SESSION 1

Chair: Pilar Riobó, MD, PhD. Head of Nutrition and Endocrinology Service. Hospital of Jimenez Díaz Foundation. Madrid. Spain

Hydration in the healthy: challenges and opportunities

Susan Shirreffs, PhD.

Scientist at New Product Research. GSK Consumer Healthcare. London. United Kingdom.

In the healthy adult population with a normal physiology being euhydrated should be the typical hydration status. The contribution to daily water intake from food can be significant, but the majority of people probably consume most of their water from drinks.

A minor, temporary hypohydration or hyperhydration will be corrected by homeostatic mechanisms; thirst to stimulate water intake, absence of thirst to attenuate consumption, and an increase or decrease in urine formation to modify water losses. But whilst urine production is not under voluntary control, water intake can occur in the absence of thirst or be absent in the presence of thirst if the physiological signals are ignored.

Causes of hypohydration can be varied including sweat loss, diuresis, diarrhea and restricted intake of water from foods and drinks. It may occur deliberately or inadvertently. Challenges to euhydration may occur when water losses are exaggerated or when water intake is reduced. Typically, when water is lost from the body it is lost with accompanying electrolytes and there are certain circumstances when electrolyte take with or in close temporal association to water intake is beneficial.

Key words: healthy adults, euhydration.

Beverage and water intake in European countries: measurement techniques

Mariela Nissensohn, PhD.

Doctor of Department of Clinical Sciences, University of Las Palmas de Gran Canaria. Las Palmas de Gran Canaria. Spain.

In the field of nutrition, fluid intake has always been a challenge to assess adequately. Nutritional surveys often collect data regarding beverage consumption but they are difficult to compare due to their different sources and different methodologies. Biomarkers of beverage intake are able to assess dietary intake/hydration status without the bias of self-reported dietary intake errors and intra-individual variability. Although some biomarkers have been proposed to assess hydration status since some years ago, to current date there is no consensus about which biomarkers truly reflect changes of hydration status in response to beverage intake.
Our work was divided in two parts: In the first part we examined the available techniques used for assessing beverage intake in European epidemiological studies and described the most frequent method applied to assess it. Information on beverage intake available from European surveys and nutritional epidemiological investigations was obtained from gray literature. Twelve articles were included and relevant data were extracted. The selected studies were carried out on healthy adults by different types of assessments. The most frequent assessment tool used was the 7-d dietary record. Only a German study used a specific beverage assessment tool (Beverage Dietary History).

In the second part we searched for beverage intake questionnaires available in the scientific literature to assess beverage intake and hydration status and their validity against hydration biomarkers. After the scientific literature search was conducted, only two articles were selected. Two different questionnaires were designed to capture the usual beverage intake. They were validated against Urine Specific Gravidity biomarker (USG). The first tool was the Water Balance Questionnaire (WBQ) and reported no correlation with USG. The second questionnaire was the Beverage Intake Questionnaire (BEVQ), a quantitative food frequency questionnaire (FFQ) that also found a negative correlation with USG.

Conclusion: From the limited data available we concluded that consumption of beverages is quite different between European countries making the need for a valid assessment tool for beverage intake of paramount importance. Current epidemiological studies in Europe focusing on beverage intake are still scarce. We also concluded that FFQ appears to measure beverage intake more accurately than WBQ when compared with biomarkers. However, the WBQ seems to be a more complete method to evaluate the hydration balance of a given population.

Further research is clearly needed to properly establish the amount of beverage intake in European population and to understand the meaning of the different correlations between intake estimates and biomarkers of beverage intake in different population groups and environments.

Key words: beverages intake, hydration biomarkers, epidemiological European studies.

Hydration an aerobic exercise performance: impact of environment and physiological mechanisms

Michael N. Sawka, PhD.

Professor at the School of Applied Physiology. Georgia Institute of Technology. Atlanta. United States of America.

Physical exertion with exposure to environmental heat, cold and high-altitude can induce body water fluxes and deficits. Total Body Water is tightly regulated (~76% of Lean Body

Mass) with normal daily variation (Coefficient of Variation) being < 1% of body mass. Body water deficits > 2% of body mass are defined as hypohydration and can occur from sweat loss (hyper-osmotic hypovolemia), and diuresis from cold, hypoxia or pharmacologics (iso-osmotic hypovolemia). Hyper-osmotic hypovolemia generally elicits a plasma volume reduction proportional to the water deficit; whereas, iso-osmotic hypovolemia results in greater plasma loss for a given water deficit due to reduced osmotic gradient to draw water from the intra-cellular to the extracellular fluid compartment. The impact of hypohydration on physical performance has received considerable research attention and resulted in much scientific controversy, despite relatively consistent finding for any given set of experimental conditions. Hypohydration does not consistently impair anaerobic performance or skeletal muscle strength; however, it can adversely impact on aerobic performance particularly in situations accompanied by a vascular vasodilation.

Aerobic performance can be quantitated as maximal intensity (e.g., maximal aerobic power) or submaximal intensity (time-trial or time-to-exhaustion), with recent studies employing time-trial protocols. Maximal intensity studies are relatively few, but demonstrated that hypohydration generally impairs VO_{2max} in hot environments (with larger water deficits inducing greater VO_{2max} impairment), but not always in temperate environments. The earliest systematic studies of hypohydration and submaximal intensity exercise capacity were conducted in the early 1940's by Adolph and colleagues; they had Soldiers attempt extended (many hours) self-paced marches in the desert during different ambient temperature conditions, while carrying different amounts of water, to determine the distance they could walk over a day. The less water carried and the hotter weather acted together to reduce walking distances. Subsequently, there were many laboratory studies examining hypohydration and submaximal intensity aerobic performance. Those studies demonstrate that hypohydration does not generally impair submaximal intensity performance in cold-temperate environments; however, in warm-to-hot environments hypohydration consistently impairs aerobic submaximal intensity performance. Unfortunately, previous studies have employed very different experimental procedures so their results were difficult to combine into trends. Our laboratory conducted a series of experiments employing similar procedures, but systematically altering skin temperatures from ~20° to ~38° C. For this paper, we define cool/cold skin as < 30° C, warm skin as 30° to 34.9° C and hot skin as 35° C and above. It is recognized that skin temperature effects on cutaneous blood flow/ volume are a continuum with warm-hot skin associated with high skin blood flow and reduced cardiac filling; while hypohydration is associated with reduced cardiac filling. We found that hypohydration begins to impair aerobic performance when skin temperatures exceeds 27° C, and even warmer skin exacerbated the impaired submaximal intensity aerobic performance (additional -1.5% impairment or each 1° C skin temperature elevation above 27° C). Acute exposure to high-altitude causes a systemic vasodilation that can be accompanied by body water deficits from hypoxia-mediated diuresis with high sweat losses. We recently examined the impact of high-altitude (3,048 m) exposure and hypohydration on submaximal intensity aerobic performance in a warm environment (eliciting skin temperatures of ~33°C). Submaximal aerobic performance was impaired by ~10% from high-altitude exposure (*vs.* euhydrated at sea-level), by -19% from hypohydration (at sea-level) and by -34% from hypohydration with high-altitude exposure. Therefore, hypohydration and high-altitude exposure combine to additively impair submaximal aerobic performance.

Multiple physiological mechanisms are likely responsible, for hypohydration impairing submaximal aerobic performance, which include: 1) cardiovascular strain from plasma volume loss (absolute hypovolemia) and tissue vasodilation (relative hypovolemia) that are sensed by baroreceptors; 2) elevated tissue temperatures in active muscle, tissues, CNS and skin that are sensed by thermal receptors; 4) metabolic changes (from tissue under perfusion and Q^{10} effects) including elevated glycogen utilization that are sensed by metaboreceptors; 5) altered brain structure and work load from water redistribution; and 6) altered perceptual cues; which are all integrated through the CNS to reducemotor drive to skeletal muscles.

Key words: aerobic performance, dehydration, hyperosmolality, hypohydration, hypovolemia.

Dehydration, thirst mechanisms and fluid intake in the elderly

W. Larry Kenney, PhD.

Professor of Physiology and Kinesiology Pennsylvania State University. Pennsylvania. United States of America.

Under "unstressed" conditions of daily life, fluid intake is governed by factors other than thirst. Most large surveys show that daily fluid consumption is the same in healthy, independently living 65-80 year old adults as in 20-35 year olds. However, timing of drinking and beverage choice often vary. Dehydration in the elderly (1) accompanies or results from clinical conditions and/or medication use, or (2) reflects a response to fluid deprivation or fluid loss.

The sensation of thirst is blunted in older subjects during and after exercise- and heat stress-induced dehydration (but not saline infusion).Thirst is a complex physiological phenomenon, involving multiple feedback loops. The primary drivers of the sensation of thirst are high serum osmolality (sensed by osmoreceptors in the brain) and low blood pressure (sensed by low-pressure baroreceptors in the central vasculature). Human and animal data support the hypothesis that thirst deficiency in the elderly is due to a reduced ability to sense a volume deficit, i.e., hypotension or low blood volume. Osmoregulation is relatively intact with progressive aging but new evidence shows that central processing of signals by satiety centers in the brain changes with aging.

Healthy older adults restore all of the fluid losses eventually, but replenishment is slower than in young adults. This age effect appears to be progressive, although the rate of decline is highly variable (no longitudinal data available).

Key words: osmolality, baroreceptors, heat stress, satiety, aging.