On the Maintenance of Human Heat Balance during Cold and Warm Fluid Ingestion

Dear Editor-in-Chief,

The influence of ingested fluid temperature on thermoregulatory responses during exercise has attracted considerable attention during the past decade. To date, however, it has remained unclear whether body heat storage is truly altered. A thermometric model is generally considered inaccurate for estimating heat storage during exercise (2). Therefore, we previously assessed the influence of ingested fluid temperature on this parameter using partitional calorimetry (1). In a follow-up study, we demonstrated that thermoreceptors in the abdomen—not mouth—might independently mediate fluid-temperature-dependent alterations in sweating (4). A recent study by Lamarche et al. (3), published in *Medicine & Science in Sports & Exercise®*, duplicated the design of our earlier study but importantly assessed heat storage using direct, rather than partitional, calorimetry—the former, ostensibly, being more accurate. Their précis suggested observations different from our two previous studies and questioned the validity of employing partitional calorimetry. However, upon closer examination, their study seemingly yielded similar findings, with one important exception that helps highlight the limitations of partitional calorimetry.

Arguably, the most practically relevant finding from our previous study (1) was that ingestion of cold fluids (10°C or 1.5°C), compared to thermoneutral (37°C) fluids, during exercise does not lead to lower body heat storage due to a reduction in evaporation that is proportional to the heat energy exchanged internally with ingested fluids. Lamarche et al. (3) reproduced the same finding (for 1.5°C), thus demonstrating that partitional calorimetry provides an apparently reliable assessment of heat storage at least during cold fluid ingestion.

No statistical difference in forehead sweat rate was observed between ingestion of 50°C water and ingestion of 1.5°C water, whereas upper back sweat rate was only statistically different after the third bolus ingestion (3). Together, these observations were reported to contradict our other previous study (4). However, a clear separation between conditions appears evident—particularly on the forehead (Fig. 3D in [3])—after ingestion, indicating that statistical significance may have been attained with a larger sample size.

With direct calorimetry, our previous conclusion of a disproportionately greater increase in evaporation from the skin relative to the heat gained internally with ingestion of 50°C water (1) is now shown to be potentially incorrect (3). These conflicting reports can probably be explained by a better maintenance of sweating efficiency with circulating airflow in a direct calorimeter, as opposed to our forward-facing airflow. Although the accuracy of both calorimetric methods is limited to combinations of activity and climate that induce complete evaporation, the present study indicates that the upper limit of these conditions is likely cooler and drier for a given metabolic rate when employing partitional calorimetry. These limits can probably be expanded though with the addition of a sideways-facing fan.

Collectively, these studies conclusively demonstrate that humans physiologically compensate for internal heat exchange with cold (and probably warm) fluid ingestion by altering sweating activity and thus evaporation from the skin. As such, when complete sweat evaporation is permitted, no differences in heat storage occur, irrespective of drink temperature. However, colder fluid is probably beneficial from a human heat balance perspective when sweat begins dripping.

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