HYDRATION STATE IN SWIMMERS AFTER THREE DIFFERENT FORMS OF HYDRIC REPLACEMENT IN THE CITY OF ARACAJU - SE - BRAZIL

Eduardo Seixas Prado1,2,3 espradoo@ig.com.br
Sheilla da Silva Barroso1,2 sheilassb@hotmail.com
Heline Oliveira Góis1,2 helinegois@hotmail.com
Thaise Reinert1,2 thaisereinert@hotmail.com

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ABSTRACT

Introduction: The physical training of athletes requires a good state of hydration, because the maintenance of adequate levels of water can favor the performance. The objective of the study is to evaluate the hydration state of swimmers from the city of Aracaju after training sessions with different forms of hydric replacement. Materials and Methods: Eight swimmers (age 24.25 ± 7.30 years-old) completed three controlled training sessions under different forms of hydric replacement: no fluid ingestion (GC), water ingestion (GA), consumption of sports drinks (GS). Hydration state was determined by urinary coloration and percentage of body mass change. Results: Based on urinary coloration, GS has better classification of hydration status than GC and GA. Significant difference was found in relation to percentage of body mass change (p<0.05) between groups, with hydric replacement advantage for GS. Discussion: The water can promote an adequate hydration status, but sports drinks seem to offer a better hydric replacement.

KEYWORDS

Swimming, Drinking, Dehydration.

1 Universidade Estadual de Londrina - UEL - Grupo de Estudo e Pesquisa em Atividade Física e Saúde - GEPAFIS - Londrina - Brazil
2 Universidade Tiradentes - Unit - Departamento de Educação Física - Aracaju - Brazil
3 Universidade Federal de Uberlândia - UFU - Instituto de Genética e Bioquímica - Uberlândia - Brazil
RESUMO

Introdução: O treinamento físico exige do atleta um bom estado de hidratação, pois a manutenção de níveis adequados de água pode favorecer o desempenho. O objetivo deste estudo foi avaliar o estado de hidratação de nadadores aracajuanos após sessões de treinamento com formas distintas de reposição hídrica. Materiais e Métodos: Oito nadadores (24,25±7,30 anos) realizaram três treinamentos controlados sob formas de reposição hídrica distintas: nenhum consumo de líquidos (GC), ingestão de água (GA), consumo de bebida esportiva (GS). O estado de hidratação foi determinado pela coloração urinária e percentual da perda da massa corporal. Resultados: Baseado na coloração da urina, GS demonstrou melhor classificação do estado de hidratação do que GC e GA. Diferença significativa foi encontrada em relação ao percentual da perda da massa corporal (p<0,05) entre os grupos, com vantagem hídrica para GS. Discussão: A água pode promover um adequado estado de hidratação, mas bebida esportiva parece oferecer uma melhor reposição hídrica.

PALAVRAS-CHAVE
Natação, Ingestão de Líquidos, Desidratação.

INTRODUCTION

To remain hydrated before, during and after the physical exercise is essential for athletes who may have their performance harmed if there is not adequate ingestion of some liquid1,2,3,4.

It is known that the adequate hydric replacement regulates the blood circulation, the plasma volume and control of body temperature. Not compensating the loss of liquids, especially in physical exercise in hot and humid environments, may bring serious consequences5,6. A state of inadequate hydration limits effectively the maintenance of temperature to a point that the thermoregulation is affected, determining physiological responses, such as decrease in performance, thermal damage and in severe cases, even death3,7,8,9. It may also affect cardiovascular responses in physical activity, impairing the performance7,10,11,12. During an aerobic exercise in the heat the heart rate increases and the volume of ejection, the cardiac output and the blood flow to the exercising muscle can be reduced, leading to situations of “cardiovascular drift”13,14,15,16,17.

In the realization of prolonged physical exercises, associated with hot and humid environments, the definition of the type of liquid to be ingested is important and significant contributions have been made18,19. The ingestion of water appears not to be the best alternative to liquid consumption, but sports drinks20 instead. It is suggested the inclusion of electrolytes, mainly sodium, increasing the retention of water in intracellular space21. If the liquid ingested includes carbohydrate, this improvement is more significant, especially in prolonged exercises with intense sweating22. However, criticism to these recommendations was recently published23.

Besides the type of beverage, the characterization of the practices and the evaluation of the state of hydration
are important elements to ensure an adequate hydration\(^{24,25,26}\). As for the methods of evaluating the state of hydration, several forms are currently used\(^{27,28}\). The body mass and urinary coloration are simple techniques for evaluating the hydration that can be used safely for this end\(^{27,29,30,31,32}\).

The city of Aracaju is characterized by a hot and humid climate, which can provide physical damages in the performance of local athletes during the training, regardless of the sport modality. Swimming, though practiced in the aquatic environment can also cause such damages. However, the levels of hydration of the swimmers from Aracaju are still unknown. Therefore, the objective of this study was to verify the state of hydration in swimmer athletes in the city of Aracaju, subjected to various forms of hydric replacement during training sessions.

**MATERIALS AND METHODS**

The sample was composed of eight athletes (24.25±7.30 years-old) males, participating in national competitions for at least five years, volunteers and residents in the city of Aracaju - SE. No participant had medical history with health problems and was not using ergogenic substances or any other type of drug that could alter the study outcome. All were informed and instructed in advance about the study realization and signed a term of free and informed consent, which guaranteed the privacy of personal information. This work also met the standards for the conduct of research in human beings, 196 resolution of the National Health Council of 10/10/96, and was approved by the Ethics in Research Committee from the University of Tiradentes (UNIT/SE), under the number 160907-R.

Throughout all the study, the athletes performed, in the period of 12 days, three training sessions with controlled ingestion of fluids (TC) on different days with intervals of 72h.

Three days before the first TC (D\(_1\)), the study was started. During this period, the athletes were instructed to maintain their normal diet and training routine (TN), but that was ingested only water or decaffeinated drinks, ad libitum, as liquid diet (DL). The same was repeated between the fifth and seventh days (D\(_5-7\)) and ninth and eleventh days (D\(_9-11\)).

On the first day of TC or 4th day of the experiment (D\(_4\)), no one consumed water and/or other type of liquid during the training, which is called the control group (GC). In the second TC or 8 days (D\(_8\)), the athletes consumed only mineral water from the Minalba\(^{30}\) brand during training, which was called the water group (GA). In the third TC or 12th day (D\(_{12}\)), the athletes ingested a sports drink (carbohydrate and electrolyte solution) from the Gatorade\(^{31}\) brand during training, called the supplement group (GS).

It is noteworthy that in the D\(_4\), D\(_8\) and D\(_{12}\), the athletes kept the recommendations of the DL in the moments before and after TC, and that the control mentioned above occurred only during the TC, with the athletes ingesting their drink ad libitum. Moreover, the training sessions were equal in duration and intensity for all athletes in the days of TC.

In each TC, both before and after, the following data were collected: environmental temperature (in Celsius degrees, °C), relative air humidity (in percentage, %), training duration (minutes, min), distance covered (in meters, m), average consumption of liquid (in milliliters, mL), body mass (in kilograms, kg) and urinary coloration. The last two were used as simple markers for evaluation of the state of hydration.

The body mass was registered before (pre) and after (post) each TC, using for such an anthropometric scale from the Filizola brand, with 100g precision. At the time of the measurement the subjects were standing, facing the evaluator, in the upright position, feet apart across the width of the hips, barefoot and wearing light clothes.

The urine samples were collected by the athletes themselves, originally when waking up in the morning (pre) and immediately after (post) all TC (Image 1). Soon after, the collected urine was submitted for review and determination of its color, with reference the scale of Armstrong et al.\(^{29}\). The samples were kept at room temperature until analyzed, immediately after collection. The results obtained from body mass and urinary coloration were classified at the table proposed by Casa et al.\(^{33}\).

Initially, the data were expressed as average and standard deviation. Then, the test was conducted to determine the degree of homogeneity of the sample. When the sample showed a normal distribution it was applied the analysis of variance (ANOVA) One Way to verify the differences between the averages from the urinary coloration indexes, body mass and percentage of difference in body mass from the groups. When the sample did not show normality, it was

**Table 1 - Characterization of the sample control**

<table>
<thead>
<tr>
<th>TC days</th>
<th>temperature (°C)</th>
<th>humidity (%)</th>
<th>training duration (min)</th>
<th>distance covered (m)</th>
<th>average water ingestion ± standard deviation (mL)</th>
<th>average sports drink ingestion ± standard deviation (mL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>D(_4)</td>
<td>28</td>
<td>66</td>
<td>80</td>
<td>3100</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>D(_8)</td>
<td>28</td>
<td>62</td>
<td>80</td>
<td>3100</td>
<td>575 ± 345.38</td>
<td>-</td>
</tr>
<tr>
<td>D(_{12})</td>
<td>29</td>
<td>65</td>
<td>80</td>
<td>3100</td>
<td>-</td>
<td>400 ± 297.61</td>
</tr>
</tbody>
</table>
used the Kruskal-Wallis One Way. All forms of verification of the differences between the averages were combined to the post-hoc test from Tukey, adopting a significance level of 5%. The results from the classification of the hydration state obtained from the urinary coloration index were also expressed as percentage (%).

**RESULTS**

Environmental conditions, duration, distance covered in training sessions, as well as the consumption of water and sports drink, are described in Table 1. During the TC the temperature was between 28°C and 29°C with a relative humidity of 66%, 62% and 65% respectively in D4, D8 and D12. The distance covered was 3.100m, with a duration of 80min in all the TC, with an average consumption of water of 575.00±345.38mL and 400.00±297.61mL of sports drink.

There were no significant differences between groups for urinary coloration indexes (p> 0.05) (Table 2). However, all groups showed high levels, both before (GC-pre =4.50±1.92; GA-pre =4.87±1.45 and GS-pre =5.00±1.19) and after the TC (GC-post =5.62±1.59; GA-post =5.62±1.76 and GS-post =5.00±2.26). This result shows that the groups already showed some state of dehydration in the moments before the TC. Moreover, the high values of the indexes presented after the TC feature a precarious state of hydration, regardless of the liquid resource used.

Furthermore, although not demonstrated significant differences for absolute values of the urinary coloration indexes, the discovery of a state of dehydration between the three groups, especially at post TC moment, regardless of the liquid resource ingestion, the GS promoted a better hydration compared with GC and GA, when an percentage analysis of the classification of hydration state from the athletes was conducted relating to the urinary coloration.

In GC-pre, 62% of the athletes were the less hydrated or with minimal dehydration, while 38% were between a significant or severe dehydration. When the GC-post was analyzed, it showed an increase in the percentage of athletes with significant or severe dehydration from 62% to 75%, and consequently the percentage of the less hydration decreased from 38% to 25%, that is, there was a worsening in the classification of the state of hydration (Image 2A).

Similar changes to the GC were verified in the GA. In GA-pre, half of the athletes (50%) were the less hydrated or with minimal dehydration, and the other half (50%) showed significant or severe dehydration. When the GA-post was analyzed, the percentage of athletes the less hydrated or with minimal dehydration decreased to 38% and the percentage of significant or severe dehydration increased to 62%, that is, there was also a loss in the classification of the state of hydration (Image 2B).

Unlike the other groups, the GS did not alter its percentage of classification of the hydration state. Both in GS-pre as in GS-post, 50% of athletes were the less hydrated or with minimal dehydration, and the other half (50%) with significant or severe dehydration (Image 2C). The maintenance of the classification percentage shows a better state of hydration in this group.

As for the absolute values of body mass, no significant difference was observed between groups (p>0.05) (Table 2). However, analyzing the variance of the body mass difference percentage, both GC and GA, showed body...
mass loss percentages (-1.66% and -0.69%, respectively), while in GS it was verified a gain (+0.72%). However, this did not represent a significant difference between GA and GS. There was a difference in this percentage between groups GA and GC, and between GA and GS (p<0.05) (Image 3).

**DISCUSSION**

It is known that the temperature, humidity, intensity, duration of exercise, adaptation from the athlete to the environment, loss of fluids, and other factors, should be considered for adequate adoption of a system of hydration before, during and after the physical exercises. In high temperatures and humidity, the performance in prolonged exercises is reduced, what can lead to fatigue.

In the study by Binkley et al. it is stated that high temperatures during a physical exercise lead to a high risk of exhaustion, of stress and possible damages to the life of the athlete. Murray also reports that the losses triggered by an inadequate hydration in high temperatures, affect the performance in the competition, causing health risks. For people who live or compete in such environments, it is recommended a good liquid diet, consuming adequate amounts of fluids during the 24h preceding the event, especially during the period between the last meal and the exercise, so that their performance is not harmed.

It is recommended to drink approximately 500mL of liquid, about 2h before exercise to promote adequate hydration and allow time for there to excrete the excess of water ingestion. Furthermore, it is advisable to increase the hydration during the breaks in training, but also the ingestion of 1L to 1.25L of liquid for each kilogram of body water lost during the exercise. Thus, it is possible to prevent a dehydration or likely hyperthermia, as well as decreases in performance during the exercise.

Generally, the city of Aracaju shows the relative humidity from air and high environmental temperature (~80% and ~35°C, respectively). However, in this study, these variables remained relatively low, and, even that way, it was possible to observe damages to the state of hydration.

Based on the urinary coloration indexes, before the TC all the groups were already dehydrated. This occurrence is due to the fact that athletes do not hydrate properly, leading to a state of cumulative and progressive dehydration. The dehydration may be due to both intense sweating during the practice of exercise and/or a deficiency in the absorption of liquids. Therefore, it is important to recognize the factors that influence the quality of hydration. When a level of severe dehydration is reached, the athlete is already dehydrated even before starting the training or is inadequately hydrated during and after the training sessions, so that he/she also starts the subsequent training with a low state of hydration.

When the recommendations of hydration in the exercise are not followed, the levels of dehydration appear to occur before the training or competition. Kutlu & Guler observed a state of dehydration in tae-kwon-do athletes in through urinary coloration by the morning. Another study, investigating the state of hydration pre-game in warm and dry environments, in athletes from football, volleyball and
basketball from Australia, through the specific gravity of urine and urinary coloration, noted that 6% of the athletes were with severe dehydration, 50% with significant dehydration, 31% with minimal dehydration and 14% the less hydrated.\textsuperscript{41}

The rates of urinary coloration observed after the TC, also demonstrated a state of dehydration in athletes, regardless of the solution ingested. It seems that deficient fluid replacement is not isolated fact only among athletes of swimming from the city of Aracaju. According to Armstrong et al.\textsuperscript{38}, the volume of fluids that most athletes voluntarily ingest during training does not reset 100% of fluid lost in sweat, especially in high-intensity exercises in an environment of high temperature, since under these conditions the rate of sweat and the volume of fluids lost increases. Yeargin et al.\textsuperscript{42} also found a state of dehydration in American football players evaluated by the urinary coloration, for eight days of training. Similarly, Tan & Sunarja\textsuperscript{43} verified a state of dehydration in sailing athletes during a competition.

An important observation in this study was the percentage of classification of the hydration state, based on urinary coloration in the less hydration, minimum dehydration, significant dehydration and severe dehydration, proposed by Casa et al.\textsuperscript{33}. Swimmers in GS\textsubscript{post} suffered minor hidric damage in relation to other groups when the analysis of the classification’s percentage was performed, that is, a smaller number of athletes was in the state of significant or severe dehydration after TC. However, for the foregoing, it is worthy to highlight some interesting points.

It is important to note that there is still no consensus in the scientific community regarding the ideal methods for evaluating the state of hydration, there are even doubts about the use of urinary coloration indexes to do it. Armstrong et al.\textsuperscript{30}, investigating the validity and sensitivity of the urinary coloration as an index of hydration state, observed in male trained cyclists, that the urinary coloration is a valid index to assess the state of hydration and may be used as well or better, than other markers. Kavouras\textsuperscript{44} also recognizes the urinary coloration as an effective marker of the hydration state. It seems that the sum of more than one simple marker of hydration state is sufficient for an accurate evaluation. The use of urinary coloration, only, can not be a marker of hydration state after 6h from the exercise’s end.\textsuperscript{45}

Another point is that there are controversies about the effectiveness of the consumption of sports drinks, as well as water.\textsuperscript{46} In the study by Grandjean et al.\textsuperscript{47} it was verified the effects on hydration in men who were subjected to two different tests of liquid diet. They received water in a test and not received any other liquid, and no differences in body weight loss between groups were found. Moreover, several studies state that the water may not be the best repository from fluids lost during exercise. To include carbohydrates and electrolytes in rehydration can improve the rate of intestinal absorption of sodium and water, and restore glycogen stores, thereby increasing the performance in subsequent exercises.\textsuperscript{34,37,48,49} Maughan & Leiper\textsuperscript{32} affirm, in their study, that the sports drinks are more effective for rehydration.

Nevertheless, Noakes\textsuperscript{22} comments that there are no sufficient evidences for recommendation of these beverages. Indeed, there is great commercial interest from the industry of sports drinks to profit with such recommendations.

The above questions appear to be better informed when the review of the state of hydration was determined by the percentage of difference in body mass, in which the benefit of the ingestion of sports drink in the process of hydration, is more evident. In the current study, the best percentage of the difference in body mass loss was obtained by the GS, though there is a significant difference only with the GC, and not with GA.

Bergeron et al.\textsuperscript{20}, aiming to examine the effects of the consumption of sports drinks and water in body mass of young tennis players, also found a significantly smaller loss in body mass when it was consumed a sports drink in a training session with duration of 120 min. These results partially corroborate the findings of Ebert et al.\textsuperscript{50} who also found a negative variation of body mass in young male cyclists after training session. It seems that the water consumption associated with electrolytes can at least reduce the total amount of liquid ingestion that are needed during a prolonged exercise.\textsuperscript{51}

The swimmers from Aracaju demonstrated a state of dehydration when observed by the set of simple markers of hydration, that is, urinary coloration index and percentage of difference in body mass after the training sessions. Perhaps, the explanation for the occurred fact is Image 3 - Percentage of the difference in body mass between groups. Values are expressed as mean ± standard deviation

![Image 3 - Percentage of the difference in body mass between groups. Values are expressed as mean ± standard deviation](image3.png)

* significant difference in GC (p < 0.05)
in the habit that the athletes have of not making a hydric replacement in the days of training. The ingestion of liquids during a session of swimming is essential to maintaining an adequate state of hydration. However, despite the use of water being a good instrument, the ingestion of sports drink, seems to play a better role as hydric repository. It is suggested that the swimmers from the city of Aracaju ingest a larger amount of liquids before, during and after the days of training, being recommended the use of sports drinks when the environmental conditions are, at least, similar to the one from this study.

REFERENCES


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