International Journal of EXERCISE SCIENCE

Original Research

Fluid Intake and Sweat Rate During Hot Yoga Participation

STEPHANIE CAMPBELL†, ROBERT PRITCHETT‡, KATIE CEDERBURG †, TIM BURNHAM‡, and KELLY PRITCHETT‡

Department of Health Sciences, Central Washington University, Ellensburg, WA, USA

†Denotes graduate student author, ‡Denotes professional author

ABSTRACT

International Journal of Exercise Science 10(5): 721-733, 2017. Hot yoga participants are at risk for dehydration due to the nature of the environment they exercise in. Therefore, the purpose of this study was to investigate the pre-exercise hydration status, fluid balance, perception of sweat loss, and sweat sodium loss in 21 male and female hot yoga participants (mean age ± SD, 33.0 ± 10.5 yr; mass, 70.7 ± 11.0 kg). Data was recorded pre and post a one- hour hot yoga class (38.7 ± 2.6 °C, 36 ± 13% relative humidity). Pre-exercise urine specific gravity (USG), hydration status, body mass changes, and fluid intake were recorded and sweat rate was calculated. Sweat sodium concentration was examined using sweat patches, and each participant reported their perception of sweat loss. A paired *t* test was used to identify significance between measured and perceived sweat loss and Pearson's correlation analyses were used to assess relationships between variables. Seventy six percent of participants began hot yoga euhydrated (USG < 1.020). Sweat rate was 0.9 ± 0.6 $L \cdot h^{-1}$. Despite free access to fluids during class, consumption was low (0.2 ± 0.2 $L \cdot h^{-1}$) and 33% did not consume any fluids. Consequently, mean percent body mass loss was 0.9 ± 0.6% and about half of the participants lost at least 1% of body mass. Participants underestimated perception of sweat loss (p = 0.01). Mean sweat sodium concentration was 49.1 ± 19.2 $mmol \cdot L^{-1}$. Findings from this study highlight the individual variability that occurs in hydration management in yoga participants and the need for personalized hydration guidelines.

KEY WORDS: Hydration, fluid balance, hatha yoga

INTRODUCTION

Yoga was rated eleventh in the top 20 fitness trends worldwide for 2013 as reported by the American College of Sports Medicine (ACSM) (34). Yoga can be divided into several branches, one of the most popular being Hatha yoga. Currently, it's popular to perform Hatha yoga in a hot and humid room with temperatures as high as 105°F (5). However, exercising in a hot and humid environment increases water and salt loss through sweating and puts individuals at risk for becoming dehydrated, especially if they are not properly hydrated prior to exercise (3).

Dehydration is the process of going from a state of euhydration to hypohydration. Euhydration can be defined as “good” hydration or a normal amount of water for proper physiological function, while hypohydration is an insufficient amount of water, being below the normal state of hydration (8). Based on the National Athletic Training Association (NATA) and American College of Sports Medicine guidelines for hydration status, a euhydrated state is a urine specific gravity (USG) below 1.020, a hypohydrated state ranges from 1.020 to 1.029, and significant hypohydration is a USG greater than or equal to 1.030 (3,27). It has been shown that USG is a valid index of hydration status in athletes (1,21).

During exercise, dehydration is associated with alterations in cardiovascular and thermoregulatory functions (4, 12, 20, 28), and results in an escalation in ratings of perceived exertion (RPE) (20), which can be further accentuated by heat stress (4, 7). The deterioration in physiological functions is related to the level of dehydration; stroke volume progressively declines, and heart rate, core temperature, and perceived exertion progressively increase as the degree of dehydration increase (12, 20). Furthermore, the increase in core temperature and cardiovascular strain is compounded if a state of hypohydration exists before the start of exercise (28). Consequently, headache, nausea, and general malaise may be experienced (17).

Despite the potential detrimental effects of dehydration, many studies that have examined the hydration of athletes and physically active adults before they begin exercise, training or competition have found that a large proportion of participants have appeared to begin exercise in a hypohydrated state (22, 23, 25, 32). Furthermore, these participants generally do not consume adequate fluid during exercise to replace sweat losses (23, 25). Stover et al. (32) reported that 46% (151 of 329) of fitness center members who were classified as physically active based on the ACSM guidelines for physical activity arrived to take part in exercise hypohydrated. Peacock et al. (25) measured fluid intake, initial hydration status, and sweat loss of 52 physically active fitness center members. Findings suggested that 37% of participants began exercise in a hypohydrated state and consumed insufficient fluids to replace sweat losses, resulting in a 0.6% decrease in initial body mass. In elite male junior hockey players, 50% of 44 players arrived with varying degrees of hypohydration before the start of practice and only replaced 58% of sweat lost. Consequently, mean body mass loss was 0.8% and 1/3 of the athletes lost more than 1% body mass even though fluid was readily accessible (24). In National Basketball Association players, where large sweat losses are expected due to the intermittent high intensity activity with repeated rest periods, 52% of the players started games in a hypohydrated state. Furthermore, fluid intake during the game did not compensate for the lack of hydration before the game. The mean change in body mass after the game was 1.4%, higher than what was reported in the previous two studies. Five players suffered a body mass loss of at least 2%(22), which is associated with impairments in performance.

Although a significant amount of research exists on pre-exercise hydration status and subsequent fluid balance after exercise in athletic populations, little is known about the pre-hydration status and fluid intake of adults who participate in structured exercise. Especially exercise such as Hatha yoga performed in a hot and humid environment, even though the participants may be at an increased risk for dehydration because of the induced environment conditions.

Therefore, the purpose of the study was to determine hydration status of male and female hot yoga participants before and after 60 minutes of hot Hatha yoga. In addition, fluid intake, sweat and sweat sodium losses, perception of sweat loss, and hydration habits were examined.

METHODS

Participants

Twenty one healthy participants, males (n = 3) and females (n = 18) were recruited at random for this observational study. Recruited participants had to have participated in a 1-hour hot yoga class 3 days a week for at least 3 months. The age, height, and body mass of the participants was 33.0 ± 10.5 yr, 173.1 ± 10 cm, and 70.7 ± 11.0 kg, respectively. Only three men were assessed as this was the natural breakdown of participants between the two studios. All volunteers, before their one- off assessment, received a written description of the study and were required to provide written informed consent before any testing began. The Central Washington University Human Subjects Review Committee ratified all procedures. Those that indicated they may have been or were pregnant, did not pass a physical readiness questionnaire, or those who had not previously participated in at least four hot yoga classes were excluded from participation.

Protocol

Research was conducted at two locations. The studios were located in Yakima, WA (10 participants) and Ellensburg, WA (11 subjects). Data gathering took place over a three-week period between March and April. The mean temperature and relative humidity (RH) in the Yakima and Ellensburg studios was 36.0 ± 0.9 ºC, 49 ± 11% (RH), and 40.5 ± 1.5 ºC, 27 ± 4% (RH), respectively. This temperature and humidity range is considered ideal for hot yoga practice (5).

All measurements were taken before and after a 60- minute hot Hatha yoga class. Participants were not asked to refrain from physical activity prior to the class, except for not participating in another hot yoga class immediately prior to the study. Before arrival to the yoga studio, Participants were instructed to bring dry undergarments for pre and post body weight measurements, separate from clothes that were to be worn during the hot Hatha yoga class. Upon arriving at the yoga studio, each subject completed a fluid consumption questionnaire, which was adopted with permission from a previous study (35). They were then asked to void their bladder and a urine sample was collected. Immediately following, participants were weighed on a digital scale (TBF-531, Tanita, Tokyo, Japan), then instructed to fill their personal water bottles prior to them being weighed (5 lb Food Scale, OXO, China). Weigh-in and the start of class were separated by 15 minutes. After pre-exercise body and water bottle weights were obtained, participants were instructed to continue their normal drinking routine and had free access to their water bottles during the yoga class. All fluid intake was restricted to water. Efforts were made to not influence drinking behavior and bias the measurements by not conversing with the participants about the measurements being taken.

After the hot Hatha yoga class, participants dried any accumulated sweat from their bodies, changed back into the dry clothes they wore for the pre-weight measurement, and a body mass was again determined to evaluate sweat loss. Water bottles were weighed again to determine fluid intake. If participants produced any urine between body weight measurements, it was collected to correct for body mass loss and sweat rate. None of the participants produced urine during the 1 hr class, but one subject did produce urine between pre-weigh in and the start of class.

To examine perceived sweat loss, three empty, 1- liter containers were set in front of the participants and they were asked to fill the container with the amount of water which they perceived to have lost as sweat. The intent was to be able compare actual sweat loss with perceived sweat loss in order to determine if participants recognized how much fluid they needed to be replacing.

Sweat samples were collected from a subset of participants (n = 8) for the intent to inform hot Hatha yoga participants of sweat electrolyte losses. Any sweat samples that were subjected to contamination or evaporation, were discarded. Sweat samples were obtained using a modified Brisson method (2). A 5 cm x 6 cm piece of impermeable parafilm (American National Can, Menasha, WI) was placed on the adhesive side of a 10 cm x 12 cm waterproof wound dressing (Tegaderm, 3M Nexcare, USA) to create a sweat patch. Patches were placed on the lower back and scapula before the class began. After class, sweat was pipetted out of the patch and placed in an airtight plastic test tube, refrigerated, and analyzed at a later time for sodium and potassium concentration with an electrolyte analyzer (ST2100, Sensa Core, India).

A digital thermometer (Perception II, Davis, Hayward, CA) was placed in the hot yoga room before class and temperature and relative humidity were recorded at the end of each class. Pre- exercise urine specific gravity (USG) was assessed within 30 minutes of collection using a portable clinical refractometer (Master-URC/NM, ATAGO Co, USA) to determine hydration status, and each urine sample was measured three times and averaged. All samples were immediately disposed of after their assessment.

To estimate percent body mass loss during the hot Hatha class, the net body mass loss (kilograms-kg) during the class was divided by the pre-exercise body mass (Calculation 1):

[Calculation 1] *Percent body mass loss = ((Pre body mass – Post body mass) / Pre body mass) x 100*

Sweat rate (liters per hour) was estimated as net body mass loss (kilograms) plus total fluid intake (liters) and minus any urine produced (liters) divided by the duration of the class (hours), assuming 1 kg = 1 L (Calculation 2):

[Calculation 2] *Sweat Rate = ((Pre body mass – Post body mass) + Fluid intake – Urine output) / class length (hrs)*

Individual total sweat sodium loss (grams) was calculated by multiplying the sodium concentration of sweat samples (millimoles per liter) by the molecular weight of sodium (22.99) and the total volume of sweat lost (liters) (Calculation 3):

[Calculation 3] *Electrolyte loss = (electrolyte concentration x molecular weight x sweat loss) / 1000*

Statistical Analysis

Results are presented as means ± SD. Paired *t*-tests were used to test for significance between perception of sweat loss and measured sweat loss, as well as body mass changes over the exercise bout. Pearson's correlation analyses were used to investigate associations between variables. Statistical significance was accepted at $p < 0.05$. Data analyses were conducted using SPSS (version 21.0 SPSS Inc, Chicago, IL).

RESULTS

Mean pre-exercise USG was 1.013 ± 0.009 indicating that participants began hot Hatha yoga in a euhydrated state. However, five of the 21 participants arrived in a hypohydrated state with USG values of 1.021 or greater (Figure 1).

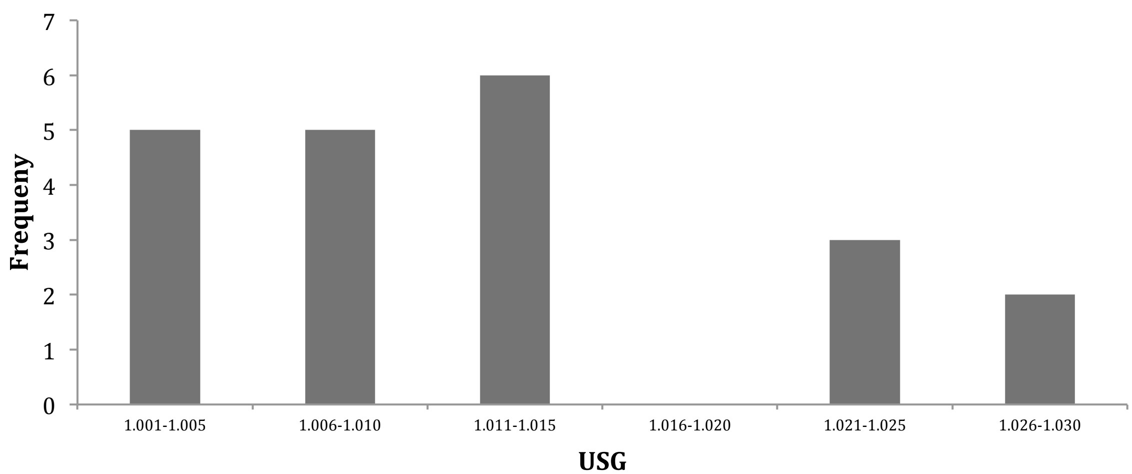

Figure 1. Frequency distribution for all urine specific gravity (USG) values for all participants (*n* = 21).

Thirteen participants (62%) correctly perceived their pre exercise hydration status prior to exercise (Table 1).

Mean sweat loss during the hot yoga session was 0.9 ± 0.6 L·h^{-1}. One participant lost less than 0.5 L·h^{-1}; fifteen (71%) participants had a sweat rate between 0.5 and 1 L·h^{-1}, and five (24%) lost between 1.0 and 2.6 L·h-1. Losses by gender are seen in Table 2.

Table 1. Comparison of participants' perceived hydration to measured hydration (USG) (n = 21).

	Males (n)	Females (n)	Total (%)
Perceived Hydration			
Self-perceived euhydration	3	15	86
Self-perceived dehydration	0	3	14
Assessed USG			
Euhydrated	0	16	76
Dehydrated	3	2	24
Perceived Correctly	0	13	62

Note: The three females that perceived they were dehydrated were actually hydrated with a USG < 1.0200. 5 participants perceived they were hydrated but were actually dehydrated with a USG > 1.0200.

Table 2. Fluid balance results by gender (Mean ± SD).

Gender (N)	Sweat Loss, $L \cdot h^{-1}$	Fluid Intake, L	Mass loss, kg	Body Mass Loss, %
Female (18)	0.7 ± 0.3	0.2 ± 0.2	0.5 ± 0.3	0.7 ± 0.5
Male (3)	2.0 ± 0.6	0.4 ± 0.4	1.6 ± 0.6	1.8 ± 0.6
Total Mean (21)	0.9 ± 0.6	0.2 ± 0.2	0.7 ± 0.5*	0.9 ± 0.6
Range (21)	0 - 2.6	0.0 - 0.8	-0.2 - 2.0	-0.4 - 2.2

Note: * significantly different from measured sweat loss, $p < 0.05$

Mean body mass loss was 0.7 ± 0.5 kg ($p = 0.02$), which corresponds to a loss of 0.9 ± 0.6% from pre-exercise body mass. However, eight participants lost between 1% and 2% of body mass, and two participants lost more than 2%. One participant had a gain of 0.4% (0.2 kg) body mass, and one participant matched sweat rate with fluid intake and did not have a net loss of body mass. Losses by gender can be seen in Table 2.

Mean total fluid intake was 0.2 ± 0.2 $L \cdot h^{-1}$, with 67% of participants consuming fluid during the class. However, seven participants (33%) did not consume any fluid and ten (48%) of the participants drank less than .5 $L \cdot h^{-1}$. Four individuals consumed between .5 and .8 $L \cdot h^{-1}$, but all participants drank less than 1 $L \cdot h^{-1}$. Table 2 displays fluid intake by gender. Total daily fluid intake, daily water intake, and fluid replacement after class were self- reported by the participants (Table 3).

Table 3. Fluid intake habits and perception of sweat loss of study participants (Mean ± SD).

	Males (n = 3)	Females (n = 18)	Total (n = 21)
Daily intake (ml)			
Total fluid intake	2710 ± 1129	2821 ± 772	2805 ± 1129
Total water intake	2346± 771	1917± 759	1978± 757
Fluid 1 hr prior to exercise (ml)			
Reported amount	404. ± 168.	391 ± 266.	392 ± 251
Sweat Loss (ml)			
Self-perceived loss	900 ± 400	400 ± 300	500.0 ± 300*
Measured loss	2000± 600	700. ± 300	900 ± 600
Fluid Replacement- 1 hr post (ml)			
Reported replacement	1084± 170	616 ± 270	683± 305

Note: * significantly different from measured sweat loss, $p < 0.05$

Mean perception of sweat loss was 0.5 ± 0.3 L·h^{-1}, which was significantly lower than the actual mean sweat loss of 0.9 ± 0.6 L·h^{-1} (p = 0.01; Table 3). Participants underestimated sweat loss by 44%. Fourteen of 21 participants (67%) underestimated how much sweat they think they lost.

Sweat electrolyte concentration and total sweat losses are shown in Table 4. Mean sweat sodium concentration was 49.1 ± 19.2 mmol·L^{-1} (n = 8). The mean total sodium loss was minimal (0.63 ± 0.40 g/mol); only one participant lost more than one gram (1.3 g/mol). A loss of ~1.59 ± 1.02 g/mol of sodium chloride was incurred, assuming that sodium was lost as sodium chloride (19). One participant lost 3.42g/mol of sodium chloride, while all others lost less than 2.4 g.

Table 4. Sweat electrolyte concentration and sweat electrolyte loss (n = 8).

	Mean ± SD	Range
Sweat [Na] (mmol·L^{-1})	49.1 ± 19.2	29.3 – 89.4
Sweat [K] (mmol·L^{-1})	5.4 ± 0.7	4.3 – 6.5
Na loss (g/mol)	0.6 ± 0.4	0.0 – 1.3
NaCl loss (g/mol)	1.6 ± 1.0	0.1 – 3.42

Note: NaCl loss was calculated assuming that sodium loss is as sodium chloride.

Sweat Rate was moderately correlated to fluid intake (r = 0.44, p = 0.05, Figure 1). Of note in the current study is the correlation between sweat rate and fluid intake, which is not always identified (19, 30). However, the correlation in this study may be influenced by one subject, as when that subject's data is excluded the relationship becomes non-significant (r =0.09, p = 0.70). No significant correlation was found between sweat rate and sweat [Na] (r = -0.45, p = 0.26, n = 8). Furthermore, a weak and insignificant correlation was found between total fluid intake and percent body mass loss (r = -0.06, p = 0.81) or sweat [Na] (r = -0.22, p = 0.60, n = 8).

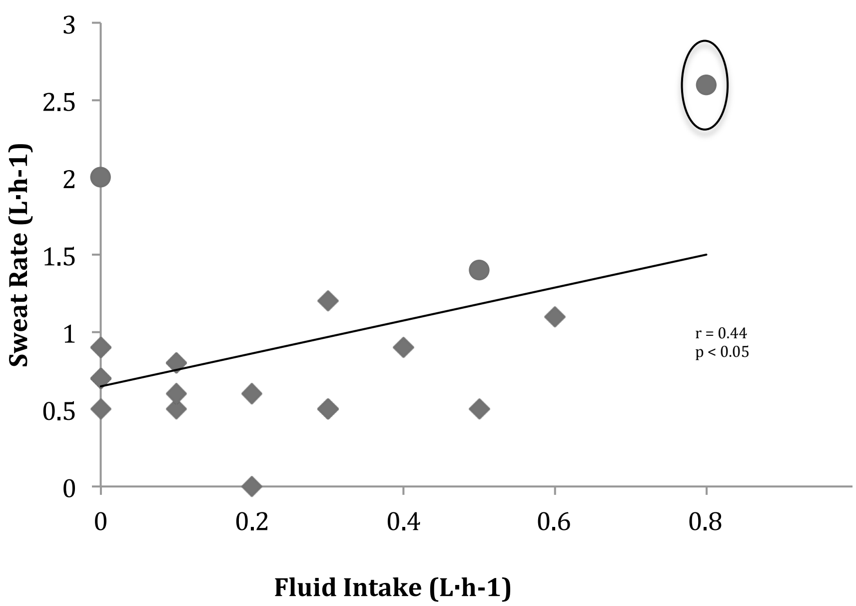

Figure 1. The relationship between fluid intake and sweat rate and fluid intake in males (●) and females (♦) during hot hatha yoga. Circled data point indicates an outlaying subject (n = 21).

DISCUSSION

The aim of the present study was to examine the hydration status, sweat rate, fluid intake, and sodium balance of hot yoga participants before and during a 1-hour hot Hatha yoga class. The main findings were that (a) 76% of the participants arrived to class in a euhydrated state, (b) sweat rates were moderate at .9 $L \cdot h^{-1}$, (c) fluid consumed by participants before and during class replaced 25% of their sweat losses, limiting body mass loss to less than 1% in 52% of participants, (d) due to inadequate fluid intake during the class, 48% of the participants did lose between 1.1 and 2.2% of body mass, (e) participants underestimated the amount of sweat they lost by 44%, and (f) participants lost a minimal amount of sodium in their sweat.

Oppliger et al. (21) and Armstrong et al. (1) have shown that USG is a viable and practical tool for the assessment of hydration status of athletes. A USG value at or below 1.020 indicates minimal dehydration and is the recommended level to begin activity to ensure adequate hydration. A value >1.020 indicates significant dehydration and a USG >1.030 indicates severe dehydration (3). The average pre-exercise USG (1.013 ± 0.009 in the current study shows that participants entered hot Hatha yoga in a euhydrated state. These results are similar to what has been reported in competitive female athletes (15), but lower than what has been reported in recreational exercisers (32), as well as male-dominated college and university sports(16,23,30). Furthermore, the current study reported that fewer participants (24%) arrived in a hypohydrated condition than reported in other competitive athletes (35,22,16,23,19,32) before practice or competition. From earlier studies, Volpe et al. (35) reported that 66% of Division I athletes arrived to practice with a USG >1.020, Osterberg et al. (22) found that 52% of NBA players began summer league games in a hypohydrated state, Palmer et al. (23) stated that over 50% of elite junior ice hockey players started practice mildly hypohydrated (USG > 1.020), and Stover et al. (32) reported that 46% physically active adults arriving to a commercial fitness center had a USG >1.020, indicating a state of hypohydation.

The pre-exercise hydration status for this cohort demonstrates that hot Hatha yoga participants are cognizant of their hydration needs prior to participation. On average, participants self-reported drinking 2805.3 ± 1129.4 ml of fluid per day, indicating an understanding of fluid needs. Nonetheless, 24% of participants arrived to yoga class/session? hypohydrated to varying degrees (Fig. 1). This suggests that individual education and pre-exercise fluid recommendations are necessary for the importance of minimizing physiological consequences such as increase in core temperature and heart rate and reduced heat tolerance and sweat rate that can occur during activity due to dehydration (3).

Sweat loss was estimated to be 0.9 ± 0.6 $L \cdot h^{-1}$ during hot Hatha yoga. Research is limited in sweat rates of recreational individuals participating in low intensity exercise in a hot environment. However, the sweat rate observed in the current investigation was similar to that reported by Peacock et al. (25) in physically active adults carrying out cardiovascular and/or resistance training exercise at a fitness center (~0.7 $L \cdot h^{-1}$), as well as sweat rates observed in ironman triathletes during the cycling (~0.8 $L \cdot h^{-1}$) and running (~1.0 $L \cdot h^{-1}$) portions in a temperate environment (31). It should be noted that mean sweat rates in these investigations included males and females, as did the current investigation. Whereas, in a cool (5°C, 81% RH) environment, Maughan et al. (19) also reported comparable sweat rates of ~1.1 L·h^{-1} in professional male soccer players during training. Conversely, sweat losses incurred in this study are less than those frequently reported in other studies for athletes during training and competition in various environmental conditions (11, 16, 18, 22, 23, 29, 36). Osterberg et al. (22) found a mean sweat rate of 2.2 ± 0.8 L over the course of a National Basketball Association game when average playing time was 21 ± 8 min. Palmer et al. (23) found mean sweat rates to be 1.8 ± 0.1 L·h^{-1} during practice in elite, male junior ice hockey players.

In the current study, individual responses to sweat loss were highly variable and ranged from 0 to 2.6 L·h^{-1}, with males sweating the most, losing 2.0 ± 0.6 L·h^{-1}. Analyzed separately from the female cohort, the males exhibited high sweat rates, similar to those in previously mentioned studies as well as Godek et al. (10) who observed sweat rates in college football players and cross- country runners during practice in a hot and humid environment (28.4-34.5°C, 43-65% RH) to be 2.1 ± 0.53 L·h^{-1} and 1.8 ± 0.4 L·h^{-1}, respectively. Females had a mean sweat rate of 0.7 ± 0.3 L·h^{-1}, which is comparable to sweat rates of ~0.5 L·h^{-1} found in international junior and female soccer players during training in a cool environment (9, 15). Despite performing low intensity exercise (6, 13), when comparing sweat rates gender for gender, similar rates are seen between yoga and higher intensity sports, illustrating the environment in the present study drove the sweat rate. Additionally, sweat rates within genders varied, suggesting individual sweat responses to hot Hatha yoga exist beyond gender differences (27), given that all participants worked at a similar intensity and wore similar clothing.

The drinking behaviors of participants in the current investigation during the hot Hatha yoga class were only sufficient enough to replace 25 ± 27% (n = 21) of their sweat losses. Despite inadequate rehydration, participants only lost 0.7 ± 0.5 kg (p =0.00), equivalent to dehydration of 0.9 ± 0.6% of pre exercise body mass. This, however, supports the "voluntary hypohydration" phenomenon described by Rothstein et al. (26) in which individuals fail to fully replace their body weight losses, and is evident in a wide variety of sports within the literature (15, 16, 18, 10, 22-25, 29, 36).

The mean fluid intake in this study (0.2 ± 0.2 L·h^{-1}) is similar to fluid intake reported by Maughan et al. (19) and Kilding et al. (15) during 90 minutes of training of elite male and female soccer players, respectively, in a cool environment (~0.3 L·h^{-1}), Godek et al. (9) in college cross country runners during preseason two a day practices in a hot and humid environment (~0.6 L·h^{-1}), and Gibson et al. (10) in elite junior female soccer players (~0.1 L·h^{-1}). Conversely, fluid intake is higher in many other studies in various environments (11, 16, 18, 22, 23, 29, 31, 36). Zetou et al. (36) found mean fluid intake in male beach volleyball players to be ~1.0 L·h^{-1} in a hot and humid environment, while Palmer et al. (23) also reported a mean fluid intake of 1.0 ± 0.1 L·h^{-1} in elite junior ice hockey players during practice. Furthermore, Godek et al. (11) reported professional football players had a mean fluid intake of ~1.2 L·h^{-1} during preseason training (25.9 ± 1.9°C).

Fluid intake and body mass losses were highly variable in the current investigation ranging from 0.0 to 0.8 L·h^{-1} and -0.4 to 2.2%, respectively, supporting results from the literature in a variety of sports (9, 18, 23, 36). While mean results indicated only mild dehydration after the hot Hatha yoga class and likely had no adverse effects (17, 18), two individuals experienced a loss in body mass greater than 2%, which can result in physiological decrements (27). Therefore, hydration guidelines should be personalized and individual education would be the most effective way to prevent hypohydration (18, 23) in hot yoga participants.

The mean sweat [Na] (49.1 mmol·L^{-1}) and sodium loss (-0.6 g) found in this study were similar to electrolyte loss reported by Gibson et al. (9) in female junior elite soccer players during training (48 mmol·L^{-1} and -0.7 g). Sweat [Na] loss was also comparable to that of elite junior hockey players during practice (54 mmol·L^{-1}), and male professional soccer players during training (42 mmol·L^{-1}) (19, 23). However, sodium loss and sodium chloride loss (1.6 g) were much lower compared to the findings of others (11, 18, 19, 22, 23). Maughan et al. (18) reported mean NaCl loss of 5.8 g in premiere soccer players during 90 minutes of preseason training. No sodium was replaced during the current investigation because fluid intake was restricted to water; regardless losses were minimal and would likely be restored through participants' regular diet and hydration practices. Current data indicate the average American consumes 3.4 g of sodium or 8.6 g NaCl per day (14), which would be sufficient to replace any losses incurred in the current study.

In an attempt to investigate the perception of sweat loss and determine if individuals are aware of how much fluid they should be replacing, participants were asked to estimate their sweat loss immediately following the hot Hatha yoga class. It was found that participants significantly underestimated their sweat losses by 44% of actual fluid loss. Passe et al. (24) found similar results when investigating perception of sweat loss in experienced runners after at 16-km race; participants underestimated sweat loss by 42.5%. These results suggest that participants do not accurately perceive fluid loss and consequently, fluid needs for rehydration (24). Recognizing there are many factors that can influence fluid intake during exercise, Passe et al. (24) suggest that the failure to estimate fluid loss might be an important contributing influence in voluntary dehydration. This may be the case for some of the participants, but anecdotally it should be noted that 29% of the participants did not opt to consume any fluid, irrespective of their sweat loss. A major factor that likely influenced fluid intake during class was drinking opportunities. There are limited breaks during a hot Hatha yoga class, as to not disrupt the yoga practice of going from pose to pose, and disrupting focus and meditation, consequently leading to dehydration, albeit minimal.

Observational field research has inherent limitations. However, due to the true observational nature of this manuscript, the authors assessed a random sample of constant yoga practitioners. Limitations of the current investigation included variability in controlled climates between the two studio locations, participant fitness, and phases of the menstrual cycle for female participants. Further research is also needed to examine equal groups of males and females so gender comparisons can be made for hydration and fluid balance measures.

In conclusion, the majority of participants in the current study began the hot Hatha yoga class in a euhydrated state. Participants experienced low mean sweat rates, fluid intake, and sodium losses, and significantly underestimated perception of sweat loss to measured sweat loss. Despite low mean fluid intake, likely due to limited drinking opportunities during hot Hatha yoga class, mean body mass losses were minimized to less than 1%. However, there were large variations in individual results, supporting previous recommendations that hydration guidelines must be personalized and individual education would be most beneficial (27).

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