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Research report

The development of the predisposition to dehydration questionnaire

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ABSTRACT

The role played by hydration in general health and well-being is an emerging public health issue, yet there are few tools available to monitor its status in large populations. The aim was therefore to develop a questionnaire that assesses individual differences in the tendency to lose body fluid in a warm environment and hence become dehydrated. Fifty-three subjects sat in a room at 30 °C for four hours and changes in mood and measures of hydration were monitored. There were marked individual differences in the loss of body mass that differed from 0.24% to 2.39%. Females who reported habitually drinking a lot had more water in their diet and at baseline the osmolality of urine was lower. After being subject to heat, those who reported habitually drinking more produced more urine, had a lower urine osmolality at the end of the study, and overall more body mass was lost. Females who reported that they responded badly to heat were more confused, unsure and depressed after four hours at 30 °C. In males those reporting that they habitually drank to a greater extent had more water in the diet, and also those who dealt badly with heat habitually drank more. It was concluded that particularly in females, questionnaire measures were able to predict changes in hydration that result from a warm environment.

Introduction

The role played by hydration in general health and well-being is an emerging public health issue as water makes up 50–60% of lean bodyweight in men and 45–50% in women. Intracellular fluid makes up about 35%, extracellular fluid about 12% and plasma about 4–5% of lean bodyweight (Kumar & Clark, 2012). Water plays a role in all aspects of bodily functioning including the distribution of oxygen and nutrients, the removal of waste products, serving as a lubricant and regulating temperature. The loss of bodily water adversely affects both physical (Cheuvront, Carter, & Sawka, 2003) and psychological performance (Benton & Young, 2014), it disrupts thermoregulation and appetite and results in headaches, irritability and sleepiness. EFSA (2010) concluded that “a cause and effect relationship has been established between the dietary intake of water and maintenance of normal physical and cognitive functions”. However, to date, much of the study of the psychological correlates of hydration status has relied on taking physiological measurements in small samples, usually in those who have exercised, an approach that cannot be easily applied more generally. If hydration is to be studied in large populations there is a need for tools that can be used widely. The present study therefore considered one aspect of the topic, the measurement of individual differences in the response to a warm environment, as adequate hydration is particularly important for thermoregulation (EFSA, 2010). The provision of water helps to maintain the body’s core temperature within the desirable range and both mood and cognition are influenced by changes in core body temperature (Holland et al., 1985; Wright, Hull, & Czeisler, 2002). An increased body temperature will result from both decreased sweating and a lower blood flow in the skin, both of which are associated with dehydration.

Euhydration implies being in water balance; that is, the intake of water matches the amount lost. However, as there are well described homeostatic mechanisms that maintain hydration within a prescribed range, many suggest that it is improbable that minor changes in the intake of fluid will disrupt functioning (Benton, 2011). Dehydration is typically defined as the loss of a particular percentage of body mass, with a loss greater than one percent being defined as dehydration. Initially water is lost from the blood and then from the cells. A loss of body mass, greater than one percent, is associated with the enlargement of the brain ventricles, a reflection of the shrinking of brain cells (Benton & Young, 2014). A review concluded that “when dehydration reduces body mass by over 2% there are consistent reports that mood is influenced; fatigue is greater and alertness lower. The effects on cognition have been less consistent. . ..” (Benton & Young, 2014).

In this context there is an interest in evaluating the water balance of populations and hence a need to develop suitable approaches. Recently, the Water Balance Questionnaire was developed by Malisova et al. (2012). This questionnaire uses a wide range of questions to estimate water intake and its loss. Water intake reflects the consumption of solid and fluid foods and the drinking of water, whereas its loss results from its excretion in urine, faeces and sweat.

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In addition what is eaten or drunk, activity levels and the weather influence water balance. One factor that such an approach does not consider is individual differences in the response to a warm environment. The present study therefore related a series of questions concerning the reaction to a warm environment to the loss of bodily fluids over a four hour period spent at 30 °C.

Method

Baseline data were collected from 110 students of Swansea University, of whom 49 were males and 61 females. Of these 23 males and 30 females were then exposed, without drinking, to a temperature of 30 °C for four hours. Of the females 78% were taking an oral contraceptive. They were on average 21.5 years. The average BMI of the males was 25.3 (4.4) and females 23.4 (3.6). The procedure was approved by the Swansea University Psychology Ethics Committee.

Procedure

Subjects came to the laboratory at 0900 having consumed their usual breakfast. They emptied their bladder and gave a sample of urine. They were weighed, rated their mood, responded to the questions concerning the reaction to a warm environment and filled in the dietary diary. Half the subjects then remained in a room at 30 °C for four hours. After 230 minutes they were again weighed before emptying their bladder and giving a second sample of urine. Then after 240 minutes they were weighed a final time and mood was rated.

Questionnaire development

Thirty questions were created that dealt with factors that could potentially influence any tendency to become dehydrated when exposed to a warm environment. Topics included whether in general you tended to feel warm or cold, the tendency to sweat, the frequency of urination, the frequency that drinks were habitually consumed, the extent to which room heating was used and how they felt in a hot environment. Examples of the questions are found in Table 1. Each question was associated with a 100 millimetre line with the statement 'Not at all like me' at one end, and the statement 'Very like me' at the other. The line was marked to indicate the extent to which the descriptions applied to the subject. Using a ruler, a score from 0 to 100 was obtained for each question.

Body mass

Body mass was measured using an electronic scale (Kern KMS-TM, Kern and Sohn GmbH, Germany) that, to avoid problems associated with movement, took 50 assessments over a 5 second period and produced an average. It was sensitive enough to weight to 5 grams and could pick up over short periods changes in body mass due to breathing and perspiration. Subjects were weighed on arrival and after 230 minutes. Finally having emptied the bladder they were weighed for a final time after 240 minutes. Changes in mass from baseline to 230 minutes reflected water loss largely due to perspiration and breathing, and changes from 230 to 240 minutes reflected urine production.

Preliminary studies examined the possible need to weigh individuals naked, as it was possible that some weight loss might be masked if perspiration remained in clothing. In the event this proved unnecessary. The percentage loss of body mass, based on 32 participants weighed naked, was 0.26% (0.05) after 230 minutes and 0.60% (0.33) following urination at 240 minutes. These values were virtually identical to the same individuals measured having worn light clothing: the comparable percentage changes were 0.26% (0.07) and 0.61% (0.35). The data presented were therefore obtained from subjects who wore the same light clothing throughout the procedure.

Osmolality

At the beginning and end of the procedure a urine sample was collected and the osmolality measured using an Osmomat 3000 freezing point osmometer (Gonotec GmbH, Berlin, Germany).

Humidity and room temperature

Room temperature and humidity were measured using a meter supplied by Trotec GmbH, Heinsberg, Germany. The temperature of the room varied from 30 to 31 °C with an average humidity of 53% that, depending on the testing day, varied from 43% to 62%.

Food intake

Subjects were asked to recall the food and drink they had consumed later than 1700 the previous evening and in the morning before coming to the laboratory. The time period was chosen to gain an indication of the contribution of recent dietary consumption to the hydration status rather than to establish general dietary habits. Where possible the size of portions were described, for example a

Table 1
Factor analysis of questions related to fluid intake and the response to heat.

	Sweats easily	Feels the cold	Drinks little	Deals badly with heat
I sweat very easily on a warm day	**0.84**	–0.03	–0.06	0.08
I find my clothes are damp on a hot day	**0.78**	–0.17	0.09	0.18
I sweat more easily than other people	**0.88**	–0.04	–0.20	–0.20
I often have sweaty hands	**0.70**	–0.13	–0.02	–0.05
When I cold I find it difficult to get warm	–0.06	**0.85**	0.03	–0.09
I like the heating turned up	–0.04	**0.77**	–0.19	0.00
I have difficulty getting warm in bed	–0.06	**0.79**	–0.16	–0.01
I frequently feel cold	–0.25	**0.83**	–0.03	0.07
I am often thirsty	0.05	–0.09	**0.80**	0.23
I urinate less frequently than my friends	0.20	0.03	**–0.82**	0.09
I drink (non-alcoholic) more than other people	0.15	–0.18	**0.80**	0.08
I get headaches when the weather is hot	–0.11	0.32	0.11	**0.63**
I feel exhausted in hot weather	0.01	0.04	0.01	**0.86**
I do not deal well with a hot temperature	0.15	-0.33	0.03	**0.73**

The figures in bold indicate the questions used to create overall scores for the four dimensions that were obtained.