Original Article (short paper)

Drinking to thirst influences fluid replacement in adolescents judokas

Nathália Mayume Moreira Hayakawa[1], Raul Canestri Galvino Reis[1], João Paulo Lima de Oliveira[1], Juciane de Abreu Ribeiro Pereira[1], Wilson César de Abreu[1*]

[1]*Universidade Federal de Lavras, UFLA, Lavras, MG, Brazil,*

Abstract — Aim: The aim of this study was to examine the influence of the type of beverage and the use of thirst sensation to guide fluid replacement in the adolescent judokas. **Methods:** Nine male judokas aged 10-16 (average age 11,8 ± 4,0 years old) were submitted to a standardized training of 90 minutes. In the first phase of the study, the athletes completed the training with ingestion ad libitum of different beverages: day 1 (water) and after 48 hours, day 2 (sports drink). In the second phase, after 7 days of first stage, the athletes completed the training with ingestion of water or sports drink, guided by thirst sensation. The total volume of liquids ingested (VI) during the training was quantified and the level of dehydration was determined by variation of body weight before and after training (ΔW). At the end of each training, the athletes were asked about the training intensity to determine perceived exertion (PE). **Results:** No differences were observed in weight loss (ΔW) (range: -0,04 ± 0,4 to -0,69 ± 1,1 %) and perceived exertion (range: 3,2 to 5,0). The use of thirst sensation to guide fluid replacement reduced the total fluid intake when the beverage offered was the sports drink (no thirst vs. thirst sensation, 521,1 ± 290 vs 152,2 ± 187 mL – p=0,006). **Conclusion:** The results suggest that fluid replacement guided by thirst sensation can be influenced by the type of beverage offered.

Keywords: judo, hydration, sweat rate, sport drink

Introduction

Physical activity increases body energy demand. The majority of the energy consumed during exercise is dissipated as heat. To avoid increasing the core temperature at levels that can impair the physical healthy and healthy performance, the body transfers heat to the environment, resulting in an increase in sweat. As a consequence, reducing body water mass can reduce muscle strength, work capacity and cognitive performance[1,2].

The magnitude of water loss during training will depend on factors such as environmental conditions (i.e., humidity, temperature, wind and solar radiation, state of acclimatization, intensity and duration of exercise, fluid replacement and wearing of heavy clothing that impedes heat loss). Judo is a sport that has high energy demand, dress that favors water loss, and which is usually practiced indoors[3]. The high performance of athletes is reached when they can maintain a hydrated state during training or competition. In order to diminish the dehydration induced by exercise, athletes use several strategies of fluid replacement, ingesting different beverages[4].

During exercise the degree of dehydration determines the degree to which physiological systems are compromised. Accompanying the increase in fluid loss is greater cardiovascular and thermic stress. As the level of dehydration increases, the body's thermo-regulation capacity decreases, increasing the risk of fatigue, cramps, muscle injuries, hyperthermia, respiratory collapse and death.[5,6,7]

Even though athletes with water loss greater than 2% were able to maintain good physical performance, sufficient liquid intake is recommended to maintain water loss below this value[5,1]. To reach this objective, some authors have recommended that athletes ingest fluids according thirst sensation[6,8,9]. However, others authorities recommend a scheduled intake of beverages, according to the sweat rate of the athletes[5,8,10].

Voluntary intake cannot be enough to avoid dehydration and performance loss in young athletes during exercise[11]. On other hand, excessive ingestion of liquids should be avoided, as it can be responsible for the impaired performance and health of a person[1,12]. Some studies have highlighted that fluid replacement followed by thirst can be enough for the maintenance of the thermo-regulatory responses and capacity of exercise practice, even that a small involuntary dehydration often can occur in this situation[1,13,14,15]. These increased extracellular concentrations trigger thirst that protect athletes from excessive fluid ingestion and severe dehydration[16]. It seems consistent that intake and thirst can be enough and adequate, because the central nervous system can be able to correctly indicate the fluid volume to be ingested, based on the information the central nervous system integrates regarding the demands of the body[12].

Therefore, the aim of the current study was to investigate if the type of drink could improve hydration during training and if the use of thirst sensation to guide fluid intake could improve the status of hydration during training.

Materials and methods

Participants

The population studied was composed of nine male athletes that belong to an amateur judo team. The athletes were between 10 and 16 years old, they were acclimated to the environmental conditions. The training routine of athletes consists of five weekly training sessions, of about 90 minutes in duration. Athletes had experience in regional and national competitions. Before the beginning of the evaluations, the athletes were informed about all of the procedures that could be realized during this study and the right of these participants to leave the project at any time. This experiment

required a signed consent form from both the athletes and their legal guardians. The study was approved by the Research Ethics Committee of Lavras University (Nº 24425213.3.0000.5148).

Procedures

The athletes were submitted to standardized training sessions of approximately 90 minutes in duration. The sessions were as follows: 10 minutes of warm-up followed by 50 minutes of training, which included, flexibility exercises, educational coordination, pace and open-close, Uchi-waza (blow input) 20 times on each side, blow input with moving projection. The last 30 minutes were for Randori (free practice). Sweat rate and fluid replacement was evaluated in two phases. In all phases the athletes ingested 250 mL of water one hour before the training began. In the first phase, the athletes did fluid replacement ad libitum. In the first training, potable water was offered to athletes, then in the second training, athletes ingested a sports drink (sports drink - Athletica®), lemon flavor (carbohydrate - 60g.L^{-1}, sodium - 426 mg.L^{-1}, Chlorine - 656 mg.L^{-1}, potassium – 122 mg.L^{-1}, vitamin C – 19,8 mg.L^{-1}). The interval between the two training sessions was 48 hours. In the second phase, after 7 days of the first stage, the athletes completed the training ingesting either water or the sports drink, guided by thirst sensation. The temperature of the beverages was maintained at 15 ± 2 ºC and the total volume of fluid intake (VI) during their training was evaluated using individual bottles. When the athlete did not ingest all the contents of the bottle, the waste was measured using a graduated beaker.

To determine the fluid loss of the athletes, each was weighed before (Pi) and after (Pf) training without kimono, shirt and barefoot. From these data the percentage variation of body weight (ΔW) and sweat rate (SR) were calculated, and the following equation was obtained: TS = (Pi-Pf) + Vi/time physical activity. Values of room temperature and relative humidity were collected at the beginning, middle and end of the training using a digital thermohygrometer (model HT-260, Instrutherm). In the end of each training the athletes were questioned about training intensity, taking as reference the scale proposed by Borg (CR10), modified by Foster et al.[17].

In the second stage the procedure described above was repeated, however the athletes were oriented to intake the beverages (water or sports drink) *ad libitum* just when they felt thirsty. No scale was used to measure thirst sensation. The athletes were instructed to self-assess their level of thirst.

Statistical analysis

The average and standard deviation for all variables studied were calculated. To compare the results between different types of beverages and strategies used, the data were submitted to two-way ANOVA, complemented by the Tukey test, if significant main effects were found. The comparison of the total amount of fluids consumed during the practice, guidedor not by thirst sensation, was made by Student t test. The data were considered statistically significant when $P < 0.05$.

Results

The study was done with 9 male athletes with a mean age of 11,8 ± 4,0 years old and weight of 47,9 ± 13,5kg. The type of drink offered during the training did not significantly influence the percentage in variation of body weight (ΔW), and perceived exertion (PE) (Table 1). The temperature conditions (RT) and relative humidity of the air (RH) presented a small, but significant variation in the training. The sweat rate and total volume of liquids intake (VI) was reduced significantly when the beverage offered was the sports drink, guided by thirst. Although the type of beverage did not influence the weight loss of the athletes, there was greater dehydration on days that athletes replaced fluids guided by the sensation of thirst (Table 1).

Table 1: Judokas' hydration during training and the use of different beverages

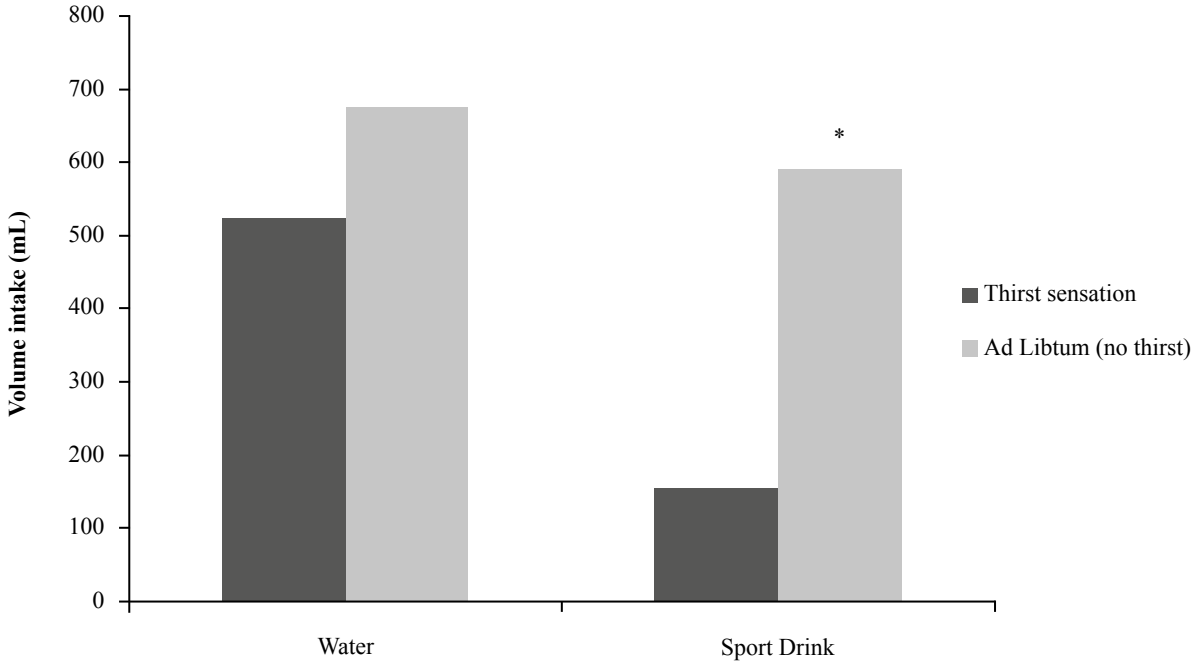
Variables	*Ad Libitum*		Thirst		Value *p**
	Water	Sports drink	Water	Sports drink	
ΔW (%)	-0.04 ± 0.4	-0.36 ± 0.6	-0.69 ± 1.1	-0.57 ± 0.6	0.17
SR (ml/min)	7.2 ± 1.7^{a,b}	7.1 ± 1.9^{a,b}	10.0 ± 7.1^{a}	4.5 ± 1.6^{b}	0.04
VI (ml)	676.7 ± 269^{a}	593.3 ± 325^{a}	521.1 ± 290^{a}	152.2 ± 187^{b}	0.01
PE	3.2 ± 1.4	4.0 ± 1.8	5.0 ± 1.9	4.1 ± 1.5	0.19
RT (ºC)	32.3 ± 0.6^{a,b}	31.6 ± 1.1^{b}	33.7 ± 0,6^{a}	32.3 ± 0.6^{a,b}	0.04
RH (%)	41.3 ± 1.4^{b,c}	43.3 ± 1.8^{a}	42.3 ± 1.4^{a,b}	40.3 ± 1.8^{c}	0.01

Note: VI (volume total intake), SR (sweat rate), PE (Perceived Exertion), RT (room temperature), URA (relative humidity). * Different letters in the same line presents significant difference by Tukey Test.

The use of thirst sensation as a strategy to promote adequate fluid intake during training was tested in two sessions of training. Athletes were oriented to ingest water or a sports drink just when they felt thirsty. There was a reduction in fluid intake

when fluid replacement was guided by thirst alone in the case of both beverages (water and sports drink) (Figure 1). When the beverage offered was the sport drink this reduction was drastic (593,3 mL without thirst sensation Vs 152,2 mL with thirst sensation). During the training, four athletes presented a fluid intake of zero when the option was a sports drink and the intake was guided by thirst sensation. These four athletes presented the highest levels of dehydration at the end of the training; three athletes presented more than 1% dehydration. This suggested that this type of beverage has low acceptance in this population.

Figure 1: Total volume of fluid intake during training with and without sensation of thirst.



Note: * Significant difference between sports drink intake with and without sensation of thirst p = 0.006 (t test).

Discussion

Judo athletes in tropical regions are susceptible to dehydration due to the common practice of fluid restriction during the training, environmental conditions, and the use of kimonos that reduce the dissipation of heat to the environment. In all conditions checked in the present study, the mean fluid loss of athletes was under 1% of body mass. These results showed that the athletes finished the training very well hydrated, according to recommendations proposed by National Athletic Trainers' Association[7].

The present study evaluated whether the use of different beverages could affect fluid loss during training. The beverages tested (water and sport drink) did not affect fluid loss in the athletes. The average modification of percentage of the body mass varied from -0,04 to -0,69 with the different beverages tested (Table 1). Barbosa and Navarro[18] found the variation between -0,15 e -0,28% of the body mass in judokas during 80 minutes of training, utilizing different strategies of hydration. Others authors found results different from those mentioned in the present study. They found medium values of dehydration in judokas, theirs being between 1,4 e 2,1% (19,2). The magnitude of fluid loss depends on a variety of factors such as training characteristics, climate conditions (temperature and humidity), level of fitness of the population and whether liquids are offered during training or not.

The physical and chemical characteristics of the beverage offered can influence the volume intake by athletes during training. There is evidence that the addition of sodium improves the palatability of the beverage and flavored beverages can contribute to an increase in the voluntary ingestion of liquids[20,11,21,22]. In this study, the presence of flavor, carbohydrates, and electrolytes in the sports drink were not enough to increase fluid intake during training when compared with water intake (Table 1). Hydration with water reached the highest values of volume intake, with an average of 676.7 ± 269 mL. These results are in accordance with Barbosa and Navarro[18], who also observed higher consumption of water when compared to a sports drink. Others authors found higher intake of sport drink compared with water[23,22] or found no differences in consumption of beverages with distinct characteristics[24,25].

The standardization and realization of training in similar climate conditions certainly favored that the sweat rate and PE did not present great differences between the exercises the training. The sweat rate was low in all training sessions, varying from 0.27 to 0.60L/h. Athletes were used to the environmental conditions and the training location, so they did not find it difficult in the training. The values of PE show that training were not considered 'moderate' or 'a little hard' intensity. The only expectation was the training session in which the consumption of

water was guided by thirst alone. In this training session, athletes rated it as "difficult" (Table 1). In this last training session, two athletes presented a high sweat rate (1.27 and 1.28 L/h) which contributed to the increase in the average of the group. Coelho, Stulbach, Marangoni, De Barros[26] did not find a significant difference regarding the sweat rate (0.72-0.84 L/h) of judokas evaluated in five different conditions (water replacement, juice, maltodextrin beverage, usual condition and no hydration).

In this study, athletes did two training sessions with ingestion of water or sports drink, guided by thirst sensation. The athletes were oriented to ingest the ad libitum beverages, just when the thirst sensation was present. The water or sports drink intake according to thirst sensation decreased when compared to training in which fluid intake was not guided by thirst sensation. Thus, drinking according to thirst sensation alone impaired the hydration of the athletes. They finished training with a percentage of body mass loss considerably high when compared with the ingestion of *ad libitum,* independent of the presence of thirst sensation (Table 1).

Researchers, coaches and athletes share the idea that fluid replacement during physical exercise is important to ensure the physical health and healthy performance of athletes. However, there is disagreement about the beverage type to be used. The use of individualized protocols based on the sweat rate of the athlete has been encouraged[4,7,10]. On the other hand, the use of thirst sensation as a guide for fluid replacement also has been encouraged by researchers to avoid diseases associated with hyperhydration such as hyponatremia[13,14,27,12,7,3]. In a study by Armstrong et al.[1] no differences were observed in the fluid intake of trained cyclists that consumed liquids ad libitum or oriented by thirst sensation.

During exercise, increased sweating will promote blood hyperosmolarity, activating the thirst center. In theory, there would be a command to increase fluid intake. However, intensity of thirst sensation is hard to quantify and varies individually[28]. Furthermore, during training, an athlete's focus on the exercises can make that athlete ignore sensations of thirst until they become intense. So, thirst sensation can be adequate to ensure correct hydration in some athletes, but not in all.

In this study, a drastic reduction of liquid ingestion according to thirst was observed when the beverage offered was a sports drink (Figure 1). The presence of carbohydrates, sodium and potassium, which accelerates the absorption of the drink -- may have contributed to the sport drink being more efficient in the restoration of the body fluids with less volume required. Moreover, there is the the fact that the sweat rate was also lower compared to training not guided by thirst. On the other hand, social custom is one of the factors that influences the type of beverage consumed to combat thirst[20]. The preference for water to quench thirst is a social custom and probably contributed to the fact that athletes presented higher consumption of water compared to the sports drink, when fluid intake was guided by thirst. The use of the sports drink inhibited the ingestion of almost half of the athletes. Nonetheless, in the conditions tested there was no significant loss of fluid. In a study made by Brito and Marins[29] 90,9% with 220 judokas evaluated, they reported that the athletes usually consume water to hydrate themselves. The presence of carbohydrates and sodium in sports drinks can also have inhibited the consumption of this beverage, because it is popular knowledge that the consumption of foods rich in sodium or carbohydrates, increases the sensation of thirst.

Ingestion of water instead of caloric beverages has been recommended to patients who needed to reduce body weight[30]. Somebody that needs to maintain body weight within standards, such as dancers and fighters, can avoid the ingestion of caloric isotonic beverages to avoid weight gain. In this study, the athletes were not prevented from ingesting isotonic beverages, because when the isotonic beverage was offered *ad libitum* independent of thirst, the athletes ingested a volume similar to that of water; though it was not asked if any athletes were in a weight loss period in the week of the thirst guided tests.

However, to reduce exercise-induced water loss, it is necessary to encourage athletes to drink fluids before, during and after training. Furthermore, it is necessary to test different strategies, always respecting the athlete and considering the recommendations and suggestions established in literature to reach the best results for each athlete.

Conclusions

Adolescent judokas encouraged to ingest different beverages ad libitum during training showed no preference for the type of drink offered. The stimulation of fluid replacement guided by presence of the sensation of thirst led to reduced fluid intake, especially with the sports drink, and increased dehydration levels for water and the sports drink.

Although, many authors recommend the use of thirst to guide adequate fluid replacement during training, the present study shows this strategy can impair fluid replacement during training. However, the athletes who did not reject the sport drink when the fluid replacement was guided by the thirst sensation showed results similar to those obtained when the water was offered, but with lower ingested volumes, an indication of efficiency.

References

1. Armstrong LE, Johnson EC, Kunces LJ, Ganio MS, Judelson DA, Kupchak BR, et al. Drinking to thirst versus drinking ad libitum during road cycling. J Athl Train 2014;49:624-31.
2. Rivera-Brown AM, De Félix-Dávila RA. Hydration status in adolescent judo athletes before and after training in the heat. Int J Sports Physiol Perform 2012;7: 39-46.
3. Périard JD, Racinais S, Sawka MN. Adaptations and mechanisms of human heat acclimation: applications for competitive athletes and sports. Scand J Med Sci Sports 2015; 25(Suppl 1): 20-38.
4. American College of Sports Medicine, Sawka MN, Burke LM, Eichner ER, Maughan RJ, Montain SJ, et al. American College of Sports Medicine position stand: exercise and fluid replacement. Med Sci Sports Exerc 2007;39:377–90.
5. American College of Sports Medicine. Rodriguez NR, Nancy M DiMarco, Langley S. Nutrition and athletic performance. Med Sci Sports Exerc 2009;41: 709-31.

6. Dugas JP, Oosthuizen U, Tucker R, Noakes TD. Rates of fluid ingestion alter pacing but not thermoregulatory responses during prolonged exercise in hot and humid conditions with appropriate convective cooling. Eur J Appl Physiol 2009;105:69–80.
7. Casa DJ, Armstrong LE, Hillman SK, Montain SJ, Reiff RV, Rich BSV, et al. National Athletic Trainers' Association position statement: fluid replacement for athletes. J Athl Train 2000;35:212–24.
8. Noakes TD, Sharwood K, Collins M, Perkins DR. The dipsomania of great distance: water intoxication in an ironman triathlete. Br J Sports Med 2004;38:E16.
9. Winger JM, Dugas JP, Dugas LR. Beliefs about hydration and physiology drive drinking behaviours in runners. Br J Sports Med 2011;45:646–49.
10. Sociedade Brasileira de Medicina do Esporte. Modificações dietéticas, reposição hídrica, suplementos alimentares e drogas: comprovação de ação ergogênica e potenciais riscos para a saúde. Rev Bras Med Esporte 2009;15: 2-12.
11. Herring SA, Kibler WB, Putukian M, O'Brien S, Jaffe R, Boyajian-O'Neill L, et al. Selected issues for nutrition and the athlete: A team physician consensus statement. Med Sci Sports Exerc 2013;45: 2378-86.
12. Moreira CAM, Gomes ACV, Garcia ES, Rodrigues LOC. Hidratação durante o exercício: a sede é suficiente? Rev Bras Med Esp 2006;12:405-09.
13. Cheuvront SN, Haymes EM. Ad libitum fluid intakes and thermoregulatory responses of female distance runners in three environments. J Sports Sci 2001;19:845-54.
14. Daries HN, Noakes TD, Dennis SC. Effect of fluid intake volume on 2-h running performances in a 25oC environment. Med Sci Sports Exerc 2000;32:1783-9.
15. Noakes TD. Overconsumption of fluids by athletes. BMJ 2003; 327:113–14.
16. Hew-Butler T, Verbalis JG, Noakes TD, International Marathon Medical Directors Association. Updated fluid recommendation: position statement from the International Marathon Medical Directors Association (IMMDA). Clin J Sport Med 2006;16:283–92.
17. Foster C, Florhaug J, Franklin J, Gottschall L, Hrovation L, Parker S, et al. A new approach to monitoring exercise training. J Strength Cond Res 2001;15:109-15.
18. Barbosa PB, Navarro F. Estado De Hidratação e Rendimento de Judocas Submetidos a Diferentes Formas de Reposição Hídrica. Rev Bras Nutr Esport 2011;5:79-87.
19. Pereira SE, Soares, ES, Loureiro, ACC, Pinto, NV. Déficit hídrico pós-treino em judocas submetidos a diferentes intensidades de treinamento com e sem hidratação. Rev Bras Nutr Esp 2015;9:30-39.
20. Greenleaf JE. Problem: thirst, drinking behavior, and involuntary dehydration. Med Sci Sports Exerc 1992;24:645-56.
21. Khamnei S, Abdollah H, Masumeh Z. Water temperature, voluntary drinking and fluid balance in dehydrated Taekwondo athletes. J Sports Sci med 2011;10: 718-24.
22. Passe DH, Horn M, Stofan J, Murray R. Palatability and voluntary intake of sports beverages, diluted orange juice, and water during exercise. Int J Sport Nutr Exerc Met 2004;14:272-84.
23. Park SG, Bae Y J, Lee YS, Kim BJ. Effects of rehydration fluid temperature and composition on body weight retention upon voluntary drinking following exercise-induced dehydration. Nutr res pract 2012;6:126-31.
24. Kalman DS, Feldman S, Krieger DR, Bloomer RJ. Comparison of coconut water and a carbohydrate-electrolyte sport drink on measures of hydration and physical performance in exercise-trained men. J Int Soc Sports Nutr 2012; 9, 1-10.
25. Wong SH, Sun FH. Effect of beverage flavor on body hydration in Hong Kong Chinese children exercising in a hot environment. Pediatr Exerc Sci 2014 May;26:177-86.
26. Cuelho AM, Stulbach T, Marangoni AB, De Barros ARZ. Avaliação da taxa de sudorese em judocas de elite. Lecturas: Educ Fís Dep 2009;13:1-5.
27. Goulet ED. Effect of exercise-induced dehydration on time-trial exercise performance: a meta-analysis. Br J Sports Med 2011; 45:1149–156.
28. Thornton SN. Thirst and hydration: physiology and consequences of dysfunction. Physiol behav 2010;100:15-21.
29. Brito CJ, Marins JCB. Caracterização das práticas sobre hidratação em atletas da modalidade de judô no estado de Minas Gerais. Rev bras cienc mov 2005; 13: 59-74.
30. Stookey JD, Del Toro R, Hamer J, Medina A, Higa A, Ng V, et al. Qualitative and/or quantitative drinking water recommendations for pediatric obesity treatment. J Obes Weight Loss Ther 2014;4: 232-40.

**Corresponding author*

Wilson César Abreu
Universidade Federal de Lavras, Nutrição, Campus Universitário, Caixa Postal 3037, Lavras, Brazil
Email: wilson@dnu.ufla.br

Manuscript received on August 24, 2017
Manuscript accepted on January 17, 2018