Hydration practices of runners during training *vs* competition

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Summary

Background: Appropriate hydration ensures that the athlete is in ideal condition during exercise. Inadequate hydration practices are still present among athletes participating in different types of sports. This could be the result of a low level of knowledge concerning the importance of hydration for athletic performance. The purpose of this study was to evaluate the level of knowledge and the hydration practices of the runners in training and competition.
Method: This study used an exploratory method involving a questionnaire containing 19 objective questions related to hydration habits and level of knowledge about hydration, as reported in prior studies, which included questions categorized into three parts: demographic characteristics, hydration habits during competition and training, and hydration knowledge. A total of 412 athletes (36.1 ± 12.9 years old) with a high experience in the sport (11.2 ± 10.9 years) were evaluated.
Results: A significant difference (p = 0.0012) was observed for reported hydration practices between training and competitions. Moreover, the data revealed that a large number of runners (41 % in competitions and 54.4% in training) had inadequate hydration habits because they did not always consume fluids. Increased consumption of fluids in the competitions was also observed. Only 35.4% of athletes consumed sports drinks, while 3.88 % had never consumed fluids during training, and 1.5% never consumed fluids in competition. Few athletes (23.2%) weighed themselves before and after exercising. Participants answered 66.6% of hydration knowledge questions correctly.
Conclusion: Runners were not able to transfer their knowledge about proper hydration during both training and competition practices.

Key words:
Sports nutrition. Hydration. Dehydration. Athletes.

Prácticas de hidratación en corredores durante el entrenamiento *vs* la competición

Resumen

Introducción: Una hidratación adecuada asegura que el atleta está en condición ideal durante el ejercicio. Se suelen presentar prácticas de hidratación inadecuadas entre los deportistas de diferentes disciplinas que podrían deberse a un bajo nivel de conocimiento sobre la importancia de una correcta hidratación para el rendimiento deportivo. El objetivo del estudio fue evaluar el nivel de conocimiento y las prácticas de hidratación en corredores durante el entrenamiento frente a la competición.
Métodos: Este estudio utilizó un método exploratorio que incluía un cuestionario con 19 preguntas objetivas relacionadas con los hábitos de hidratación y el nivel de conocimiento sobre hidratación, según lo informado en estudios previos, cuyas preguntas estaban divididas en tres partes: características demográficas; hábitos de hidratación durante el entrenamiento y competición, y conocimientos sobre hidratación. Se evaluaron 412 corredores (36,1 ± 12,9 años) con una elevada experiencia en la práctica del atletismo (11,2 ± 10,9 años).
Resultados: Hubo diferencia significativa (p = 0,0012) de las prácticas de hidratación durante los entrenamientos y la competición, con mayor consumo de líquidos durante las competiciones. Por otra parte, los datos revelaron que un gran número de corredores (41,0% en competición y 54,4 % en entrenamiento) tenían hábitos de hidratación inadecuados al no consumir siempre líquidos. Sólo el 35,4 % de los atletas declararon consumir bebidas deportivas. La ingesta de líquidos era inexistente en el 3,8% de los atletas durante el entrenamiento y el 1,5% en competiciones. Sólo el 23,2% de los encuestados controlaban el peso corporal antes y después del ejercicio. Los participantes respondieron correctamente al 66,6% de las preguntas sobre conocimiento de hidratación.
Conclusiones: Los corredores participantes no fueron capaces de trasladar sus conocimientos sobre el tema de hidratación en prácticas adecuadas tanto en entrenamiento como en competición.

Palabras clave:
Nutrición deportiva. Hidratación. Deshidratación. Deportistas.

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Introduction

Recently, the number of Brazilians who are dedicated to competitive sports has increased significantly. The last edition of the São Silvestre race in 2013 was attended by twenty-five thousand runners, and the International Marathon of São Paulo was attended by twenty thousand runners this year. However, some reports show that many of these participants are not concerned about factors that influence their performance, such as proper training, rest and nutrition, and they are either not getting regular exercise or exercising minimally.

Because running is a long-duration sporting event, it has distinctive features, as it involves supporting weight at different intensities, aerobic and anaerobic activity, a high metabolic demand and increasing water loss, the last of which can be exacerbated by weather conditions such as temperature and humidity[1]. Maintenance of fluid balance is therefore essential for athletic performance[2] and thermoregulation. Weight loss, even as little as 2 % of the total body weight, can have a negative effect on thermoregulation and exercise performance. Fluid lost through sweat during exercise must be replaced[3-5].

Studies that have monitored water loss during long races, such as marathons and ultramarathons, observed significant fluid loss[6,7]. These studies demonstrated that these losses can reach high levels. Indeed, a runner at The Los Angeles Marathon in 1984 lost 3.7 liters of water per hour[8]. These studies illustrate the importance of hydration. A dehydrated runner may have decreased performance, altered cardiovascular parameters and an altered electrolyte balance, which can trigger anything from minimal inconvenience to cramps and even more serious conditions, such as convulsions or fainting[3]. Appropriate hydration ensures that the athlete is in ideal condition during exercise.

Many researchers to date have demonstrated that inadequate hydration practices are still present among athletes participating in different types of sports[9-16]. This could be the result of a low level of knowledge concerning the importance of hydration for athletic performance. This lack of knowledge can lead to inappropriate behavior, such as drinking water during long bouts of exercise instead of drinking the recommended sports drinks during endurance competitions[17-19]. Therefore, long distance runners must have knowledge about hydration habits and practices for adequate planning of fluid replacement during training and competitions.

Thus, our hypothesis is that runners do not have and appropriate knowledge about hydration during training and competition. Therefore, the aim of this study was to investigate the level of knowledge about hydration and the hydration practices during training and competition in Brazilian runners.

Material and methods

Participants

The sample consisted of 412 volunteer male runners who were willing to participate in the study by answering the questionnaire. All of them were previously informed about the objectives of the research and evaluation procedures. Those who agreed to participate signed their consent to participate in the survey. So, the sample had a characterization of probabilistic type.

Data were collected at major road races held in the cities of Belo Horizonte, Juiz de Fora, Mariana, Contagem and Viçosa, all in the State of Minas Gerais, Brazil. Contact with runners was at random after the competition is held. All questionnaires were administered by trained evaluators, allowing uniformity in procedures and data collected. The average time to complete the questionnaire was 15 minutes for each runner.

The research project was approved by The Federal University of Viçosa Ethics Committee of Human Research (approval no. 035/2006).

Procedure

This study used an exploratory method involving a questionnaire containing 19 objective questions related to hydration habits and level of knowledge about hydration, as reported in prior studies[9-12,14]. Before starting the study, the questionnaires were pilot tested on a group of ten runners who were not included in the sample described in this study.

The questionnaire was divided into three parts. Part 1 included questions on demographic information such as gender, hometown, age and years of sport practice. Part 2 referred to hydration practices and included questions related to the frequency of hydration; time at which hydration occurred; type, taste and temperature of fluid used; weight control; symptoms caused by inadequate hydration practices; and clothing worn during exercise. Part 3 consisted of six questions that investigated the level of knowledge about hydration. Each correct answer was awarded 1 point, with a possible maximum score of 6. No points were awarded for an incorrect answer. For questions seven and nine, the answers were considered correct if anything other than "nothing" was selected. For question 18, the correct answer was "have already obtained guidance about the best method of rehydration". The athletes were encouraged to ask for clarification regarding any questions they did not understand.

The questionnaire was previously evaluated by three professional sports nutritionists, and was previously used in earlier studies with Spanish runners[9], fighters[10], undergraduate athletes[11] and young soccer players[14].

Data analysis

All statistical analyses were conducted using Epi–info 2002 software. Descriptive statistics were used to calculate the mean and standard deviation for age and years of sport practice. A frequency analysis was calculated for each question, discarding unanswered questions. The chi-square test was used to compare the differences between hydration habits during training and competition situations. Significance was set at $p<0.05$.

To compare hydration habits (never, rarely, sometimes and always) during training and competition using the chi-square test, "always" was considered the appropriate response for each habit, and all other options were considered inappropriate and were grouped together.

Results

Sample characteristics

Among the 412 street runners who answered the questionnaire, 83% were from Minas Gerais and lived in 39 different cities in the state, with a mean age of 36.1 ± 12.9 years and an average of 11.2 ± 10.9 years of practice in the sport. All individuals were of Brazilian nationality.

Hydration practices

Figure 1 shows the percentage of responses (from never to always) related to the hydration practices of athletes in training and competition.

There was a statistically significant difference ($\chi^2 = 14.78$; $p = 0.0012$) between the athletes' behavior in training and competition situations. Fluid intake was greater in competitions. Moreover, the data revealed that a large number of runners—41% in competitions and 54.4% in training—have inadequate hydration habits because they do not always consume fluids.

When athletes were asked about when they hydrated (Figure 2), a low percentage (36.9%) reported that they hydrated during training, indicating that athlete behavior during competition is not always the same as that during training.

As shown in Figure 2, a high percentage of athletes reported ingesting fluids after physical activity, demonstrating that there is a need to restore the fluid homeostasis lost during exercise.

In terms of the type of fluid ingested, 72.7% of athletes reported that they were concerned about what to use for hydration. However, when asked about what type of fluid they drink, the respondents reported that they consumed water the most before (77%), during (86.2%) and after exercise (64.6%), showing that, in practice, few athletes hydrate with sports drinks.

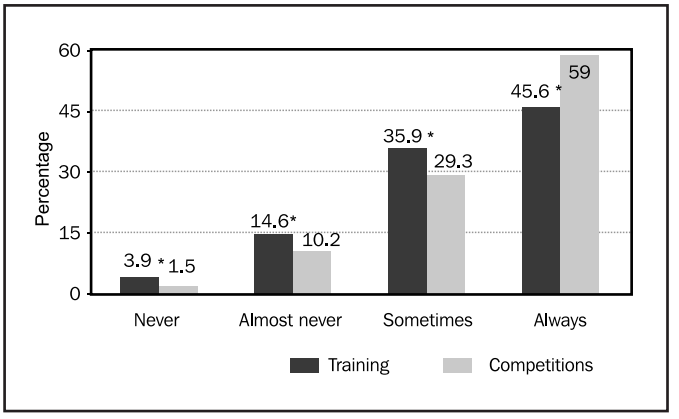
In addition to water and sports drinks, other possible fluids that could be consumed for hydration during sports events were also investigated. Water was the most fluid consumed by 95.6% of the athletes. Apart from water, other fluids consumed by the athletes included fruit juices (48 %), sport drinks (35.4%) and fruit soft drinks (18%).

Among the athletes who consumed sports drinks, 67.5% of them took the same brand among available in Brazil. Another relevant finding is related to the flavor of drinks that athletes prefer, as flavor contributes significantly to increased consumption when compared with water[1,20]. The favorite flavors among the runners were orange (34.5%), tangerine (21.4%), citrus (14.6%) and lemon (13.1%).

The largest percentage of athletes (62.8%) were concerned about hydration regardless of season, while 34.7% of the athletes reported that they were more concerned with hydration in the summer, and 2.6% said they do not to worry about hydration. The data revealed that only 23.2% of the athletes regularly weighed themselves before and after exercise. In contrast, 76.8% of the athletes weighed themselves occasionally, almost never or never.

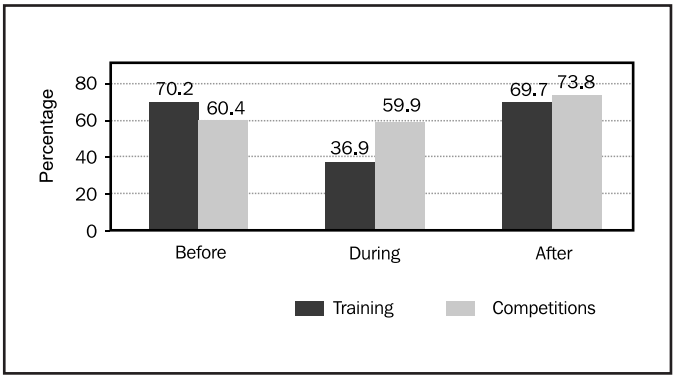
Whereas dehydration is associated with a series of physiological impairments, athletes were asked to indicate which symptoms they had experienced in their careers. Table 1 shows the frequency of symptoms that could be related to dehydration.

Figure 1. Fluid intake of runners in training and competition.



*Statistically significant difference between the athletes' behavior in training and competition situations.

Figure 2. Timing of hydration among runners in training and competition.



Among the athletes, 94.5% said they worry about the type of clothing they use, and the biggest concern was related to the type of fabric (80.9%). Only 31.7% of the athletes said they were concerned about the color or the amount of fabric they use.

In this study, athletes were asked to provide the preferred temperature of the fluid they used to hydrate. Fifty-one percent of the athletes preferred to hydrate with fluid at room temperature, while 47.2% preferred moderately cold fluid and only 1% preferred extremely cold fluid.

Level of hydration knowledge

The sample mean was 4 out of a maximum score of 6 points, meaning that the sample answered 66.6% of the questions correctly. Table 2 shows the percentage of correct answers for each question.

Thirst was identified as an indicator to start hydrating by 22.8% runners. In this study, the correct option was to consume fluids before feeling thirsty. The athletes' answers indicated that 89.8% were familiar with a brand of sports drink and 83% were familiar with a brand of energy drink. The best known sports drink was reported by 82% of the

Table 1. Physiologic manifestations that occur in training and/or competition.

Signs of Dehydration	Frequency
Intense thirst	24.8 %
Feelings of loss of strength	20.4 %
Cramps	19.4 %
Generalized fatigue	13.6 %
Headache	10.2 %
Concentration difficulties	9.2 %
Difficulty performing a technical movement easily performed under normal conditions	6.8 %
Tiredness	5.8 %
Paleness	4.9 %
Deep eyes	3.9 %
Alterations in vision	3.9 %
Lack of sensation in the hands	2.9 %
Interruption of sweat production	1.9 %
Interruption in planning an activity	1.9 %
Momentary loss of consciousness	1.5 %
Convulsion	1.0 %

Table 2. Percentage of athletes who correctly answered each question.

Question	Frequency of correct answer
Liquids must be consumed before thirst is felt	75.7 %
Familiar with a brand of hydro-electrolytic replacement	89.8 %
Familiar with a brand of energy drink	82.5 %
Consumption of liquid must be 250 mL per 15 minutes	45.5 %
Has acquired information on the best hydration habits	64.0 %
The function of an isotonic solution is to hydrate, replace electrolytes and provide energy	41.8 %

athletes, while the second most cited brand obtained 26.7%. Among the energy drinks, there was a balance between the different brands, as 33 % of the athletes were familiar with two brands.

These data show that few athletes regularly ingest sports or energy drinks. This is due in part to lack of knowledge about the drinks, as 17.5% said they did not know any sports drink brands, and 10.2 % did not know any energy drink brands.

The questionnaire also asked about the volume and frequency of hydration that athletes considered appropriate. Only 45.5% of athletes who reported always hydrating during competitions were found to hydrate adequately during training.

As shown in Table 2, 64% of the athletes had already received information about the best method of hydration. Guidance was most often provided by coaches (43.7%), doctors (35.5%) and magazines (31.8%). The nutritionist was responsible for providing information to only 17.5% of athletes. It was noted that only 41.75% of the athletes understand the correct function of the sports drinks, even though a majority reported that they had already received information about hydration.

Discussion

The large number of runners that have inadequate hydration habits indicates that the group needs educational intervention because dehydration can compromise not only performance but also health[1,3,5].

Despite being relatively small, a percentage of the athletes said they never consume fluid in training or competitions. This finding is alarming because the weekly training load of street runners can range from 50 to 200 km depending on the stage of training or competition, which can place a large burden on the body.

Inadequate hydration habits were also described by Duarte *et al*[6], in a study with Brazilian ultramarathon runners and by Marins *et al*[9], in a study with runners in Europe, which demonstrated that these athletes are susceptible to the deleterious effects of dehydration.

The athletes in this study prioritized hydration in competitive situations. However, if the competitive situation is not reproduced in training, the athlete may not be adapted to the increased hydration and may experience stomach discomfort at the time of competition. Furthermore, it is important to emphasize that attention should be devoted to hydration especially in training because this is part of the everyday life of an athlete. If water levels are inadequate, the quality of training will be reduced and the possibility of damage to the athlete's health will be increased.

Studies on the timing of hydration were also undertaken with athletes of other sports, such as triathlon and cycling[9], judo[10], karate[12] and various college sports[11]. The authors reported that in those types of sports, there is no balance between the timing of hydration or between two different exercise situations (training and competition).

Hydrating prior to beginning exercise by the majority of athletes in both training and competitions is a preventative action intended to avoid low water levels or dehydration, which could contribute significantly to a reduction in performance[1,3].

Ingesting fluids after exercise can be stimulated by thirst and can be caused by the difference between the rate of gastric emptying and sweating rate[21] or by the adoption of inadequate hydration strategies during exercise.

The low consumption of sports drinks found before, during and after exercise is concerning because in the majority of street races, the distances range from 10 km to a marathon length (42,195 meters). This habit increases the chances of experiencing hypoglycemia in individuals who participate in events lasting more than one hour[22].

The low level of intake of energy fluids during physical activity found in this study demonstrates the need to prepare campaigns to guide athletes. Water intake alone can only keep hydration levels close to normal, while the ingestion of an energy source in fluid form can restore the water supply and maintain glucose levels within the normal range, minimizing the occurrence of hypoglycemia[22]. In this way, it is possible to improve the athlete's cognitive performance and reduce muscle fatigue[23].

It is necessary to increase the consumption of drinks containing carbohydrates before and after long bouts of exercise. Before exercise,

this practice allows the athlete to start with maximal reserves of liver and muscle glycogen and keep blood glucose at the appropriate levels. After exercise, however, the purpose is to promote the restoration of muscle and liver glycogen and accelerate the recovery process[24].

The low consumption of sports drinks among runners was previously described[6,17], and according to Duarte *et al*[6], only 24.5% of ultramarathon runners drink some type of beverage containing carbohydrates during long training periods.

Unlike studies that applied the same questionnaire in other sports[9,11,12] the use frequencies of drinks such as Coca-Cola®, coffee and beer were lower in this study (5.34%, 6.31% and 4.85%, respectively). This represents a positive habit compared to that observed in athletes of other sports, given that these drinks are not appropriate for effective hydration[21].

The favorite flavors among the runners in this study were similar to the flavors most cited by judokas[10] and college athletes[11], although the percentages differed compared with those in this study.

Few athletes evaluated in this study regularly weighed themselves before and after exercise. Marins and Ferreira[11] investigated college athletes and found that 41% of them do not weigh themselves.

Rockwell *et al*[25], investigated the effective use of weight monitoring by coaches and athletes. Their study showed that 39% of college coaches considered weight monitoring to be important, which is less than the percentage described by Corley *et al*[26], who found that 60% of coaches monitored weight to control body mass changes in their athletes.

The importance of weighing oneself is related to establishing the amount of fluid that must be replaced after exercise[27]. Given the effect that dehydration and improper rehydration has on performance, any method capable of monitoring these changes would be invaluable. Pre- and post-exercise body mass changes are reliable and simple to measure, providing accurate and timely information related to fluid loss and rehydration[28].

Maughan and Shirrefs[29] reported that the required amount of fluid ingestion after exercise is equal to one and a half times the amount lost. In other words, 150% of the amount lost should be consumed within 6 hours after the end of the exercise. The amount proposed by these authors is justified by the continuity of water loss in urine and sweat after the end of the exercise. The American College of Sports Medicine[1] agree with these authors, also recommending the consumption of 1.5 times what was lost, stating that this amount allows the restoration of water levels even if elimination through the kidneys occurs.

Evaluating that recommendation in a practical way, we can establish that when weight loss is less than or equal to 3 kg, the guidance above is relevant. However, when there is a marked loss (4 kg or more), it will become difficult to implement this recommendation because of the large amount of fluid that would be necessary for replacement. In this case, it is suggested that athletes consume the amount of fluid lost during the activity.

Symptoms commonly caused by dehydration could be minimized if the proper hydration strategy with appropriate quantity, frequency and type of fluid is adopted. The occurrence of cramps may or may not be related to dehydration, as demonstrated by Sulzer *et al*[30]. If dehydration is associated with cramps in these athletes, adequate hydration using fluids containing carbohydrates and electrolytes could ameliorate these cramps. Symptoms such as thirst, loss of strength and cramps were also the most prevalent among the college athletes evaluated by Marins and Ferreira[11].

Runners also experienced more serious symptoms such as visual disturbances, interruption of sweat production, loss of consciousness and seizures. Although this study found that a small number of athletes that reported these symptoms, it is important to monitor and plan hydration adequately. Except for the interruption of sweat production, which is related to a high degree of dehydration and can even lead to hyperthermia, all other symptoms may be related to dehydration in less than 5% of cases[19]. Alternatively, the symptoms may be related to hypoglycemia, indicating that athletes should drink fluids that provide approximately 30 to 60 g of carbohydrates per hour. Consuming only water is not sufficient to prevent or minimize the occurrence of these symptoms[1,20].

Symptoms such as cramps may also be related to hyper-hydration, highlighting the need for monitoring not only regular hydration but also the type, amount and frequency of fluid consumption[4,31].

Individual sweat rates vary and depend on factors such as ambient temperature, humidity, air movement, exercise intensity, body size and clothing[32]. This study investigated athletes' concerns regarding features such as color, type and amount of fabric used when exercising. Few athletes reported being concerned about the color and the amount of fabric they use. This lack of worry can lead to damage to the athlete because dark-colored clothing will promote greater thermal stress because it absorbs more heat. Likewise, exercising on hot days or while wearing more fabric will cause greater difficulty in dissipating heat by sweating, which may lead to hyperthermia[33].

Brouns[33] showed that the temperature of the liquid has little influence on the rate of gastric emptying; therefore, the best temperature is that which is preferred by the athlete. Pinto *et al*[34], used water at three different temperatures (10 ºC, 24°C and 38 °C) and found that water temperature did not interfere with body temperature or performance when submaximal exercise was performed in a thermoneutral environment.

According to Greenleaf[35], beginning hydration after feeling thirst is not effective because a person is approximately 2% dehydrated when they start feeling thirsty. On the other hand, some studies have demonstrated that encouraging athletes to drink fluids before the sensation of thirst may lead to hyper-hydration, resulting in reduction of plasma electrolytes[31]. However, it should be noted that this condition typically occurs in only cold-weather climates. In Brazil, with a typically tropical climate, the weather conditions associated with heat are more frequent and thus impose a more continuous heat stress, minimizing the risk of hyper-hydration.

Machado-Moreira *et al*[36], claimed that fluid intake according to thirst is sufficient and appropriate because the central nervous system can correctly indicate the volume of fluid that should be taken in by providing information on the demands of the body.

As there is no consensus in the literature related to the amount of fluid that must be ingested before or after the sensation of thirst, the discussion is ongoing. Common sense is required by athletes and coaches as to the amount of fluid consumed during their sports practice.

Marins and Ferreira[11] reported that 21.5% of Brazilian college athletes said that they should hydrate after they feel thirst. The result was

similar in the current study, in which 17.3% of athletes indicated they should consume fluid after thirst and 6.9% said they should consume fluid after feeling really thirsty. Rosenbloom *et al*[37], also found that among the Americans who were evaluated, only 79% of men and 73% of women know that thirst is not a good indicator of the need for fluid. Marins *et al*[9], found that different percentages of runners, triathletes and cyclists consumed fluids after the sensation of thirst (25%, 8.4% and 14 %, respectively).

These studies show that although most athletes understand when they should initiate fluid intake, it is still necessary to extend this level of knowledge and always encourage them to ingest fluids in pre-determined quantities and frequencies, regardless of the feeling of thirst. This action may allow a balance of fluid intake with the loss due to sweating, which is especially important in exercises performed under extreme temperatures.

Proper hydration implies a balance between the amount of fluid intake and the interval of ingestion. Less than half of the runners in this study were properly hydrated. This behavior limits the benefits that could be attained from their training because large quantities of fluids, as well as insufficient quantities, may limit performance.

Guidance about hydration was provided mainly by coaches. Information provided by coaches is very important and needs to be expanded because they exert a direct influence on the athletes. However, some studies show that coaches do not have enough knowledge about nutrition, particularly about hydration[27,38] therefore, coaches could give inadequate information.

The quality of information provided to athletes should be investigated to avoid the transmission of erroneous information. Soper *et al*[39], reported that 55% of the dance instructors surveyed said that thirst was a good signal to start fluid replacement.

Nutritionists less frequently served as professionals responsible for giving information to athletes about hydration, which may be due to the small number of athletes who have access to nutritionists. Bianco *et al*[40], showed that nutritionists participated infrequently in dietary recommendations for athletes. Instead, coaches were chosen as the best consulting source.

Journals were common sources of information for athletes. Thus, journal editors should devote special attention to articles on hydration because if the journal does not have expertise in this area, it cannot be used as a reliable source and could lead to the creation of myths.

Other studies that investigated the source of nutrition information for athletes showed that coaches, parents, doctors and family members were the main sources[41]. However, Cupisti *et al*[42] reported that the most information came from parents, the media and teammates.

Although hydration knowledge is important for improving the athletes' practices, it has been observed that knowledge on the subject does not always result in the best practice, as has been shown in studies that found no correlation between the level of knowledge and the level of hydration[16].

Conclusions

Knowledge about the role and benefits of sports drinks can lead to an increase in their consumption. In this study, 64 % of the runners reported having received information about the best method of hydration, and more than 80% were familiar with one or more brands of sports drinks. It was expected, therefore, that the athletes were properly informed about the functions of a sports drink, but this was not observed. This shows the need to devote more attention to the quality of information provided.

The high percentage of athletes who do not understand the function of sports drinks may be an important cause for the low consumption of this drink among athletes.

Brazilian street runners hydrate most frequently during competitions; however, in training, fluid intake was not regular. Moreover, consumption of sports drinks among athletes was low, and some reported never hydrating in training or competitions.

The runners demonstrated a failure to translate hydration knowledge into proper hydration strategies. Knowledge alone is not enough; therefore, continued efforts must be made by coaches, athletes and others involved with racing to develop and implement more effective hydration strategies.

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