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COUNTERVIEW: Is Drinking to Thirst Adequate to Appropriately Maintain Hydration Status During Prolonged Endurance Exercise? No

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No, drinking to thirst (DTT) is not adequate to maintain hydration status or optimal performance during prolonged endurance exercise (which should not be limited to timed events). Enough individual and athletic scenarios exist that preclude the DTT recommendation from being an absolute, unwavering, universally effective guideline suitable for all participants. Importantly, "drinking to thirst" is not equivalent to ad libitum fluid intake,[1] and we are certainly not supporting drinking in excess or "as much as tolerable" during or after exercise. However, optimal fluid intake during any prolonged, repeated, or intermittent physical activity is indeed situation- and individual-specific, which can partially rely on thirst as part of an evidence-informed advanced-planned fluid intake strategy.

To further elucidate, we begin by defining terms and underscoring the key relevant issues. The phrase *appropriately maintain hydration* may be applied in terms of preventing fluid overload, or from the perspective of optimally supporting training-competitive athletic performance. Specific to fluid overload (ie, intake and retention of water exceeding the rate of fluid loss), the concept of DTT (ie, relying solely on one's personal

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sensation of thirst as the only stimulus or guide to drinking) originated from concerns about exertional hyponatremia during marathons, ultramarathons, and Ironman triathlons lasting longer than 4 hours.[2,3] Subsequently, DTT has been recommended for recreational, sport, and military activities.[4] DTT is 1 of 4 modes of fluid intake including, as well, ad libitum drinking (ie, whenever or in whatever volume desired); an individualized drinking plan (ie, based on past experiences and simulations of a specific sport or activity, including one's measured sweating rate); and programmed drinking (ie, all individuals drink a specified volume per unit of time; volume or rate may be adjusted on the basis of exercise intensity or type of activity).

When considering optimal support of training-competitive athletic performance, it is widely accepted that a measurable degree of hypohydration can reduce strength, power, local muscular endurance, and cardiovascular endurance.[5] Although controlled laboratory and field experiments have demonstrated decrements in prolonged endurance exercise with a minor total body water deficit approximating 1.5% body weight loss,[6–8] a body weight loss of 3% to 4% reduces high-intensity muscular endurance by approximately 10% and muscular strength by approximately 2%.[5] The relevance of these specific body water deficit levels to DTT is that thirst is not recognized until one reaches a body weight loss of 1% to 2%.[9] We recognize that athletes can safely tolerate a small total body water deficit (ie, 2% of body mass loss) by the end of a race or other athletic bout without medical complications or, in some cases, a measurable negative impact on performance. This is especially evident in short-duration or low-intensity bouts of activity. However, an unintended accumulation of total body water deficit can have a measurable negative effect on cardiovascular and thermal strain,[10] exercise-heat tolerance, performance, and safety when the desired pace is forced and intensity is maintained for an extended duration. This is not to say that adequate hydration is sufficient to prevent exertional heat illness.[11] It is simply one of many contributing factors that can mitigate risk, if appropriately addressed.

Although DTT has a logical foundation based on the physiology of thirst,[4] no research has systematically evaluated the effectiveness of DTT to reduce the risk of exertional hyponatremia or to optimize exercise performance. This was acknowledged by the expert participants of the 2015 International Exercise-Associated Hyponatremia Consensus Development Conference,[4] who recommended that future investigations gather evidence with regard to the success of the DTT strategy. Such research ideally uses either a repeated-measures, crossover experimental design in which subjects perform multiple trials (eg, DTT vs ad libitum) or a controlled, group comparison in which one group uses DTT and the other drinks ad libitum. Previous studies that have reported evaluations of runners or cyclists (ie, who claim to "drink to thirst") rarely, if ever, used these experimental designs or recorded ratings of thirst during prolonged endurance exercise. Without ratings of thirst, it is difficult to state with confidence that DTT was the governing sensation behind and prompting the observed drinking behaviors. Importantly, it is unlikely that it can be empirically determined in the field or laboratory whether any athlete is solely relying on 1) inherent thirst alone to avert incurring an undue body water deficit, or 2) a combination of thirst and other influences that underlie ad libitum fluid intake volume or frequency. This challenges the legitimacy of previous arguments[12] and comments[2] that are based on experiments in which fluids were freely available and in which observed practical fluid intake behavior was described as being solely thirst-driven. Further, it is unlikely that laboratory studies (ie, incorporating control of food intake, environment, and exercise) can be extrapolated validly to marathons, ultramarathons, and Ironman triathlons in which athletes routinely consume a variety of foods and sodium, based on individual preferences, during a 4- to 30-hour event.[13,14]

In cases of undue and extraordinary fluid intake, athletes choose to drink far above thirst (eg, between 6 and 12 L during an 89-km ultramarathon[3]), and far above what any individualized hydration plan would have stipulated on the basis of field observations that simulate competition.[15] Although we do not know what prompted such excessive fluid intake in these select instances, we recommend integrating an evidence-informed individualized drinking plan based on personal competitive or training experiences and field measurements,[16] not solely on the subjective sensation of thirst, which has large interindividual variance and is influenced by numerous intrinsic and extrinsic factors.[9,17] In support of this recommendation, no conclusive research evidence exists to explain how different individuals interpret the concept of DTT, or how to accomplish it. In our experience,[1] the concept of DTT is vague and may be easily misinterpreted by athletes (eg, Should I drink so that thirst is always absent? Should I drink only when my sensory perceptions indicate that I am thirsty?). Simply stated, DTT means many things to many people. Researchers also use the terms DTT and ad libitum drinking interchangeably, with no standardization.[1] Further, during endurance cycling exercise lasting 9 hours, thirst ratings and the change of thirst ratings were not statistically correlated with any of the following variables[18]: total fluid intake, preevent body weight, change of body weight, body water balance, height, and ground speed