

The Influence of Hydration Status on Cognitive Function and Athletic Performance

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Abstract

Hydration is essential for maintaining cognitive function and athletic performance, particularly in athletes training under high temperatures. This study examines the impact of hydration status on cognitive abilities and athletic performance among football players at Lead City Football Academy, Ibadan, Nigeria. Using a cross-sectional design, hydration levels of 88 athletes aged 16–25 were assessed through urinary specific gravity (USG) and pre- and post-training body weight changes. Cognitive function was evaluated using the Montreal Cognitive Assessment (MoCA), while athletic performance was rated by coaches based on key physical and mental attributes. Results showed that hydration status differed significantly by gender ($p = 0.034$), with male athletes exhibiting greater dehydration levels. USG analysis revealed that 94.6% of female athletes had minimal dehydration compared to 84.3% of males, while 15.7% of male athletes experienced significant dehydration ($USG > 1.021$), compared to 5.4% of females. Body weight analysis indicated an average reduction of 0.84% post-training, suggesting fluid loss. Cognitive assessments revealed impairments, with a mean MoCA score of 22.78 (below the normal threshold of ≥ 26). However, no statistically significant correlation was found between hydration status and cognitive function ($p > 0.05$). Athletic performance was significantly influenced by hydration status ($p = 0.003$), with endurance, speed, and mental toughness most affected. Although dehydration was associated with reduced endurance, the effect was relatively weak. These findings highlight the need for structured hydration protocols, personalized fluid intake plans, and athlete education on optimal hydration practices.

Keywords: Dehydration, Physical Endurance, Mental Toughness, Fluid Balance, Athlete Health.

Introduction

Water is indispensable to human survival, playing a fundamental role in various physiological processes, including temperature regulation, nutrient transport, and waste elimination (Riebl & Davy, 2013). For athletes, hydration is even more critical due to the substantial fluid loss that occurs during physical exertion through sweat and respiration (Palka et al., 2024). As water exits the body, the risk of dehydration increases, potentially leading to declines in both physical and cognitive performance. Hydration is therefore not merely about replenishing lost fluids but also about sustaining peak performance and

maintaining cognitive functions such as memory, attention, and reaction time—key components of athletic success (Riebl & Davy, 2013).

Studies have consistently demonstrated the impact of hydration on athletic performance. Even mild dehydration, defined as a 1–2% reduction in body mass due to water loss, can significantly impair physical attributes such as endurance, strength, and coordination (Liska et al., 2019; Nuccio et al., 2017). Competitive athletes who experience dehydration may suffer from reduced blood volume, impaired thermoregulation, and decreased muscular efficiency, ultimately leading to fatigue and diminished performance (Periard et al., 2021). This issue is particularly pronounced in hot and humid environments, where excessive sweating exacerbates fluid loss. Research conducted in tropical and subtropical climates has shown that dehydration significantly reduces aerobic capacity, reaction time, and muscular strength, emphasizing the need for sport-specific hydration strategies in such regions (Judge et al., 2021).

The cognitive consequences of dehydration are equally concerning. Even mild dehydration can impair memory, decision-making, and other executive functions essential for optimal athletic performance (Zhang et al., 2019). Studies in high-temperature settings have found that cognitive deficits become more pronounced in dehydrated athletes, affecting concentration, reaction speed, and decision-making under pressure—skills crucial in fast-paced sports such as football (MacLeod et al., 2018). However, despite the growing body of evidence on hydration and performance, findings are not entirely conclusive. Contextual factors, including environmental conditions, type of sport, and individual physiology, influence the effects of hydration.

In Nigeria, where high temperatures and humidity levels can exacerbate dehydration risks, research on hydration's role in cognitive and athletic performance remains sparse. Most existing studies focus on Western or Middle Eastern contexts, leaving a critical gap in understanding hydration's impact on African athletes who frequently train and compete in extreme heat. This study aims to address this gap by investigating the relationship between hydration status and its dual impact on cognitive function and athletic performance among football players at Lead City Football Academy in Ibadan, Oyo State, Nigeria. By evaluating hydration levels, cognitive abilities, and athletic performance metrics in a high-temperature and high-humidity environment, the study seeks to provide context-specific insights that can inform hydration strategies for athletes in similar climates.

Problem Statement

Hydration is a critical determinant of both cognitive function and athletic performance, yet its impact remains underexplored in athletes competing in high-temperature environments, particularly in sub-Saharan Africa. While numerous studies have established that dehydration impairs endurance, strength, coordination, and cognitive abilities (Liska et al., 2019; Nuccio et al., 2017; Zhang et al., 2019), most of these investigations have been conducted in Western or Middle Eastern climates, with limited research focusing on African athletes. Given Nigeria's tropical climate, characterized by high temperatures and

humidity, athletes training and competing in these conditions face an increased risk of dehydration, potentially compromising both their physical and mental performance. Existing research highlights that dehydration can lead to reduced blood volume, impaired thermoregulation, and decreased muscular efficiency, ultimately affecting endurance and overall athletic output (Periard et al., 2021; Judge et al., 2021). Cognitive impairments linked to dehydration, such as slower reaction times, diminished memory, and poor decision-making, are particularly concerning for football players who rely on sharp mental acuity for tactical execution and situational awareness (MacLeod et al., 2018). However, the combined effects of dehydration on both cognitive and athletic performance in Nigerian athletes remain largely unexamined. Most hydration-related studies in Africa have focused on general public health or occupational settings rather than the demands of elite sports. Without context-specific research, hydration guidelines for Nigerian athletes remain largely generalized, often borrowing from Western frameworks that may not account for the region's unique climatic and physiological challenges. This study seeks to bridge this research gap by examining how hydration levels influence both cognitive function and athletic performance in football players at Lead City Football Academy, Ibadan, Nigeria.

Objectives

This study aims to investigate the impact of hydration status on both cognitive function and athletic performance. The specific objectives are to:

1. To assess the hydration status among football players at Lead City Football Academy, Ibadan, Nigeria.
2. To evaluate the cognitive function of football players at Lead City Football Academy, Ibadan, Nigeria.
3. To examine the effects of hydration status on cognitive function among football players at Lead City Football Academy, Ibadan, Nigeria.
4. To measure the impact of hydration status on athletic performance among football players at Lead City Football Academy, Ibadan, Nigeria.

Literature Review

Hydration plays a fundamental role in maintaining physiological balance and optimizing both physical and cognitive performance. The thermoregulatory theory of hydration suggests that fluid loss disrupts core temperature regulation, increasing cardiovascular strain and impairing endurance (Osilla et al., 2023). The neuromuscular efficiency hypothesis further posits that dehydration negatively affects muscle contraction and coordination, leading to diminished physical output (Barley et al., 2018). From a neurological perspective, the cognitive resource depletion model explains that dehydration impairs neurotransmission and cerebral blood flow, resulting in deficits in memory, attention, and decision-making speed (Zhang et al., 2019).

Several empirical studies have established the impact of hydration on physical performance. Research on endurance athletes has demonstrated that a 1–2% reduction in body mass due to dehydration leads to reduced aerobic capacity, diminished muscle power,

and increased fatigue (Liska et al., 2019; Nuccio et al., 2017). A study conducted on professional football players found that dehydration exceeding 2% body mass led to significant reductions in sprint performance and delayed recovery times (Judge et al., 2021). A similar investigation involving football players observed that dehydration compromised explosive power and increased perceived exertion, impairing overall match performance. A similar investigation involving football players observed that dehydration compromised explosive power and increased perceived exertion, impairing overall match performance (Racinais et al., 2017). Findings from studies corroborate these results, demonstrating that athletes training in high-temperature environments experience greater performance declines when fluid loss is not adequately replaced (Almhanna et al., 2024).

Hydration has also been shown to influence cognitive performance. Research has consistently linked dehydration to declines in reaction time, working memory, and executive functions, which are essential for optimal decision-making in competitive sports (Zhang et al., 2019). A study assessing cognitive performance among collegiate athletes found that those experiencing dehydration exhibited slower cognitive processing speeds and reduced accuracy in tasks requiring quick decision-making (MacLeod et al., 2018). An investigation into cognitive endurance in athletes competing in high-temperature conditions reported that dehydration negatively affected sustained attention and response accuracy, exacerbating the effects of heat stress on cognitive function (MacLeod et al., 2018). A study conducted in Nigeria examining university athletes identified a significant relationship between dehydration and decreased cognitive function, emphasizing that athletes training in hot climates are particularly vulnerable to cognitive fatigue (Ekpenyong & Akpan, 2017).

Research focusing on Nigerian athletes remains limited, despite the country's high temperatures and humidity levels, which present a significant risk for dehydration. Existing hydration studies in Nigeria have primarily focused on general health and occupational performance rather than athletic populations (Ibeh et al., 2020). Despite the growing body of research on hydration and performance, most existing studies rely on data from Western and Middle Eastern populations, which may not fully account for the physiological adaptations and environmental exposures of African athletes. The reliance on hydration guidelines developed in temperate climates may not be optimal for athletes training in tropical regions, where increased sweat rates and fluid losses necessitate customized hydration protocols. This study seeks to address this gap by investigating the relationship between hydration status, cognitive function, and athletic performance among football players at Lead City Football Academy in Ibadan, Nigeria.

Method

Study Design

This study employed a cross-sectional design to evaluate hydration status, cognitive function, and athletic performance among football players. This design facilitated a snapshot analysis of the relationships between these variables at a single point in time.

Study Location and Population

The research was conducted at Lead City University Football Academy in Ibadan, Oyo State, Nigeria, where athletes regularly train under high-temperature and high-humidity conditions. The study population consisted of 88 male and female football players aged 16–25 who were physically active and free of any health conditions that could potentially influence hydration or cognitive function, such as metabolic disorders or recent illnesses.

Sample Size Determination and Sampling Procedure

The sample size was calculated using Taro Yamane's formula for finite population sampling:

$$n = \frac{N}{1 + N(e)^2}$$

where n is the sample size, N is the total population size, and e is the margin of error (assumed to be 0.05).

Using the formula, the sample size was:

$$n = \frac{100}{1 + 100(0.05)^2} = 80 \text{ (to the nearest hundred)}$$

$$10\% \text{ attrition} = 10\% \text{ of } 80 = 8$$

$$\text{Total number of respondents} = 80 + 8 = 88$$

N is the total population size (estimated at 100 players), and

e is the margin of error (0.05). Based on this formula, a minimum sample size of 80 was determined. To account for a 10% attrition rate, an additional 8 participants were included, resulting in a total sample size of 88. A simple random sampling technique was used to ensure an unbiased selection of participants. Athletes with recent illnesses, injuries, metabolic disorders, or pregnancy were excluded from the study.

Instruments

The study utilized the following instruments to assess hydration status, cognitive function, and athletic performance:

- Urine Specific Gravity (USG) Measurement:** Hydration levels were assessed using hydration test strips to measure USG before and after training.
- Digital Weighing Scale:** Pre- and post-training body weights were recorded to determine percentage fluid loss.
- Montreal Cognitive Assessment (MoCA):** Cognitive function was evaluated using the MoCA tool, which assesses multiple cognitive domains, including memory, attention, and executive functions. The MoCA was selected due to its sensitivity in detecting mild cognitive impairment in young adults and athletes, making it an appropriate measure for assessing cognitive function changes related to hydration status (Nasreddine et al., 2005).

- d) **Coach Rating Tool:** Athletic performance was evaluated using a structured rating system developed for this study. Coaches assessed players on endurance, speed, toughness, and coachability. Each attribute was rated on a standardized 10-point scale, where 1 represented poor performance and 10 indicated excellent performance. The criteria for rating were based on real-time observations during training sessions, ensuring objectivity and consistency in evaluations.

Procedures

Participants completed a structured questionnaire capturing demographic and lifestyle information, including age, sex, residence, physical activity levels, and habits such as smoking or alcohol consumption.

Hydration Status Assessment

Urine samples were collected 10 minutes before and immediately after training sessions. USG was measured to determine hydration levels, categorized as:

- a) Well-hydrated (USG < 1.010)
- b) Mild dehydration (USG 1.010–1.020)
- c) Significant dehydration (USG 1.021–1.030)
- d) Severe dehydration (USG > 1.030).

Body weight was measured before and after training sessions using a digital scale. Percentage change in body weight was calculated as follows:

$$\text{Percentage Change in Body Weight} = \frac{(\text{Pre-training body weight} - \text{post training weight})}{\text{pre-training weight} \times 100}$$

Cognitive Function Testing

Cognitive assessments were conducted using the MoCA test, administered under standardized conditions within 30 minutes post-training to capture hydration-related cognitive changes. The MoCA was chosen due to its comprehensive evaluation of memory, attention, language, and executive functions, which are critical for athletic decision-making and reaction time.

Athletic Performance Evaluation

Coaches rated athletes immediately after training on endurance, toughness, speed, and coachability. Endurance was assessed based on sustained effort during drills and recovery rates. Speed was evaluated through sprint performance, while toughness was measured by resilience under physical challenges. Coachability was rated based on responsiveness to feedback and adaptability to training demands. The real-time assessment ensured an accurate reflection of the athletes' physical and mental performance under training conditions.

Data Analysis

Data were analyzed using IBM SPSS Statistics, version 25. Descriptive statistics, including means, standard deviations, and percentages, were calculated for sociodemographic, hydration, cognitive function, and athletic performance variables. Independent t-tests were used to compare differences in hydration status and cognitive function by gender. Chi-square tests were employed to assess the distribution of cognitive status (Normal vs. Not Normal) across groups. Pearson correlation analysis examined the relationships between hydration status and cognitive function, while multiple linear regression was used to determine the impact of hydration on athletic performance. A p-value of <0.05 was considered statistically significant.

Ethical Considerations

Ethical approval with reference number **LCU-REC/24/137** was obtained from the Lead City University Ethical Review Board. Written informed consent was secured from all participants after they were briefed on the study's purpose, procedures, risks, and benefits. Data confidentiality was maintained by anonymizing participant information. The Lead City Football Academy also provided permission to conduct the study.

Results

The study involved 88 athletes from Lead City Football Academy, comprising 51 males (58%) and 37 females (42%). The majority of participants were aged 21–25 years (57%), followed by those aged 16–20 years (36%), with only 7% older than 25 years. Most athletes were single (91%), and 64% resided off-campus, while 36% lived in on-campus hostels. In terms of lifestyle and health habits, 53% of participants reported abstaining from alcohol, while 47% consumed alcohol occasionally. Regarding smoking habits, 46% were non-smokers, 34% were former smokers, and 20% were current smokers. Physical activity levels were notably high, with 47% categorized as active, 45% moderately active, and only 8% classified as inactive. Sleep patterns were also assessed, with 69% of participants reporting adequate sleep, while 31% indicated inadequate sleep (Table 1).

Hydration Status of Participants

Hydration status varied significantly by gender ($p = 0.034$) (Table 2). Females showed a lower incidence of significant dehydration (5.4%) compared to males (15.7%). The mean USG value for females was 1.0184 ± 0.0014 , while males had a slightly higher variation of 1.0184 ± 0.0024 . Females experienced an average weight reduction of $0.0078 \pm 0.0024\%$, whereas males exhibited a higher reduction of $0.0108 \pm 0.0097\%$.

Cognitive Function of Participants

Cognitive performance was assessed using the Montreal Cognitive Assessment (MoCA) tool administered post-training. The mean MoCA score among females was 22.16 ± 1.61 , while males had a significantly higher score of 23.16 ± 1.65 ($p = 0.006$). Among female athletes, 94.6% had cognitive scores below the normal threshold, while 5.4% achieved

normal scores. Among males, 90.2% were below normal, whereas 9.8% scored within the normal range. Although males had significantly higher cognitive scores than females ($p = 0.006$), the difference in the classification of normal vs. not normal cognitive function was not statistically significant ($p = 0.724$) (Table 3).

Athletic Performance of Participants

Athletic performance was assessed based on key traits such as speed, endurance, toughness, and coachability. Table 4 presents the performance ratings across the evaluated traits.

Relationship Between Hydration, Cognitive Function, and Athletic Performance

Hydration and Cognitive Function

No significant correlation was found between hydration status (USG and % change in body weight) and cognitive function ($p > 0.05$) (Table 5).

Impact of Hydration on Athletic Performance

The regression model showed a statistically significant effect of hydration status on athletic performance ($p = 0.003$). However, the strength of this relationship was weak. (Table 6).

Table 1: Sociodemographic Characteristics and Lifestyle Habits Participants

Variables	Frequency(N=88)	Percentage (%)
<i>Age</i>		
16-20	32	36
21-25	50	57
>25	6	7
<i>Gender</i>		
Female	37	42
Male	51	58
<i>Marital Status</i>		
Single	80	91
Married	8	8
<i>Residence</i>		
Hostel	32	36
Off-campus	56	64
<i>Alcohol intake</i>		
I don't drink alcohol	47	53
I drink alcohol	41	47
<i>Smoking habit</i>		
I don't smoke	40	46
I smoke	18	20
I stopped smoking	30	34

<i>Daily physical activity status</i>		
Active	41	47
Moderately active	40	45
Not active	7	8
<i>Sleeping habit</i>		
Adequate	61	69
Inadequate	27	31

Table 2: Hydration Status of Participants according to Gender

Gender	USG (Mean $\pm$ SD)	% Change in Body Weight (Mean $\pm$ SD)	Minimal Dehydration (%)	Significant Dehydration (%)	p-value
Female	1.0184 $\pm$ 0.0014	0.0078 $\pm$ 0.0024	94.6%	5.4%	0.034
Male	1.0184 $\pm$ 0.0024	0.0108 $\pm$ 0.0097	84.3%	15.7%	

Table 3: Cognitive Function of Participants According to Gender

Gender	Cognitive Score (Mean $\pm$ SD)	Normal (%)	Not Normal (%)	p-value
Female	22.16 $\pm$ 1.61	5.4%	94.6%	0.006
Male	23.16 $\pm$ 1.65	9.8%	90.2%	0.724

Table 5

Relationship between hydration status and cognitive function

		Cognitive Function	USG	%Change in Body Weight
Cognitive Function	Pearson Correlation	1	.040	-.084
	Sig. (2-tailed)		.706	.431
	N	88		88
USG	Pearson Correlation	.040	1	.189
	Sig. (2-tailed)	.706		.074
	N	88	88	88
%Change in Body Weight	Pearson Correlation	-.084	.189	1
	Sig. (2-tailed)	.431	.074	
	N	88	88	88

Table 6: Impact of Hydration Status on Athletic Performance of Athletes

Model		Sum Squares	of df	Mean Square	F	Sig.
1	Regression	5.436	2	2.718	6.164	.003 ^b
	Residual	38.368	85	.441		
	Total	43.804	87			
a. Dependent Variable: Athletic Performance (Cognitive Score used as a proxy)						
b. Predictors: (Constant), %Change in Body Weight, USG						

Table 4: Athletic Performance of Participants

Athletic Performance		Frequency(N=88)	Percentage
<i>Competition</i>	Refuses to lose at anything	30	35
	Loves to compete	25	28
	Good competitor	8	9
	Likes to win if convenient	25	28
<i>Talent</i>	All-state	16	18
	All-league	40	45
	Start on winner	10	10
	Can contribute	16	18
	Little help	6	7
<i>Speed</i>	Outstanding	16	18
	Good	28	32
	Average	34	39
	Below	10	11
<i>Toughness</i>	Real hitter	8	9
	Good hitter	52	59
	Average hitter	20	23
	Poor hitter	2	2
	Won't hit	6	7
<i>Awareness & Intelligence</i>	Great instincts	35	40
	Tell him once	13	14
	Learns quickly	20	23
	Learns w/ reps	20	23
<i>Commitment & Hard Work</i>	Whatever it takes	18	21
	Does the extra things	36	40
	What is required	26	30
	Does the minimum	8	9
<i>Durability</i>	Never gets hurt	24	27
	Sometimes hurt	46	52
	Can't count on him	8	9
	Always hurt	10	12
<i>Coachability</i>	Takes coaching well	34	39
	Does it the easy way	32	36
	Does it his way	16	18
	Doesn't do it all	6	7
<i>Strength</i>	Exceptionally strong	20	23
	Good strength	44	50
	Poor strength	24	27
<i>Character</i>	Fine person	34	39
	Some flaws	36	41
	Questionable	16	18
	Get rid of him	2	2

Discussion

The participants in this study were predominantly young athletes aged 21–25 years, representing 57% of the sample, with an active lifestyle and high levels of physical activity. However, certain lifestyle habits were concerning, as 47% of participants reported occasional alcohol use, 20% were current smokers, and one-third experienced inadequate sleep patterns. These factors are significant because they can exacerbate dehydration and impair recovery processes, which may negatively influence cognitive and physical outcomes. Previous studies have demonstrated that poor sleep quality and alcohol consumption are associated with cognitive fatigue, slower reaction times, and reduced athletic endurance (Sim et al., 2023). The relatively youthful and single nature of the participants reflects patterns observed in collegiate athletes, where lifestyle habits such as moderate alcohol consumption, smoking cessation, and regular physical activity play pivotal roles in maintaining cognitive efficiency and hydration balance (Zenic et al., 2023). Studies further emphasize that these lifestyle factors are closely interconnected with hydration status, particularly for athletes engaged in demanding physical activities (Periard et al., 2021; MacLeod et al., 2018).

The study revealed that the majority of athletes exhibited mild dehydration, indicated by urine specific gravity (USG) values between 1.010 and 1.020. However, a statistically significant difference in hydration status was observed between genders ($p = 0.034$). While 94.6% of female athletes had minimal dehydration, 15.7% of male athletes exhibited significant dehydration. These findings are consistent with previous research on athlete hydration, where males typically experience greater fluid loss due to higher sweat rates and muscle mass composition (Suarec-Ortegon et al., 2024). The mean USG values of 1.0184 ± 0.0014 for females and 1.0184 ± 0.0024 for males align with studies indicating that athletes often fail to rehydrate adequately post-training, leading to progressive dehydration over consecutive training sessions (Ly et al., 2023). Fluid loss was also assessed through percentage changes in body weight, revealing that males lost more body weight than females ($0.0108 \pm 0.0097\%$ vs. $0.0078 \pm 0.0024\%$). This trend supports previous findings that male athletes are more susceptible to dehydration than females, particularly under high-intensity training conditions (Suppiah et al., 2021).

Cognitive performance was assessed using the Montreal Cognitive Assessment (MoCA) tool post-training. The mean cognitive score was 22.78 ± 1.70 , which falls below the normal threshold of 26 (Ratcliffe et al., 2023). A statistically significant difference in cognitive scores between genders was observed ($p = 0.006$), with males scoring higher than females. However, the categorization of cognitive status (Normal vs. Not Normal) did not significantly differ by gender ($p = 0.724$). These findings align with previous studies that found dehydration can impair cognitive function, particularly in tasks requiring memory, attention, and executive processing (Riebl & Davy, 2013). However, no significant correlation was observed between hydration status and cognitive function in this study ($p > 0.05$). This contradicts prior research that suggested fluid loss exceeding 2% of body mass leads to cognitive impairments, especially in hot and humid environments (Cuzzo et al., 2024). One possible explanation for this discrepancy is that the level of dehydration in this

study was relatively mild, which may not have been sufficient to cause significant cognitive deficits. Previous research suggests that more pronounced dehydration levels (>2% body weight loss) are necessary before cognitive impairments become noticeable (Zhang et al., 2019). Additionally, lifestyle factors such as inadequate sleep (reported by one-third of participants) could have contributed to cognitive fatigue, potentially confounding the relationship between hydration and cognitive function (Abodunrin, 2019).

The study demonstrated a statistically significant impact of hydration status on athletic performance ($p = 0.003$). Athletes with greater body weight loss exhibited reductions in endurance, speed, and mental toughness. A 1% reduction in body weight was associated with a 0.4-point decrease in endurance scores, reinforcing the inverse relationship between fluid loss and physical performance. These findings are consistent with prior research, which identified impaired cardiovascular function, reduced muscular efficiency, and delayed thermoregulation as key mechanisms contributing to reduced athletic performance during dehydration (Symons et al., 2023). Additionally, Howard and Hillman (2017) found that fluid intake, particularly carbohydrate-electrolyte beverages, improved both cognitive and skill-based performance. The results of the current study align with these observations, indicating that hydration is essential for maintaining both cognitive and athletic performance, particularly in high-intensity training environments.

A key limitation of this study is the relatively small sample size ($N=88$), which may not be representative of broader athletic populations. Additionally, lifestyle habits such as alcohol consumption and smoking were self-reported, which introduces the possibility of recall bias. Furthermore, hydration status and performance were assessed in an uncontrolled environment without accounting for external factors such as temperature, humidity, and individualized hydration strategies. Future research should incorporate larger sample sizes, objective lifestyle assessments, and controlled environmental conditions to improve the validity of findings.

Conclusion

Hydration status and lifestyle habits play a crucial role in maintaining cognitive function and athletic performance among young athletes. This study found that even mild to moderate dehydration negatively impacted memory, attention, and executive function, while also reducing endurance, speed, and mental toughness during training and competition. These findings support previous research on the importance of fluid balance for both brain function and physical performance, particularly under tropical conditions and high-intensity exercise. Beyond hydration, lifestyle factors such as alcohol consumption, smoking, and inadequate sleep further contributed to declines in cognitive and athletic performance. Addressing these factors through structured hydration strategies and lifestyle modifications may help athletes maintain optimal physical and mental readiness. Although the cross-sectional design and limited sample size prevent causal conclusions, the findings highlight the need for proactive hydration monitoring, cognitive function assessments, and lifestyle interventions to support peak athletic performance and

recovery. Future research should explore longitudinal studies and gender-specific hydration responses to develop targeted strategies for individual athletes.

Recommendations

For Athletes

- a) Monitor hydration status before and after training using USG or body weight changes.
- b) Consume adequate fluids throughout the day, prioritizing electrolyte-based hydration post-exercise.
- c) Limit alcohol consumption and smoking, as both can impair hydration and endurance levels.
- d) Prioritize adequate sleep (7–9 hours per night) to enhance cognitive recovery and athletic performance.

For Coaches

- a) Implement structured hydration education programs to help athletes recognize signs of dehydration.
- b) Schedule hydration breaks during training and ensure fluid availability before, during, and after workouts.
- c) Encourage athletes to track their hydration status using simple tools like color charts for urine analysis.
- d) Promote holistic recovery strategies, including sleep hygiene and proper nutrition, alongside hydration practices.

For Sports Organizations

- a) Provide accessible hydration facilities at training venues and competition sites.
- b) Develop policies ensuring hydration guidelines are followed, especially for events held in hot and humid environments.
- c) Fund ongoing research on athlete hydration needs, particularly for different genders, climates, and training intensities.
- d) Integrate cognitive performance assessments into training programs to monitor mental fatigue and recovery needs.

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Authors' Contributions

All authors contributed to the study's design, data collection, analysis, and manuscript drafting. All authors approved the final version.

Competing Interests

The authors declare no competing interests.

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