre for Sport Science and Human Performance MSc programme.

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