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REBUTTAL from "Yes"

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We are pleased that we seem to be in agreement with Armstrong and colleagues[1] that 1) thirst is a valuable signal for the need for fluid intake, and 2) drinking in excess during or after exercise should not be promoted. It seems that we differ with regard to the extent to which thirst can be relied upon for signaling fluid need and the interpretation of the science on appropriate hydration during exercise. Perhaps most relevant are our differing beliefs about the underlying stimulus for the overhydration resulting in exercise-associated hyponatremia (EAH).

Armstrong and colleagues refer to the 2015 International Exercise-Associated Hyponatremia Consensus statement,[2] of which one of us was an author, and seem to misrepresent some conclusions from that work by suggesting there was uncertainty about the role of thirst in supporting appropriate fluid intake during exercise. In fact, the document is quite clear in noting that drinking to thirst was considered to provide adequate stimulus for preventing performance decrements due to dehydration as well as preventing the development of dilutional EAH, although a few potential exceptions were noted. Perhaps most importantly among the exceptions is the situation where thirst is driven by excessive sodium intake during exercise. Sodium supplementation is a common practice among endurance athletes,[3,4] and there is suggestion that excessive sodium intake can drive thirst, resulting in overhydration and even dilutional EAH[5,6] or pulmonary edema.[7]

It is commonly stated that the sensation of thirst is not recognized until some dehydration has already developed, as was argued by Armstrong and colleagues. Although we accept that there might be some situations involving very high sweat rates when dehydration could precede adequate thirst drive, it is no longer universally accepted that thirst is inadequate to maintain proper hydration during exercise, and concern has been raised that such guidance has been a stimulus for overhydration.[2,8] Interestingly, even the work of Armstrong et al seems to refute the idea that thirst sensation is not elevated until fluid loss has reached 1% to 2% body mass, as they have found thirst with dehydration amounting to less than 1% body mass loss, at least under resting conditions.[9] This supports earlier findings that thirst adequately stimulates drinking before any significant body fluid changes are apparent.[10]

It is also worth noting that both fit and unfit individuals are distinctly thirsty during exercise at mild (∼2%) extents of imposed hypohydration, but fit individuals seem to have greater thirst and greater fluid intake in accordance with their higher requirements during self-regulated exercise for a given level of hypohydration.[11] Fit individuals therefore seem unlikely to be at increased risk of insidious functional dehydration during training or competitive exercise.

We agree with Armstrong and colleagues that appropriate hydration implies avoidance of fluid overload or fluid losses that would impair exercise performance. However, it is not surprising that we disagree on the amount of body mass loss associated with hypohydration and the extent of hypohydration required to impair

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performance. They contend that endurance exercise performance is impaired with “a minor total body water deficit approximating 1.5% body weight loss.” This is in keeping with various guidelines on hydration during exercise, including one published recently.[12] But we have already countered this assertion in our initial response, including the citation of meta-analyses showing that thirst-driven fluid intake results in no performance disadvantage compared with programmed fluid intake[13] and that hypohydration up to 4% of body mass does not impair endurance performance during real-world exercise conditions.[13,14] Furthermore, recent work provides evidence that the percentage of total body water is maintained with ad libitum drinking despite a loss in body mass of ~2% to 3.5% during exercise[15,16] and that thirst-driven drinking sufficiently maintains blood osmolality within an appropriate physiological range.[16] It is this latter point that we believe is most important and should be the focus for defining appropriate hydration.

A distinction between “drinking to thirst’ and “ad libitum fluid intake” has been made by researchers on both sides of the current debate and was used by proponents of the “No” side as support for a difference between these two hydration strategies.[17,18] Yet, their cited study shows there was no difference in weight change or any other hydration marker between groups drinking to thirst versus ad libitum during a 164-km road cycling event in the heat.[17] In a practical sense, these drinking strategies appear to have similar results during exercise when athletes have adequate access to fluid, which we contend applies to most training and competitions. It may be that the concern over a distinction in defining these two drinking strategies is overblown, and simply referring to “self-determined drinking” may be more appropriate to the essence of a discussion comparing the effects of prescribed versus autonomous drinking.[18] We reiterate that both evidence and logic support the adequacy of self-determined drinking for optimizing performance and avoiding hazardous hypohydration.

Armstrong and colleagues indicate an unawareness of what might have prompted excessive fluid intake in cases in which overhydration has resulted in injury. We believe that understanding the driving forces for overhydration is key to prevent further morbidity and mortality from dilutional EAH. Examination of the scientific literature describing EAH cases makes it evident that overhydration is often driven by excessive concerns about dehydration, muscle cramping, and heat illness.[19–23] Additionally, a review of media reports on the deaths of 2 high school American football players in August 2014 suggests that these young men were on teams in which such concerns stimulated the development of cultures of overhydration.

There is no doubt that professional organization guidelines on hydration during exercise are propagated diffusely by commercial marketing efforts and the lay literature, as we have found.[24] It has also been shown that guidelines from scientific organizations influence the hydration behaviors of athletes.[4,8] Based on this, we believe that hydration guidelines that overemphasize the adverse effects that body mass loss during exercise has on performance, muscle cramping, and heat illness have contributed to excessive fluid and sodium intake. We appeal to professional organizations responsible for hydration guidelines to closely scrutinize their recommendations and to consider the effects of their guidelines from this perspective.

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REBUTTAL from "No"

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Although we appreciate a number of the points made in the response by Hoffman et al,[1] it is important to recognize several key limitations in the presented reasoning and interpretations. Notably, the response failed to define drinking to thirst (DTT) and did not consider the varying hydration needs and challenges of those who engage in sporting activities beyond the scope of endurance running. Further, exertional hyponatremia prompted the first description of the DTT approach to rehydration. However, Hoffman et al did not address exertional hyponatremia and its association with DTT beyond noting that it is prompted by excessive fluid intake, and they presented no evidence that DTT reduces the risk of exertional hyponatremia, because that evidence does not exist, to our knowledge.

Maintenance of circulating blood volume, in the presence of an accumulating total body water deficit, does not indicate the absence of an effect or burden on other fluid compartments, physical performance, or exercise metabolism. Thus, the argument by Hoffman et al[1] does not support relying solely on DTT. We present the case for a more objective approach based on individualized sweating rate for the following reasons. First, the maintenance of plasma volume precludes primary sensory neurons in the hypothalamus and cardiac atria from initiating significant thirst that is typically prompted by altered plasma osmolality and/or volume. Second, fluid intake also is highly variable due to unique individual responses to the perceptual integration of oropharyngeal sensations, stomach fullness, beverage characteristics, exercise mode/duration, and ambient temperature. This complexity explains why DTT is difficult to define and investigate in a systematic manner. Furthermore, thirst is fleeting—that is, consuming water causes it to diminish or disappear.[2–4]

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