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LETTER TO THE EDITOR

Hoffman MD, Snipe RM, Costa RJ (2018) Ad libitum drinking adequately supports hydration during 2 h of running in different ambient temperatures. Eur J Appl Physiol 118:2687–2697

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Dear Editor,

The negative effects of dehydration on physiological responses (e.g., increased cardiovascular and thermal strain), exercise performance (e.g., reduced endurance, strength and power), and health (e.g., greater risk of heat exhaustion and exertional heatstroke) have been widely documented in hundreds of publications since 1940. These detrimental effects are graduated in proportion to the amount of dehydration accrued during exercise lasting 2–3 h or longer in a hot environment (e.g., 1–4% body weight loss; 45–70% maximal aerobic power; > 33 °C). Because sweat loss and water intake are the primary factors in determining net exercise-induced dehydration, and because humans do not voluntarily replace all body weight loss via drinking (Hoffman et al. 2018), athletes/laborers/soldiers are justified in seeking supplementary approaches to practically and appropriately minimize resulting body water and weight loss.

Specific to adequate consumption of water and strategies to minimize body weight change during endurance exercise, the merits and disadvantages of three methods have been debated during the past decade—subjectively drinking water as often and as much as desired (ad libitum), using the sensation of thirst as a signal and principal water intake prompt (drinking to thirst, DTT), or informed planned drinking (PD) that is based on individualized sweat rate and anticipated sweat loss. Having participated in this debate previously, we view a recent publication in the journal (vol. 118, issue 12; Hoffman et al. 2018) as a pursuit to support the following perspectives: (a) consuming water ad libitum and DTT provide for adequate hydration during prolonged exercise; (b) body mass change does not fully and directly denote a body water change; and (c) ad libitum drinking during exercise does not impair exercise performance. We question these statements and their practical extrapolation to all prolonged exercise or activities.

In support of statement (a), Hoffman et al. (2018) explain that homeostasis of physiological (Tables 1 and 2) and perceptual variables changed minimally during 2 h of running in the ad libitum condition. However, no mention is given to the fact that the two PD conditions (GLU and WPH in Table 2) resulted in similar pre- to post-exercise plasma osmolality responses and more favorable body mass, plasma volume, and body water changes versus the ad libitum condition.

In further reference to statement (a), Hoffman et al. (2018) neglect to discuss that the mean final rectal temperature of the ten runners in the present study was 39.6 ± 0.7 °C (35 °C environment, Analysis 1). Specifically, the ad libitum drinking trial was not "adequate" to prevent reaching the recognized threshold rectal temperature for exertional heatstroke (39–40 °C; Armstrong et al. 2007), indicating a status closer to a potential medical emergency requiring rapid recognition and cooling. Notably, the mean final rectal temperature in Analysis 2 was numerically highest during ad libitum (39.2 °C) versus GLUC (38.9 °C) and WPH (39.0 °C) trials.

Statement (b) is refuted by the data in Table 1 (columns 2–4, 2 h duration) and Table 2 (columns 2–4). In the four ad libitum water conditions and the two PD conditions, when total body water loss ranged from 2.0 to 2.8 L/2 h, body mass change (kg) was nearly equivalent to the net change

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of body water (L), with differences of only 0.1–0.4 L/2 h. A previous publication similarly reported that body mass change (pre- versus post-exercise) was an accurate and reliable method to estimate change of total body water (0.07 kg difference) after > 2 h of running in a 30.0 °C environment (Baker et al. 2009). Thus, if an athlete knows his/her absolute body mass change in kilograms, that value represents an excellent surrogate for net total body water change, within 100–400 ml (total body water ~ 40 L for a 66 kg adult).

The present experimental design does not inform statement (c), because no performance data are presented (Hoffman et al. 2018). Exercise involved 2 h of continuous running at a slow speed (173 m/min, 9:18/mi, 57:48/10 km). This protocol simulates few if any sports (e.g., football, rugby, tennis, or basketball) or labor/military scenarios, but rather is similar to the all-time fastest pace of the Western States 161 km run (172 m/min, 15.6-h finish time) where all runners other than the winner (Hoffman & Wegelin 2009) moved at a slower pace, including the middle-of-the-pack runner (25 h approximate median finish time; running pace of 107 m/min).

A thirst rating of 5 in Figs. 1 and 3 represents a moderate level of thirst. In all six experiments, the mean thirst ratings ranged from 2 to 4 on a 10-point scale. Relative to our past laboratory research experiences, these mean values are low for a 2-h continuous exercise session, especially when the ambient temperature is 30 or 35 °C and test participants consumed water ad libitum. Despite the text dismissing the influence of investigator interactions on drinking behavior as "unlikely" (page 2695), we propose that the act of asking runners to rate their thirst 12 times during 2-h exercise sessions encouraged them to focus inordinately on thirst, biased their rate of water consumption, and influenced thirst ratings.

Heat exhaustion is the most common form of heat illness. In the U.S. Army between the years of 1980–2002, for example, the incidence of heat exhaustion was 4–18 times greater than that of exertional hyponatremia (Fig. 3 in Carter et al. 2005). Dehydration increases the risk of heat exhaustion and is part of its etiology (Armstrong et al. 2007). Planned drinking is encouraged by U.S. Military doctrine that prescribes the rate of hourly water intake and work–rest cycles per hour, on the basis of ambient wet-bulb globe temperature readings.

In summary, the present study does not demonstrate that ad libitum or DTT methods are superior to PD in any scenario. Thus, we believe it is important to qualify the following statements by Hoffman et al. to explain that they are mainly relevant to specific individuals (notably those with a low sweat rate) and certain activities and events: ad libitum drinking does not impair exercise performance, and ad libitum drinking is adequate to support fluid needs during exercise (Hoffman et al. 2018). As noted above, these statements certainly do not apply to all endurance activities or other extended duration training sessions and sport events.

Author contributions LEA and MFB conceived the ideas for this Letter to the Editor, edited the text, and approved the final version of this manuscript.

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