***Original Research Article***

**Hydration knowledge and Practices among School Athletes and Coaches in tropical area**

ABSTRACT

|  |
| --- |
| **Purpose:** Water makes up 60 - 70% of body, adequate hydration is essential for the performance of student-athletes, but little is known about hydration practices in school sports settings in sub-Saharan Africa. This cross-sectional study aimed to assess the knowledge and practices of hydration among school athletes and coaches in Ngaoundéré, Cameroon. **Methods:** A total of 200 student-athletes and 30 coaches from 10 secondary schools and 12 sports disciplines were surveyed using a structured questionnaire. Data were collected on participants' knowledge of hydration principles, self-reported hydration practices during training and competition, and perceived impact on athletic performance. **Results:** Over 84% of athletes, 93% of coaches recognized the importance of hydration for athletic performance. However significant knowledge gaps existed. Only 17.1 and 31.7% of athletes, 45.5 and 67.2% of coaches could correctly identify the signs of overhydration and dehydration respectively. Less than half of the athletes (44.8%) reported drinking water before, during, and after exercise. Coaches were more likely to encourage proper hydration behaviors, but 23.9% did not provide access to drinking water during training sessions. Factors such as lack of access to clean water and limited sports nutrition education contributed to suboptimal hydration practices. Importantly, athletes who reported adequate hydration were more likely to perceive improvements in their athletic performance and recovery compared to their peers with suboptimal hydration practices (p<0.01). Similarly, coaches who encouraged proper hydration reported better overall athletic performance among their teams. **Conclusion:** The findings highlight the need for targeted hydration education and interventions to support the health and athletic development of school-based athletes in tropical area. Collaboration will be necessary between schools, sports governing bodies, and public health authorities could help promote optimal hydration practices in this setting. |

**Keywords:** Hydration, school-athletes, coaches, sports nutrition, athletic performance, tropical area

**1. INTRODUCTION**

Water makes up 60 - 70% of body, proper hydration is essential for athletic performance, health, and overall well-being. Both dehydration and over-hydration can lead to a range of negative effects that can significantly impact an athlete's ability to perform and recover (Sawka et al., 2007; Maughan & Shirreffs, 2010; Muñoz & Johnson, 2019). Dehydration can impair muscle coordination, reduce endurance, and decrease reaction time, all of which are critical for athletic performance (Arnaoutis et al., 2013; [Nuccio](https://pubmed.ncbi.nlm.nih.gov/?term=%22Nuccio%20RP%22%5BAuthor%5D) et al., 2017). Additionally, dehydration can lead to decreased concentration, impaired decision-making, and reduced mental focus, which can compromise an athlete's decision-making and strategic abilities during competition (Osterberg et al., 2009; [Riebl](https://pubmed.ncbi.nlm.nih.gov/?term=%22Riebl%20SK%22%5BAuthor%5D) & [Davy](https://pubmed.ncbi.nlm.nih.gov/?term=%22Davy%20BM%22%5BAuthor%5D), 2014).

Another significant risk of improper hydration is the increased susceptibility to heat-related illnesses, such as heat cramps, heat exhaustion, and heat stroke (Casa et al., 2015; Armstrong et al., 2020). These conditions can be life-threatening if not properly managed and can lead to organ damage and neurological impairments (Binkley et al., 2002; Casa et al., 2015; [Szymczak](https://www.researchgate.net/scientific-contributions/Anna-Szymczak-2121886408?_tp=eyJjb250ZXh0Ijp7InBhZ2UiOiJwdWJsaWNhdGlvbiIsInByZXZpb3VzUGFnZSI6bnVsbH19) et al., 2021). Dehydration can also impair an athlete's recovery process, delaying the replenishment of fluids, electrolytes, and glycogen stores (Maugham & Leiper, 1995; Akerman et al., 2016). This can prolong muscle soreness, fatigue, and the risk of injury, ultimately hindering the athlete's ability to perform at their best in subsequent training sessions or competitions (Shirreffs & Maughan, 1997; Powers, 2015).

Given the significant risks associated with dehydration, it is vital for athletes, especially school athletes, to maintain proper hydration practices. However, this can be particularly challenging for young athletes due to limited access to resources, lack of sports nutrition education, and cultural beliefs (Osterberg et al., 2009; Arnaoutis et al., 2013; Haughton et al., 2020). On the other hand, over-hydration, or hyponatremia, can also have serious consequences. Excessive fluid intake can dilute the body's sodium levels, leading to symptoms such as nausea, confusion, and in severe cases, seizures and coma (Noakes, 2010; Hew-Butler et al., 2015). Over-hydration can be particularly dangerous for athletes who engage in prolonged exercise in hot and humid environments, as they may lose significant amounts of sodium through sweat (Montain & Coyle, 1992; Noakes, 2010; Kalra, 2023).

In Cameroon, Africa in miniature, the climate in the northern region, including the city of Ngaoundéré, is become generally dry, which can further exacerbate the hydration challenges faced by young athletes. Ngaoundéré experiences high temperatures and limited access to clean water sources, making it difficult for school athletes to stay properly hydrated during training and competition. Additionally, cultural beliefs and practices may influence the hydration strategies of school athletes in Cameroon, which could conflict with recommended hydration practices (Haughton et al., 2020).

Therefore, the aim of this study was to assess the knowledge and practices of hydration among school athletes and coaches in the city of Ngaoundéré, Cameroon, in order to identify areas for improvement and develop targeted interventions to enhance the overall hydration status of the young athletes.

**2. METHODOLOGY**

**2.1. Study Design and Participants**

A cross-sectional survey was conducted in the city of Ngaoundéré, Cameroon, from January to July 2024. The study population included school athletes and their coaches from secondary schools and twelve sports disciplines (Athletics, Arm wrestling, Badminton, Basketball, Football, Gymnastics, Handball, Judo, Tennis, Table tennis, Volleyball and Wrestling) in the region.

**2.2. Methods**

**2.2.1. Sampling**

A multistage sampling approach was used. First, a list of all secondary schools in Ngaoundéré was obtained from the local education authority. Then, 10 schools were randomly selected using a simple random sampling technique. Within each selected school, 20 athletes and 3 coaches were randomly chosen, irrespective of the sports discipline practiced.

The inclusion criteria for athletes were: enrolled in a secondary school in Ngaoundéré, actively participating in school sports, and aged between 13 and 18 years. For coaches, the inclusion criteria were: employed as a coach in a secondary school in Ngaoundéré and responsible for coaching school sports teams. Based on these criteria, 310 school athletes and 42 coaches were recruited. Finally, 200 school athletes (mean age 15.2 ± 1.9 years, body mass 54 ± 13 kg, 55% male) and 30 coaches (73% male, mean age 34.5 ± 6.2 years, average of 7.3 ± 3.2 years of coaching experience) actually took part in the study.

**2.2.2. Data Collection**

Data was collected using a structured questionnaire that assessed participants' knowledge and practices related to hydration. The questionnaire was developed based on a review of the literature and input from experts. The questionnaire included the following sections: demographic information, knowledge about hydration, and hydration practices. The questionnaire was translated into French, the primary language used in the region, and pilot-tested with 25 school athletes and 8 coaches to ensure the clarity and relevance of the items. The questionnaires were administered by trained research assistants during competitions of National School Sports Federation.

**2.2.3. Data Analysis**

The collected data was analysed using Sphinx v.4.5.0.19 statistical software. Descriptive statistics were used to summarize the participants' knowledge and practices. The differences in knowledge and practices between athletes and coaches, as well as between subgroups within each population, were evaluated using chi-square and student tests. Statistical significance was set at p < 0.05.

**2.2.3. Ethical Considerations**

The research protocol was evaluated and approved by the Institutional Review Board of the Faculty of Education of the University of Ngaoundéré. Participants were informed about the study's purpose and provided written consent before participating. For school athletes, informed and written consent has been provided by parents or guardians. The confidentiality of the participants was maintained throughout the study.

**3. RESULTS AND DISCUSSION**

**3.1. Knowledge of the importance of hydration on athletic performance**

Knowledge of the importance of hydration on physical and mental performance by school athletes and coaches is presented in figure 1. The majority of both school athletes (84.5%) and coaches (93.33%) recognized the importance of proper hydration for athletic performance. This finding is consistent with previous studies that have highlighted the widespread awareness of the critical role of hydration in supporting physical and cognitive function during sports activities (Maughan et al., 2005; Kenefick & Cheuvront. 2012; Hew-Butler et al., 2015; Ruskin et al., 2020). However, a significant proportion of athletes (15.5%) and some coaches (6.68%) did not fully comprehend the importance of hydration. This lack of knowledge is concerning, as maintaining proper hydration status is essential for optimizing both physical and mental aspects of sports performance, such as endurance, decision-making, and reaction time (Maughan, 1991; Sawka & Montain, 2000; [Nuccio](https://pubmed.ncbi.nlm.nih.gov/?term=%22Nuccio%20RP%22%5BAuthor%5D) et al., 2017). Targeted educational interventions aimed at reinforcing the importance of hydration for overall athletic performance could help address this gap (Nichols et al., 2005; Osterberg et al., 2009; Kavouras et al., 2012; Garcia-Garcia, 2022).

**Fig. 1:** Knowledge of the importance of hydration on physical and mental performance by school athletes and coaches

**3.2. Knowledge of the improper hydration symptoms during sports activities**

**3.2.1. Knowledge of the dehydration signs**

The fatigue experienced by an athlete is most often due to dehydration, partly because there is a time lag between the sensation of thirst and actual dehydration. This is why it is considered that by the time thirst is felt, the body is already dehydrated, which affects thermoregulation and can lead to an increase in core body temperature above 40°C (Gizowski & Bourque, 2018). In hot conditions, when body temperature rises excessively, a greater amount of catecholamines is released into the bloodstream. This leads to the rapid depletion of muscle glycogen stores, contributing to earlier onset of fatigue and symptoms such as dizziness, nausea, facial erythema, increased heart rate, and fainting (Mee et al., 2015).

Figure 2 shows the knowledge of the dehydration signs during sports activities by school athletes and coaches. The obtained results indicate that only 31.7% of school athletes could correctly identify the signs of dehydration, such as increasing thirst, rapid heartbeat, dry skin, dry mouth, dark yellow urine, sticky saliva, headache, fatigue, dizziness, and muscle cramps. In contrast, a higher proportion of coaches (67.2%) were able to recognize the signs of dehydration. This disparity suggests that coaches may have received more comprehensive training or education on hydration-related issues compared to their athletes (Binkley et al., 2002; Casa et al., 2015).

The low level of knowledge about dehydration symptoms among athletes is particularly problematic, as recognizing the early signs of dehydration is essential for implementing timely prevention and treatment strategies. Unrecognized dehydration can lead to decreased physical and cognitive performance, as well as more serious health consequences like heat-related illnesses (Sawka & Montain, 2000; [Nuccio](https://pubmed.ncbi.nlm.nih.gov/?term=%22Nuccio%20RP%22%5BAuthor%5D) et al., 2017). Incorporating hydration education into athlete training and development programs could help address this knowledge gap (Nichols et al., 2005; Osterberg et al., 2009; Ruskin et al., 2020).

**Fig. 2**: Knowledge of the dehydration signs during sports activities by school athletes and coaches

**3.2.2. Knowledge of the overhydration signs**

The knowledge of overhydration signs was even lower, with only 17.1% of athletes and 45.5% of coaches able to correctly identify the symptoms of over-hydration, including nausea, muscle weakness, vomiting, headache, fatigue, swelling in the hands, change in behaviors, coma, confusion, and seizures (figure 3). This finding is concerning, as exercise-associated hyponatremia, or overhydration, can also be life-threatening if left unmanaged (Maughan & Leiper, 1995; Shirreffs & Maughan, 1997; Powers,2015; Hew-Butler et al., 2015; Kalra, 2023).

The lack of awareness about the signs of overhydration among both athletes and coaches highlights the need for comprehensive hydration education programs that cover the recognition and management of both dehydration and overhydration (Noakes, 2010; Hew-Butler et al., 2015; [Fauza](https://www.researchgate.net/profile/Ahdiyatul-Fauza?_tp=eyJjb250ZXh0Ijp7InBhZ2UiOiJwdWJsaWNhdGlvbiIsInByZXZpb3VzUGFnZSI6bnVsbH19) et al., 2022). Empowering athletes and coaches to effectively monitor and respond to hydration-related issues is important for ensuring the health and safety of young sports participants.

**Fig. 3**: Knowledge of the overhydration signs during sports activities by school athletes and coaches

**3.3. Timing of fluid intake**

Figure 4 presents the timing of fluid intake before, during and after exercise. Less than half of the school athletes reported drinking water before (31.5%), during (23.9%), and after (44.8%) exercise. In the other hand, most coaches recommend drinking before (56.4%) and after (78.3%) exercise. Drinks during effort are indicated for endurance and intermittent sports. This may explain the low proportion of coaches (47.2%) who recommend drinking during exercise. These would be the coaches of the above-mentioned sports. This finding is concerning, as maintaining proper hydration throughout the entire exercise period, including before and after, is a key for optimizing performance and recovery (Shirreffs & Maughan, 1997; Sawka & Montain, 2000; Maughan et al., 2005; Armstrong, 2021).

**Fig. 4:** Timing of fluid intake

**3.4. Volume of water intake in function of duration of exercise**

The results of figure 5 shows that the majority of athletes who trained for 1 h 30 min had a peak fluid intake of 2 L per day. When training sessions lasted up to 2 h, the maximum could drink 3.5 L. For training session lasted 1 h or less, the majority of athletes drank 4.5 L. In all cases, taking into account the average weight of school athletes, they were equally exposed to dehydration and overhydration.

Many athletes may not be consuming adequate volumes of fluids to maintain proper hydration status, especially during prolonged exercise (Maughan et al., 2005; Roumelioti et al., 2018). Inadequate fluid intake during sports activities can lead to dehydration, which can negatively impact physical and cognitive performance, as well as increase the risk of heat-related illnesses (Maughan et al., 2005; Kenefick & Cheuvront, 2012; [Nuccio](https://pubmed.ncbi.nlm.nih.gov/?term=%22Nuccio%20RP%22%5BAuthor%5D) et al., 2017). Educating athletes and coaches on the recommended fluid intake guidelines based on exercise duration and intensity, as well as providing access to hydration resources, could help improve the volume of water consumption during training and competitions.

Overhydration, also known as hyponatremia, is concerning condition that can arise in athletes, particularly during endurance and force training (Noakes, 2012; [El-Sharkawy](https://www.researchgate.net/profile/Ahmed-El-Sharkawy?_tp=eyJjb250ZXh0Ijp7InBhZ2UiOiJwdWJsaWNhdGlvbiIsInByZXZpb3VzUGFnZSI6bnVsbH19) et al., 2015). It occurs when the body’s sodium levels become diluted, causing an imbalance in the body’s electrolyte and fluid balance (Convertino et al., 1996; [Szymczak](https://www.researchgate.net/scientific-contributions/Anna-Szymczak-2121886408?_tp=eyJjb250ZXh0Ijp7InBhZ2UiOiJwdWJsaWNhdGlvbiIsInByZXZpb3VzUGFnZSI6bnVsbH19) et al., 2021), with serious health and performance consequences (Hew-Butler et al., 2015). The development of overhydration in athletes is multifactorial, with the following mains variables, including: excessive fluid intake, electrolyte imbalances, hormonal dysregulation, medical condition and environmental factors (Hew-Butler et al., 2006; Maughan et al., 2007; Hew-Butler et al., 2008; Rowlands et al., 2022). A multifaceted approach can be used to prevent overhydration in athletes: master fluid intake during sports activities, hydration education, individualized hydration plans, electrolyte supplementation and medical supervision (Sawka et al., 2001; Noakes, 2003; Maughan & Shirreffs, 2010; Hew-Butler et al., 2015; Nakamura et al., 2020).

**Fig. 5:** Volume of water intake in function of duration of training session or competitions

**3.5. Hydration management by coaches**

Figure 6 presents the hydration management by coaches during training sessions and competitions. The coaches (100%) employed in secondary school did not measure hydro electrolytic losses of athletes during sports activities. Only 14.5% of athletes reported white urine at wake up after training session. However, 89.5% of coaches chose the type of drink their athletes drank. These results suggest that some coaches may not be fully implementing best practices for supporting optimal hydration among their athletes. Coaches play a key role in promoting and facilitating proper hydration behaviors among their teams (Nichols et al., 2005; Shepherd, 2011; Armstrong et al, 2021; Ghafouri et al., 2021; Li et al., 2023). By ensuring access to drinking water and actively encouraging athletes to maintain adequate fluid intake throughout the exercise period, coaches can help foster a culture of hydration awareness and healthy practices. Targeted interventions to educate and empower coaches on hydration management strategies could contribute to improved hydration practices among school athletes (Kavouras et al., 2012).

**Fig. 6:** Hydration management by coaches

**3.6. Factors of hydration**

As shown in figure 7, the main factors limiting optimal hydration practices among school athletes were lack of access to clean water sources (94.7%) and limited sports nutrition education (66.7%). Other factors included socioeconomic barriers (45.6%). Previous studies reported that suboptimal hydration practices may be influenced by a variety of factors, such as limited access to clean water sources, lack of sports nutrition education, and cultural beliefs (Sawka et al., 2007; Maughan & Shirreffs, 2010; Garcia-Garcia, 2022). Addressing these barriers through multi-faceted interventions, including improving access to hydration resources and providing comprehensive hydration education, could help promote more consistent and effective hydration behaviors among school athletes.

These results highlight the importance of addressing contextual and resource-related barriers to support the implementation of effective hydration strategies (Nakamura, 2020; Amstrong, 2021; Rowlands et al., 2022). Interventions aimed at improving access to clean water sources, providing sports nutrition education, and addressing cultural beliefs and economic factors could help create an enabling environment for optimal hydration practices among school athletes. Collaborations between schools, sports governing bodies, and public health authorities may be necessary to develop and implement such multi-faceted solutions (Kavouras et al., 2012; Eime et al., 2013; Holt et al., 2017).

**Fig. 7:** Factors limiting optimal hydration

**3.7. Perceived effectiveness of hydration on performance**

The results in figure 8 show that athletes who reported adequate hydration were more likely to perceive improvements in their athletic performance and recovery compared to their peers with suboptimal hydration practices (p<0.01). Similarly, coaches who encouraged proper hydration reported better overall athletic performance among their teams. These findings align with the existing evidence that maintaining proper hydration status can enhance physical and cognitive function, as well as recovery, during sports activities (Kenefick & Cheuvront, 2012; [Riebl](https://pubmed.ncbi.nlm.nih.gov/?term=%22Riebl%20SK%22%5BAuthor%5D) &.[Davy](https://pubmed.ncbi.nlm.nih.gov/?term=%22Davy%20BM%22%5BAuthor%5D), 2014; Hew-Butler et al., 2015; [Nuccio](https://pubmed.ncbi.nlm.nih.gov/?term=%22Nuccio%20RP%22%5BAuthor%5D) et al., 2017; Muñoz & Johnson, 2019). The perceived benefits of adequate hydration reported by both athletes and coaches underscore the critical importance of promoting and supporting optimal hydration practices in the school sports setting. By addressing the knowledge gaps and barriers identified in this study, stakeholders can work towards ensuring that all school-based athletes have the necessary resources and support to maintain proper hydration for optimal performance, health, and safety.

**Fig. 8**: Perceived effectiveness of hydration on athletic performance

**4. CONCLUSION**

The findings of this study suggest that school athletes and coaches in Ngaoundéré, Cameroon, generally recognize the importance of proper hydration. However, there are significant gaps in their knowledge and practices, particularly regarding specific fluid intake recommendations, the use of electrolyte-containing beverages, and the importance of maintaining hydration during training and competition. The identified barriers, such as limited access to clean water sources and lack of sports nutrition education, highlight the need for targeted interventions to improve the hydration status of school athletes in the region. These interventions should focus on enhancing knowledge, providing access to clean water and appropriate hydration resources, and promoting sustainable hydration practices among both athletes and coaches. Collaborations between schools, sports governing bodies, and public health authorities could help promote optimal hydration practices in this setting.

**ACKNOWLEDGMENTS**

 The authors would like to express their deep gratitude to the parents of athletes and coaches of the city of Ngaoundéré in Cameroon for their participation in this study; and to the high school authorities for their cooperation, as well as National Federation of School Sports.

**ETHICAL APPROVAL**

The study was approved by the institutional Research Committee of the Faculty of Education, University of Ngaoundéré. Informed and written consent was obtained from all parents of school athletes and coaches, as well as permissions from Secondary school and National Federation of School Sports authorities.

**DISCLAIMER (ARTIFICIAL INTELLIGENCE)**

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

**REFERENCES**

Akerman, A. P., Tipton, M., Minson, C. T., & Cotter, J. D. 2016. Heat stress and dehydration in adapting for performance: Good, bad, both, or neither? *Temperature*, *3*(3), 412–436. <https://doi.org/10.1080/23328940.2016.1216255>.

Armstrong, L.E. 2021. Rehydration during Endurance Exercise: Challenges, Research, Options, Methods. Nutrients, 13, 887.

Armstrong, L.E., Muñoz, C.X., Armstrong, E.M. 2020. Distinguishing Low and High Water Consumers-A Paradigm of Disease Risk. Nutrients, 12, 858.

Arnaoutis, G., Kavouras, S. A., Kotsis, Y. P., Tsekouras, Y. E., Makrillos, M., & Bardis, C. N. (2013). Ad libitum fluid intake does not prevent dehydration in suboptimally hydrated young soccer players during a training session of a summer camp. International Journal of Sport Nutrition and Exercise Metabolism, 23(3), 245-251. doi: 10.1123/ijsnem.23.3.245.

Binkley, H. M., Beckett, J., Casa, D. J., Kleiner, D. M., & Plummer, P. E. (2002). National Athletic Trainers' Association position statement: exertional heat illnesses. Journal of Athletic Training, 37(3), 329-343.

Casa, D. J., DeMartini, J. K., Bergeron, M. F., Csillan, D., Eichner, E. R., Lopez, R. M., & Yeargin, S. W. (2015). National Athletic Trainers' Association position statement: exertional heat illnesses. Journal of Athletic Training, 50(9), 986-1000. doi: 10.4085/1062-6050-50.9.07.

Convertino, V. A., Amstrong, L. E., Coyle, E. F., Mack, G. W., Sawka, M. N., Senay, L. C., Sherman, W. M. (1996). American College of Sports Medicine Position Stand. Exercise and fluid replacement. Medicine and Science in Sports and Exercise, 28, 1-6.

Eime, R. M., Young, J. A., Harve, J. T., Charity, M. J., Payne, W. R. A. (2013). Systematic review of the psychological and social benefits of participation in sport for children and adolescents: informing development of a conceptual model of health through sport. International Journal of Behavioral Nutrition and Physical Activity, 10, 1-21. doi: 10.1186/1479-5868-10-98.

[El-Sharkawy](https://www.researchgate.net/profile/Ahmed-El-Sharkawy?_tp=eyJjb250ZXh0Ijp7InBhZ2UiOiJwdWJsaWNhdGlvbiIsInByZXZpb3VzUGFnZSI6bnVsbH19), A. [M., Sahota](https://www.researchgate.net/profile/Opinder-Sahota?_tp=eyJjb250ZXh0Ijp7InBhZ2UiOiJwdWJsaWNhdGlvbiIsInByZXZpb3VzUGFnZSI6bnVsbH19), O., [Lobo](https://www.researchgate.net/profile/Dileep-Lobo?_tp=eyJjb250ZXh0Ijp7InBhZ2UiOiJwdWJsaWNhdGlvbiIsInByZXZpb3VzUGFnZSI6bnVsbH19), D. N.. 2015. Acute and chronic effects of hydration status on health. Nutrition Reviews. 73 DOI: [10.1093/nutrit/nuv038](http://dx.doi.org/10.1093/nutrit/nuv038).

[Fauza](https://www.researchgate.net/profile/Ahdiyatul-Fauza?_tp=eyJjb250ZXh0Ijp7InBhZ2UiOiJwdWJsaWNhdGlvbiIsInByZXZpb3VzUGFnZSI6bnVsbH19), A., [Astuti](https://www.researchgate.net/profile/Widya-Astuti-8), W., 2022. Hydration In Athletes: A Literature Review. Journal of Applied Food and Nutrition. 2(1): 25-33. DOI: [10.17509/jafn.v2i1.42698](http://dx.doi.org/10.17509/jafn.v2i1.42698).

Garcia-Garcia, D. (2022). Health promotion and hydration: A systematic review about hydration care. Florence Nightingale Journal of Nursing, 30(3), 310-321.

Ghafouri, A. M., Arkoubi. S. H., Al Amri, T. M., Alshamari, A. M., Alqahtani, M. A., Alyami, Z. S., et al. 2021. Causes, management and complications of severe adult dehydration in the emergency room. Int J Community Med Public Health, 8:943-7.

Gizowski, C., Bourque, C.W. 2018. The neural basis of homeostatic and anticipatory thirst. Nat. Rev. Nephrol., 14, 11–25.

Haughton, J., Takemoto, M. L., Schneider, J., Hooker, S. P., Rabin, B., Brownson, C. R., Arredondo, E. M. (2020). Identifying barriers, facilitators and implementation strategies for a faith-based physical activity program. Implementation Science Communications, 1(1). doi:10.1186/s43058020000433.

Hew-Butler, T., Ayus, J. C., Kipps, C., Maughan, R. J., Mettler, S., Meeuwisse, W. H., Shirreffs, S. M. (2008). Statement from the international Exercise Associated Hyponatremia Consensus Development Conference, cape Town, South Africa. Clinical Journal of Sport Medicine, 111-121. doi: 10.1097/JSM0b013e31825458f31.

Hew-Butler, T., Rosner, M. H., Fowkes-Godek, S., Dugas, J. P., Hoffman, M. D., Lewis, D. P., & Verbalis, J. G. (2015). Statement of the 3rd International Exercise-Associated Hyponatremia Consensus Development Conference, Carlsbad, California, 2015. Clinical Journal of Sport Medicine, 25(4), 303-320. doi: 10.1097/JSM.0000000000000221.

Hew-Butler, T., Verbalis, J. G., Noakes, T. D. (2006). Updated fluid recommendation: position statement from the international Marathon Medical Directors Association. Clinical Journal of Sport Medicine, 16, 283-292.

Holt, N. L., Neely, K. C., Slater, L. G., Camiré, M., Côté, J., Fraser-Thomas, J., Tamminen, K. A. (2017). A grounded theory of positive youth development through sport based on results from a qualitative meta-study. International Review of Sport and Exercise Psychology, 10, 1-49. doi: 10.1080/1750984X.2016.1180704. Muñoz, C. X., Johnson, E. C., 2019. Hydration for Athletic Performance. In: [Nutrition and Enhanced Sports Performance (Second Edition)](https://www.sciencedirect.com/book/9780128139226/nutrition-and-enhanced-sports-performance). Muscle Building, Endurance, and Strength. P. 533-543.

Kalra, D. 2023. Overhydration: A boon or bane. Indian J. Pharm Pharmacol. 10(2):73-75. <https://doi.org/10.18231/j.ijpp.2023.017>.

Kavouras, S. A., Arnaoutis, G., Makrillos, M., Garagouni, C., Nikolaou, E., Chira, O., Ellinikaki, E., Sidossis, L. S. 2012. Educational intervention on water intake improves hydration status and enhances exercise performance in athletic youth. Scandinavian journal of medicine & science in sports.22(5):684-9.

Kenefick, R. W., Cheuvront S. N. (2012). Hydration for recreational sport and physical activity. Nutrition Reviews, 70, S137-S142. doi: 10.1111/j.1753-4887.2012.00523.

Li, S., Xiao, X., Zhang, X. 2023. Hydration Status in Older Adults: Current Knowledge and Future Challenges. Nutrients, 15, 2609. https://doi.org/10.3390/ nu15112609

Maughan, R. J. (1991). Fluid and electrolyte loss and replacement in exercise. Journal of Sports Sciences, 9, 117-142. doi: 10.1080/02640419108729871.

Maughan, R. J., & Leiper, J. B. (1995). Sodium intake and post-exercise rehydration in man. European Journal of Applied Physiology and Occupational Physiology, 71(4), 311-319. doi: 10.1007/BF00240410.

Maughan, R. J., & Shirreffs, S. M. (2010). Dehydration and rehydration in competitive sport. Scandinavian Journal of Medicine & Science in Sports, 20(s3), 40-47. doi: 10.1111/j.1600-0838.2010.01207.

Maughan, R. J., Shirreffs, S. M., Leiper, J. B. (2007). Fluid and electrolyte balance in football. Journal of Sports Sciences, 25(s1),. S57- S66.

Maughan, R. J., Shirreffs, S. M., Merson, S. J. (2005). Fluid and electrolyte balance in elite male football (soccer) players training in a cool environment. Journal of Sports Sciences, 23(1), 73-79. doi: 10.1080/02640410410001730115.

Mee, J. A., Gibson, O. R., Doust, J., Maxwell, N. S. 2015. A comparison of males and females' temporal patterning to short- and long-term heat acclimation. Scandinavian J Med Sci Sports ; 25: 250-8.

Montain, S. J., & Coyle, E. F. (1992). Influence of graded dehydration on hyperthermia and cardiovascular drift during exercise. Journal of Applied Physiology, 73(4), 1340-1350. doi: 10.1152/jappl.1992.73.4.1340.

Nakamura, Y., Watanabe, H., Tanaka, A., Yasui, M., Nishihira, J., Murayama, N. 2020. Effect of Increased Daily Water Intake and Hydration on Health in Japanese Adults. Nutrients, 12, 1191.

Nichols, P. E, Jonnalagadda, S. S., Rosenbloom, C. A., Trinkaus, M. (2005). Knowledge, attitudes, and behaviors regarding hydration and fluid replacement of collegiate athletes. International Journal of Sport Nutrition and Exercise Metabolism, 15, 515-527. doi: 10.1123/ijsnem.15.5.515.

Noakes, T. D. (2003). Overconsumption of fluid by athletes, MBJ, 327, 113-114.

Noakes, T. D. (2010). Is drinking to thirst optimum. Annals of nutrition and Metabolism, 57(2), 9-17. doi: 10.1159/00032697.

Noakes, T. D. (2012), Hyponatremia in distance runners: fluid and sodium balance during exercise. Current sports medicine reports, 11, 125-133. doi: 11249/JSR0b013e31825458f3.

[Nuccio](https://pubmed.ncbi.nlm.nih.gov/?term=%22Nuccio%20RP%22%5BAuthor%5D), R. P.,  [Barnes](https://pubmed.ncbi.nlm.nih.gov/?term=%22Barnes%20KA%22%5BAuthor%5D), K. A, [Carter](https://pubmed.ncbi.nlm.nih.gov/?term=%22Carter%20JM%22%5BAuthor%5D), J. M., [L. B. Baker](https://pubmed.ncbi.nlm.nih.gov/?term=%22Baker%20LB%22%5BAuthor%5D). 2017. Fluid Balance in Team Sport Athletes and the Effect of Hypohydration on Cognitive, Technical, and Physical Performance. Sport Medicine. 47(10):1951–1982. doi: [10.1007/s40279-017-0738-7](https://doi.org/10.1007/s40279-017-0738-7).

Osterberg, K. L., Horswill, C. A., & Baker, L. B. (2009). Pregame urine specific gravity and fluid intake by National Basketball Association players during competition. Journal of Athletic Training, 44(1), 53-57. doi: 10.4085/1062-6050-44.1.53.

Powers, K. S. 2015. Dehydration: Isonatremic, Hyponatremic, and Hypernatremic Recognition and Management. Health Sciences Library, Stony Brook University. Pediatrics in Review. 36 (17). DOI: 10.1542/pir.36-7-274.

[Riebl](https://pubmed.ncbi.nlm.nih.gov/?term=%22Riebl%20SK%22%5BAuthor%5D), S. K. [Davy](https://pubmed.ncbi.nlm.nih.gov/?term=%22Davy%20BM%22%5BAuthor%5D), B. M. 2014. The Hydration Equation: Update on Water Balance and Cognitive Performance. ACSMs Health Fit J. 17, 21–28. doi: [10.1249/FIT.0b013e3182a9570f](https://doi.org/10.1249/FIT.0b013e3182a9570f).

Roumelioti, M. E., Glew, R. H., Khitan, Z. J., Rondon-Berrios, H., Argyropoulos, C. P., Malhotra, D., Raj, D. S., Agaba, E. I., Rohrscheib, M., Murata, G. H., Shapiro, J. I., Tzamaloukas, A. H. 2018. Fluid balance concepts in medicine: Principles and practice. World J Nephrol, 7(1): 1-28. DOI: http://dx.doi. org/10.5527/wjn.v7.i1.1

Rowlands, D. S.,  Kopetschny, B. H., Badenhorst, C. E. 2022. The Hydrating Efects of Hypertonic, Isotonic and Hypotonic Sports Drinks and Waters on Central Hydration During Continuous Exercise: A Systematic Meta‑Analysis and Perspective. Sports Medicine. 52:349–375. <https://doi.org/10.1007/s40279-021-01558-y>.

Ruskin, I., Preetha, S., [Prathap](https://saveethauniversity.academia.edu/lavanyaprathap?swp=tc-au-82755116), L., 2020. Awareness of Dehydration and Health Effects Among People - A Survey. The Journal of Contemporary Issues in Business and Government. 26, 2. DOI: 10.47750/cibg.2020.26.02.195.

Sawka, M. N., Burke, L. M., Eichner, E. R., Maughan, R. J., Montain, S. J., & Stachenfeld, N. S. (2007). American College of Sports Medicine position stand. Exercise and fluid replacement. Medicine and Science in Sports and Exercise, 39(2), 377-390. doi: 10.1249/mss.0b013e31802ca597.

Sawka, M. N., Burke, L. M., Eichner, E. R., Maughan, R. J., Montain, S. J., Stachenfeld, N. S. (2007). American College of Sports Medicine position stand. Exercise and fluid replacement. Medicine and Science in Sports and Exercise, 39(2), 377-390. doi: 10.1249/mss.0b013e31802ca597.

Sawka, M. N., Montain, S. J. (2000). Fluid and electrolyte supplementation for exercise heat stress. The American Journal of Clinical Nutrition, 72(2), 564S-572S. doi: 10.1093/ajcn/72.2.564S.

Sawka, M. N., Montain, S. J., Latzka, W. A. (2001). Hydration effect on thermoregulation and performance in the heat. Comparative Biochemistry and Physiology A: Molecular and Integrative Physiology, 128, 679-690.

Shepherd, A. 2011. Measuring and managing fluid balance. Nursing Times. 107, 28, 12-16.

Shirreffs, S. M., & Maughan, R. J. (1997). Restoration of fluid balance after exercise-induced dehydration: effects of alcohol consumption. Journal of Applied Physiology, 83(4), 1152-1158. doi: 10.1152/jappl.1997.83.4.1152.

[Szymczak](https://www.researchgate.net/scientific-contributions/Anna-Szymczak-2121886408?_tp=eyJjb250ZXh0Ijp7InBhZ2UiOiJwdWJsaWNhdGlvbiIsInByZXZpb3VzUGFnZSI6bnVsbH19), A., [Kusztal](https://www.researchgate.net/profile/Mariusz-Kusztal?_tp=eyJjb250ZXh0Ijp7InBhZ2UiOiJwdWJsaWNhdGlvbiIsInByZXZpb3VzUGFnZSI6bnVsbH19), M., [Krajewska](https://www.researchgate.net/profile/Magdalena-Krajewska-3?_tp=eyJjb250ZXh0Ijp7InBhZ2UiOiJwdWJsaWNhdGlvbiIsInByZXZpb3VzUGFnZSI6bnVsbH19), M.. 2021. Overhydration: A cause or an effect of kidney damage and how to treat it. Advances in Clinical and Experimental Medicine. 30(2). DOI: [10.17219/acem/132035](http://dx.doi.org/10.17219/acem/132035).