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Hydration status of competitive rowers during indoor and outdoor training sessions

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ABSTRACT

Rowing is characterized by high physiological demands and environmental challenges. The aim of this study was to assess hydration status of rowers before and after indoor and outdoor training conditions. Ten male competitive rowers (20 ± 4 years; 11 ± 2% of body fat; training 4h/day, 7 days/week, underwent two 16-km training sessions, one indoor (60 min) and one outdoor (80 min). Urine color (color chart), urine specific gravity (refractometer), body mass alterations, fluid intake and sweating rate were assessed before and after training sessions. Dehydration was present in at least 70% of athletes, before both training sessions, as measured by urine color and urine specific gravity. There was a body mass loss greater than 2% in 80% (indoor) and 70% (outdoor) of the rowers. Sweating rate was higher indoor (1.8 ± 0.7 $L.h^{-1}$) as compared with outdoor (1.2 ± 0.4 $L.h^{-1}$) ($p = .016$). The majority of the rowers start the morning training sessions hypohydrated and further dehydrated beyond 2% body mass due to sweating during both bouts. Sweating rate and body mass changes were higher after indoor training.

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Estado de hidratação de remadores de competição durante sessões de treinamento *indoor* e *outdoor*

RESUMO

O remo é caracterizado por altas demandas fisiológicas e desafios ambientais. O objetivo deste estudo foi acessar o nível de hidratação de remadores antes e depois de condições de treinamento *indoor* e *outdoor*. Dez remadores homens competitivos (20 ± 4 anos; 11 ± 2% gordura corporal; treinando 4h/ dia, 7 dias/ semana) realizaram duas sessões de treinamento de 16 km, uma indoor (60 min) e uma outdoor (80 min). Foram mensuradas a cor da urina (cartela de cor), a gravidade específica da urina (refratômetro), alterações na massa corporal, ingestão de líquidos e taxa de suor, antes e depois das sessões de treinamento. A desidratação estava presente em pelo menos 70% dos atletas, antes de ambas as sessões de treinamento, como mensurado pela cor da urina e gravidade específica da urina. Houve uma perda de massa corporal maior que 2% em 80% (*indoor*) e 70% (*outdoor*) dos remadores. A taxa de suor foi maior no *indoor* (1.80,7 L.h-1) comparado ao *outdoor* (1.20,4 L.h-1) (p = .016). A maioria dos remadores iniciou a manhã das sessões de treinamento hipohidratado e desidratou mais ainda, acima de 2% da massa corporal, devido ao suor, durante ambos os treinos. A taxa de suor e as mudanças na massa corporal foram maiores no treinamento *indoor*.

PALAVRAS CHAVE:
Remo. Desidratação. Suor.
Ingestão de líquidos. Atletas. Exercício.

INTRODUCTION

Rowing is a sport characterized by high physiological demands [17], requiring a blend of endurance, strength and power [18, 31]. In rowing, a high level of technical ability is essential to enable an effective transfer of power through the rowing sequence [3]. Rowing training programs include indoor exercising on rowing ergometers along with outdoor rowing in the boat, which may impose different stress conditions, such as temperature, humidity and wind speed.

To reach maximum performance, rowers must have a large volume of different exercises leading to many hours of training per week. A successful training program includes high intensity loads with adequate recovery [14]. To achieve these aims, factors that contribute to optimize training without compromising performance may be controlled, as rest, diet and hydration [16].

Intense exercise, such as those performed in rowing, leads to metabolic heat production, which elicits a response from the hypothalamus to maintain core body temperature within a physiological range [9]. Evaporation of sweat is the main mechanism involved in this process, and might lead to sweat-induced dehydration [9, 29]. Dehydration during exercise is expected, and is directly proportional to exercise intensity, duration, environmental conditions, types of clothes and equipment [24, 25, 26]. A loss of body mass greater than 2% may negatively affect the cardiovascular system [5, 23, 30], immune system [11], brain function [28, 29], and performance, due to fluid imbalance [24, 29].

However, we did not find any study that assessed hydration status of rowing athletes, and therefore, our aim was to describe hydration status of male competitive rowers in both indoor and outdoor conditions. Our initial hypothesis was that dehydration would be higher in indoor than in outdoor conditions because of the lack of wind which dramatically reduces the thermoregulatory convection effect.

METHODS

Ten competitive male rowers, members of the first team of a sports club in the southern Brazil, were invited to participate in this observational, cross-sectional study. The mean age was 20.2 ± 2.1 years, body mass 80.7 ± 5.4 kg, height of 186.3 ± 4.6 cm, body fat 11.0 ± 2.0 %, and sum of skinfold thickness of 34 ± 14 mm. Six rowers were heavyweight and four rowers were lightweight. The study was conducted during the out season period, in order to avoid that the preparation to competition could influence the results.

Rowers trained for four hours per day, seven days a week. They had participated in at least one national competition and seven of them were members of the Brazilian national rowing team, and had no injury prior to the study. All rowers volunteered to participate; they received verbal and written information about the study protocol, and signed the informed consent form. The study was approved by the University's Ethics Committee under the number 886.698.

All data collection was performed in February 2015, which corresponds to summer season in Brazil what increased thermic stress during the trials. Rowers were assessed in two occasions, during indoor training on the rowing ergometer (Concept 2, Brazil) and outdoor training on the boats (Empacher, Germany; Filippe, Italy). Temperature and relative humidity data were obtained from the Brazilian National Institute of Meteorology, about the days and times of the study data collection. Indoor training sessions occurred at 23.5ºC and 83% of relative humidity, and the outdoor training sessions at 24.4ºC and 65% of relative humidity.

Seventy-two-hour prior the sessions alcohol, diuretics and other medications were avoided. Participants reported no gastrointestinal symptoms.

Percentage body fat was estimated from 4 skinfold thickness (triceps, subscapular, abdominal and iliac crest) measured in triplicate using a skinfold calliper (CescorfÒ, Porto Alegre, Brasil). Skinfold sum was used to calculate the percentage of body fat using Faulkner equation [6].

The athletes were allowed to drink *ad libitum* during the exercise. The amount of liquid consumed was assessed by weighing the bottles before and after training by using a portable scale (Western®, São Paulo, Brazil; 0.001 kg precision). The rowers were instructed to use the fluids exclusively for hydration purposes.

EXERCISE PROTOCOLS (ROWING TRAINING)

Rowers underwent two 16-km training sessions, one indoor and one outdoor, separated with one-week interval. The sessions started at 7h30, and lasted for 60 and 80 minutes, respectively. This difference in training sessions duration was not related only to intensity, but rather to environmental conditions (wind and water temperature, salinity, depth and stream), differences in technical efficiency, type of boat and oars, and number of rowers in each boat (one or two). Despite this, to simulate the real condition of training and to reduce bias of unplanned effort, all rowers were exposed to the usual conditions, on boats that they usually use for training and competition

URINE TESTS

Total urine excreted was collected in sterile, disposable, known-volume containers before and immediately after the training sessions. The samples were analyzed by the same investigator for color (Ucol), specific gravity (USG) and pH. Urine color was assessed using a color chart in a place with good natural lighting, and classified using a scale from 1 to 8 [1]. Analysis of USG was performed in triplicate, using a portable refractometer (Uridens Inlab®, São Paulo, Brazil), and a gravity scale starting from 1000 $g.mL^{-1}$ [4]. Since it is known that USG results may be affected by a pH greater than 8 [10], urine pH was also analyzed. The cutoff points used to determine the hydration status were: well hydrated (urine color 1 or 2, USG < 1 010), minimal dehydration (urine color 3 or 4, USG 1 010 – 1 020), significant dehydration (urine color 5 or 6, USG 1 021 – 1 030), and serious dehydration (urine color 7 or 8, USG > 1 030). Minimal dehydration was the cutoff point used to classify the athletes as "dehydrated".

BODY MASS AND SWEATING RATE

Total body mass (TBM) was determined after urine collection, with rowers wearing light clothing and no shoes, using a digital scale (Welmy®, Santa Bárbara d'Oeste, São Paulo; 0.1 kg precision) before and after exercise. Before the assessment, subjects wiped visible sweat off. Body weight change (ΔBW) was calculated by the difference between pre- and post-training BW, corrected by the amount of fluids consumed during the training session, using the following equation: ΔBW = (post-training body weight – pre-training body weight -) + fluid intake. The result was used to calculate hydration status (%) based on the loss of body mass, using the equation: %BW = (ΔBW*100)/pre-exercise body weight. Rowers were classified as "dehydrated" when they presented a reduction >2% body weight [2]. Sweating rate ($L.h^{-1}$) was calculated using the following equation: sweating rate = ([pre-exercise body weight – post-exercise body weight) + (fluid intake – urine volume])/exercise time in hours.

STATISTICAL ANALYSIS

All data were tested for normality of distribution using Shapiro-Wilk test and were presented as the mean ± standard deviation (SD). A paired t-test was used to compare pre- and post-training data, and the Student's t-test or the Mann-Whitney U test was used to compare indoor and outdoor training values. Associations between the percentage of body mass loss, sweating rates and fluid intake were evaluated using Pearson's correlation test. We used the *software* IBM SPSS Statistics version 20 for the analyses, and the significance level was set at 5%.

RESULTS

URINE ANALYSIS (UCOL AND USG – FIGURE 1):

According to the Ucol, 100% and 70% of the rowers were dehydrated before the indoor and outdoor training session, respectively, and according to the USG, 100% of the rowers were dehydrated before both sessions. Before the indoor and outdoor training, respectively, the prevalence of minimal dehydration was 70% and 30% according to Ucol, and 50% and 30% according to USG; significant dehydration was present in 30% and 40% of rowers according Ucol, and in 50% and 50% of rowers according to USG. Serious dehydration was present in 20% of rowers before the outdoor training session according to USG only. There was no difference between Ucol and USG in comparing pre-training and post-training data and, according to Ucol, the level of dehydration increased after the indoor training.

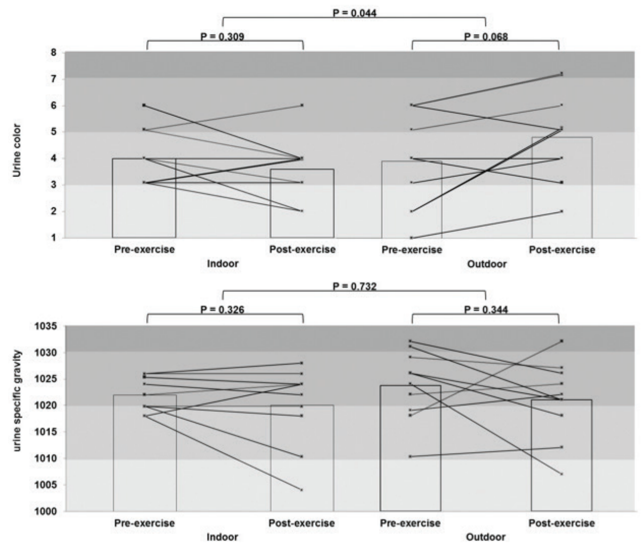

FIGURE 1. Change in hydration status of each rower according to urine color test and urine specific gravity, before and after the indoor and outdoor training session. Well hydrated: urine color 1 or 2, USG < 1.010; minimal dehydration: urine color 3 or 4, USG 1.010 – 1.020; significant dehydration: urine color 5 or 6, USG 1.021 – 1.030; serious dehydration: urine color 7 or 8, USG >1.030.

WATER BALANCE (TABLE 1):

Loss of body mass greater than 2% was observed in 80% of rowers after the indoor training session, and in 70% after the outdoor training session. Both body mass loss (p = .045) and sweating rate (p = .016) were higher after indoor trial as compared with outdoor trial. No difference was observed in fluid intake between training sessions (p = .684).

There was a strong, positive association between sweating rate and loss of body mass (%) in the indoor (r = .876, p < .001) and outdoor sessions (r = .943, p < .001). Sweating rate was not associated with fluid intake in indoor trial (r = .309, p = .385) or outdoor trial (r = .424, p = .221).

TABLE 1. Water balance of rowers during indoor and outdoor training sessions (mean ± standard deviation)

VARIABLE (N=10)	INDOOR	OUTDOOR	P
Loss of body mass (%)	2.5±0.8	2.2±0.8	0.393
Change in body mass (kg)	-1.7±0.7	-1.1±0.6	0.045
Sweating rate (L.h^{-1})	1.8±0.7	1.2±0.4	0.016
Fluid intake (mL)	639±303	589±241	0.684

Note: % – percentage; kg – kilograma; L.h-1: liters per hour; mL – milliliters

DISCUSSION

This study aimed to describe the hydration status of rowers in both indoor and outdoor settings. The main results showed that rowers were dehydrated when they started the training bouts in both indoor and outdoor conditions.

Comparing trials, the loss of body mass and sweating rate were significantly higher after the indoor training session as compared with the outdoor session.

The high prevalence of dehydration after exercise detected by USG has been previously described in adolescent swimmers [9], sports club members [8], rugby players [21], triathletes [12,19] and junior soccer players [7]. On the other hand, Hahn and Waldréus reported a state of euhydration in tennis players, cross-country runners and Muay Thai boxers before exercise [8]. In our study, the reason why the rowers begun the training sessions dehydrated (according to Ucol and USG) may be related to the short time available for water replacement in the morning, after night fasting, leading to an inadequate hydration care prior to exercise training and making urine more concentrated and dark. No medication or food consumption prior the test seems to influence this results. Probably, an aggressive rehydration strategy should be employed in these athletes [25].

According to official position, a post-exercise loss of body mass higher than 2% is considered the cutoff for the diagnosis of dehydration [4]. In our study, despite the *ad libitum* fluid intake by participants during exercise, there was a high prevalence of post-exercise dehydration according to this parameter. Similar results have been found in studies with triathletes [2,12,19]. In addition, studies where the amount of fluid intake was restricted, it was also observed a loss of body mass by dehydration higher than 2% in amateur sports athletes [22] and indoor tennis players [13].

One important finding of this study was the higher loss of body mass and higher sweating rate by the subjects after the indoor training as compared with the outdoor training. This may be explained by the different aspects affecting environmental conditions. It is believed that the lack of wind in the indoor setting could limits the loss of body heat by convection. Additionally, the high relative humidity on the day of data collection on ergometer may have increased the sweat evaporation rate, and the process of thermoregulation. Despite all this, fluid intake was not different between indoor and outdoor sessions, which may have contributed to the higher prevalence of dehydration in the former. While an adequate fluid replacement should be based on the loss of body mass according to the American Dietetic Association (ADA) [24], some authors [20] suggest that fluid replacement should be based on thirst. But, both evaluations should be use with caution, the thirst reflex may be a late mechanism to stimulate fluid consumption, so the dehydration would already be present, and body weight can not only retract losses of fluid, mainly in exercises that spent hours of training.

In the present study, although we did not measure the temperature and humidity of the air during the training sessions, data of temperature and humidity of the city at the time of the trainings were obtained from the Brazilian National Institute of Meteorology. Also, similar to other studies, we assumed that the loss of body mass was entirely due from sweat loss, although losses from respiration and metabolism of energy substrates may also occur [15]. Discrepancies between rowing condition during outdoor session could be related to the number of rowers and boats. But, the majority was rowing individual boats (single skiff) and four athletes were in coxless pairs (2-).

The methods used to assess hydration status in this study are relatively low cost, simple and easy to be routinely used by sports teams and individual athletes. Nevertheless, further studies are needed to evaluate dehydration rates in a larger sample of rowers and the impact of dehydration on training and performance.

In conclusion, the majority of the rowers were dehydrated in the beginning of the training sessions. In both training conditions (indoor and outdoor), the loss of body mass due to sweating was greater than 2%. Attention should be given to indoor training using rowing machines, since dehydration variables, including sweating rate and body mass change were more elevated in this setting as compared with outdoor conditions. These findings should encourage multidisciplinary teams to establish routine evaluation of dehydration status of rowers, and specific hydration protocols to the type of training.

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Preferência percebida por estilos de aprendizagem em situações da vida diária e esportiva de atletas e não atletas

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Ensino. Aprendizagem. Esporte. VARK.

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RESUMO

A comunicação entre treinador e atleta pode facilitar a aprendizagem e consequentemente aperfeiçoar o desempenho em treinamentos/competições. Sendo assim, talvez seja relevante que o treinador tenha o conhecimento das preferências de aprendizagem de seus atletas. Dessa forma, o objetivo foi investigar a preferência percebida de estilos de aprendizagem de atletas e não atletas. Para isso foi utilizado o questionário *Visual, Aural, Read/ Write e Kinesthetic* (VARK) para situações de vida diária e esportiva. Foram avaliados 57 atletas de handebol (14.5 ± 1.5 anos) e 30 sujeitos não atletas (15.3 ± 1.1 anos). Ambos os grupos apresentaram preferência de aprendizagem auditiva para as situações de vida diária (52.6% dos atletas e 33.3% do grupo não atleta) e esportivas (36.8% dos atletas e 40% do grupo não atleta); e cinestésica nas situações de vida diária (15.8% dos atletas e 26.6% do grupo não atleta) e esportiva (28.0% dos atletas e 33.3% do grupo não atleta). Os achados mostram que a preferência percebida dos estilos de aprendizagem, de atletas e não atletas foram as formas auditiva e cinestésica (para as situações da vida diária e esportivas). A prática sistemática de esporte parece não impactar a preferência e perfil do estilo de aprendizagem para aqueles treinam e competem no esporte de alto nível.

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