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The Effect Of Fluid Intake On The Hydration Status Of Male Collegiate Football Athletes: Basis For A Proposed Hydration Strategy

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Abstract: This study investigated the hydration strategies of male football athletes at the Polytechnic University of the Philippines – Sta. Mesa, focusing on the differences in hydration status when consuming water, sports drinks, or a combination of both during training sessions. The research aimed to address gaps in existing literature by employing a pre-experimental design, assessing hydration through urine parameters such as specific gravity, osmolality, color, and volume. Furthermore, the researcher used pre-experimental research, which was distinguished by its absence of randomization and control groups. Results indicated that water alone as a hydration strategy could lead to overhydration among athletes. In contrast, sports drinks were more effective in maintaining normal hydration and electrolyte balance. The combined hydration strategy of water and sports drinks showed promise in balancing fluid and electrolyte intake, effectively supporting athletes' hydration needs. Statistical analysis revealed a significant difference in urine specific gravity among the hydration strategies, although no significant differences were found in urine osmolality. Thus, it implies that planning hydration strategies, which include both fluids and electrolytes, is critical to prevent overhydration and ensure optimal performance of athletes during training.

***IndexTerms* -** Hydration strategies, Male football athletes, Urine Specific Gravity, Urine Osmolality, Urine Color and Volume

I. INTRODUCTION

Football players are constantly looking for ways to improve their training routines, and one thing that could assist them in performing better is proper hydration. Staying hydrated is essential for maintaining health and supporting several bodily functions. Understanding your hydration necessities and following practical ways to remain hydrated will help guarantee your body performs properly (Wilson, 2024). It is well known that proper hydration affects athletic performance, particularly in sports like football, where players may lose a significant amount of fluid via perspiration and engage in high-intensity intermittent physical activity.

While water remains the primary hydration source for most athletes, the use of sports drinks containing electrolytes and carbohydrates has grown in popularity due to their ability to replenish electrolytes lost through sweating and provide readily available energy during exercise (Pound Cm & Blair, 2017). The consumption of sports drinks has seen a marked increase, particularly among adolescents. A study highlighted that the consumption of these beverages among adolescents tripled between 1999 and 2008, suggesting a growing perception of their health benefits linked to athletic performance (Hennessy et al., 2015).

Several factors influence football players' training performance, including performance-related aspects. One of the most important nutritional components is water, which can impact athletes' performance and fatigue if their intake is insufficient. The body absorbs water, particularly from the beverage they intake during trainings. A football athlete's hydration level will be impacted if there is inadequate water intake (Rachmawati, 2024). According to Kooima et al. (2024), dehydration may hinder performance during endurance training sessions, especially during hot temperatures. In large populations, urine markers appear to be a reasonable option for evaluating hydration levels (Baron et al., 2014).

The existing literature emphasizes the importance of personalized hydration strategies for athletes (Belval et al., 2019), the impact of hydration status on sports performance (Orrú et al., 2018), and the need for normative sweat-sodium concentration data to tailor hydration and electrolyte-replacement strategies for professional team-sport athletes (Ranchordas et al., 2017). Furthermore, studies have examined the influence of cultural differences on hydration habits among physically active people (Leow et al., 2022), as well as the effects of hydration on physiological indicators and subsequent athletic performance (Samsani et al., 2021). In addition, Sommerfield et al. (2016) investigated the validity of urine specific gravity as a marker of hydration status in college athletes.

Proper hydration is crucial in sports, especially football. However, there is a gap in knowing the most effective hydration techniques for football athletes, particularly when it comes to evaluating the effects of water and sports drinks on the hydration status. While there have been studies on hydration status in elite football players (Castro-Sepúlveda et al., 2016), and the role of functional beverages in sport performance and recovery (Orrú et al., 2018), there is a lack of extensive and local studies comparing hydration strategies between water and sports drinks among football athletes.

Therefore, this study aimed to fill the research gaps by conducting an experimental study of male football athletes' hydration strategies, focusing on determining the significant difference in hydration status between football athletes drinking water, sports drinks, and combined beverages during training and assessing the sample using the urine parameters.

RESEARCH METHODOLOGY

The methodology section outlines the plan and method that how the study is conducted. This includes Universe of the study, sample of the study, Data and Sources of Data, study's variables and analytical framework. The details are as follows.

3.1Population and Sample

The population examined consisted of male football student athletes currently enrolled at the Polytechnic University of the Philippines – Sta. Mesa. All male students who participated in football as part of their sports activities were included in the demographic. The study's sample size consisted of (3) three football students, as calculated by the 95% confidence level and 5% margin of error computation.

3.2 Data and Sources of Data

The researchers used a one-shot case study design, a pre-experimental design consisting of giving an approach or intervention to a single group of individuals, followed by administering a single post-test to gauge the results. The sampling technique employed for this research was cluster sampling. The researchers established the following criteria for cluster sampling: (1) Football players who consistently attended practices. (2) Must be an attacking midfielder. (3) Had been a player or participant in competitions for a year. (4) Must have been aged 19 to 24. (5) Must have had a medical clearance to assure that they were physically capable of participating in the study. (6) Must have been willing to engage in the study.

3.3 Theoretical framework

This study was anchored in two theories that focused on hydration strategies among male football athletes, specifically integrating Li's Theoretical Integration Approach to Athlete's Pre-Exercise Fluid Intake and Creighton's Mechanisms of Hypohydration. The use of these theories was essential for understanding the nature of hydration in sports.

Li's approach combined elements of self-determination theory and the theory of planned behavior, which clarified the psychological motivations behind athletes' fluid intake behaviors. This framework emphasized how personal motivation, social influences, and perceived control could significantly impact athletes' hydration decisions prior to exercise. On the other hand, Creighton's exploration of hypohydration offered a physiological perspective, detailing how inadequate hydration could impair muscle strength, power, and overall performance.

By employing these theories, the study comprehensively analyzed both the psychological and physiological dimensions of hydration, providing a framework for understanding how different strategies affected male football athletes. The application of these theories was important for developing effective hydration strategies in accordance with the specific needs of athletes. Li's theoretical integration helped identify the motivational factors influencing pre-exercise fluid intake, enabling coaches and sports scientists to promote better hydration practices. Meanwhile, Creighton's research highlighted the importance of maintaining adequate hydration for optimal performance, allowing for informed choices between water, sports drinks, or a combination of both.

This supported the evaluation of various hydration strategies by providing a basis for assessing their effectiveness in enhancing athletic performance. Moreover, insights from both theories could guide the development of hydration protocols that met the physiological needs of athletes while aligning with their psychological readiness and motivation to hydrate properly. By leveraging these theoretical insights, the study aimed to determine how different hydration strategies impacted the performance of male football athletes, leading to improved athletic outcomes and performance optimization.

3.4Statistical Treatment of Data

The data needed in the study were tested in a one-way ANOVA test to determine the significant difference between water, sports drink and combined. The significance level was tested at $p \leq 0.05$. The researchers used the following statistical measures in analyzing the data and its interpretation:

1. Mean – the method used to determine the average of Urine Specific Gravity, Urine Osmolality, and Urine Volume of athletes' urine for statistical treatment.

$$\bar{x} = \frac{\sum x_n}{n}$$

Where $\sum$ = sum of the computed numbers

= total number of variables

2. One-way Analysis of Variance – It was employed to determine the significant difference between the two independent variables, water, sports drink, and combined.

Source of Variance	Degree of Freedom (df)	Sum Square (SS)	Mean Square (MS)
Between Groups (Treatment)	k-1	$SSB = \sum_{j=1}^{k}\left(\frac{T_j^2}{n_j}\right) - \frac{T^2}{n}$ $SSB = \sum_{j=1}^{k} n_j(\bar{X}_j - \bar{X}_t)^2$	$MSB = \frac{SSB}{k-1}$
Within Groups (Error)	n-k	$SSW = \sum_{j=1}^{k}\sum_{i=1}^{n} X_{ij}^2 - \sum_{j=1}^{k}\left(\frac{T_j^2}{n_j}\right)$ $SSW = \sum_{j=1}^{k}\sum_{i=1}^{n}(X_{ij} - \bar{X}_j)^2$	$MSW = \frac{SSW}{n-k}$

• SST = SSB + SSW k: number of groups n: number of samples
df: degree of freedom

IV. RESULTS AND DISCUSSION

Hydration Status of the Participants During Training Sessions

HYDRATION WITH WATER

Table 01. *Results of Urine Parameters for Day 1 (Hydration with Water)*

DAY 1 (WATER)			
Urine Parameters	**Athlete 1**	**Athlete 2**	**Athlete 3**
Urine Specific Gravity	1.001	1.001	1.001
Urine Osmolality	63 mOsm/kg	52 mOsm/kg	118 mOsm/kg
Urine Color	Straw	Straw	Straw
Urine Volume	20 ML	20 ML	20 ML
VERBAL INTERPRETATION	Overhydrated	Overhydrated	Overhydrated

Table 01 presents the day 1 hydration status of athletes 1, 2, and 3, using water as their hydration strategy based on various urine parameters, including specific gravity, osmolality, color, and volume. Specific gravity and osmolality measurements indicate hydration status, with hypersthenuria (>1.012) and osmolality >900 mOsm/kg suggesting dehydration, isosthenuria (1.007-1.012) and normal osmolality (300-900 mOsm/kg) indicating minimal dehydration or normal hydration, and hyposthenuria (<1.007) with osmolality <300 mOsm/kg pointing to overhydration.

For Athlete 1, the urine parameters indicate overhydration, as evidenced by the low specific gravity of 1.001 and osmolality of 63 mOsm/kg. This overhydrated state aligns with Marwan and Rohayati's (2020) findings, which emphasize the importance of water in preventing dehydration. However, low osmolality indicates an excess of water intake without sufficient electrolyte replenishment, which can dilute the body's electrolyte levels. It supports Burke's (2021) observation that solely relying on water may lead to hyponatremia during intense physical exertion.

Athlete 2 also shows signs of overhydration, with a specific gravity of 1.001 and osmolality of 52 mOsm/kg. The low osmolality, alongside the straw-colored urine, further suggests that the hydration strategy of using only water led to an excessive dilution of body fluids. As highlighted by Perrier (2019), while water is crucial for maintaining hydration, the absence of electrolytes in water can compromise the balance necessary for optimal athletic performance, reinforcing the need for a more balanced hydration approach.

Similar to the other athletes, Athlete 3 displays overhydration with a specific gravity of 1.001 and an osmolality of 118 mOsm/kg. The slightly higher osmolality compared to the other athletes indicates marginally better fluid balance, yet it still falls within the range of overhydration. This overhydration could impair performance due to the dilution of electrolytes, supporting Veilleux et al. (2020), who stress the importance of balanced hydration strategies tailored to individual needs and environmental conditions.

HYDRATION WITH SPORTS DRINKS

Table 02. *Results of Urine Parameters for Day 2 (Hydration with Sports Drink)*

DAY 2 (SPORTS DRINK)			
Urine Parameters	**Athlete 1**	**Athlete 2**	**Athlete 3**
Urine Specific Gravity	1.006	1.010	1.016
Urine Osmolality	114 mOsm/kg	235 mOsm/kg	443 mOsm/kg
Urine Color	Straw	Light yellow	Light yellow
Urine Volume	20 ML	20 ML	20 ML
VERBAL INTERPRETATION	Overhydrated	Normally Hydrated	Normally Hydrated

Table 02 presents the day 2 hydration status of athletes 1, 2, and 3, using sports drinks as their hydration strategy based on various urine parameters, including specific gravity, osmolality, color, and volume. Specific gravity and osmolality measurements indicate hydration status, with hypersthenuria (>1.012) and osmolality >900 mOsm/kg suggesting dehydration, isosthenuria (1.007-1.012) and normal osmolality (300-900 mOsm/kg) indicating minimal dehydration or normal hydration, and hyposthenuria (<1.007) with osmolality <300 mOsm/kg pointing to overhydration.

On Day 2, Athlete 1 still shows overhydration, indicated by a specific gravity of 1.006 and an osmolality of 114 mOsm/kg. The use of sports drinks, which contain electrolytes, was expected to regulate hydration levels better. However, the overhydrated state suggests that Athlete 1 might have consumed excessive fluids, underscoring Atan and Kassim's (2019) findings that hydration strategies need to be carefully tailored to avoid overhydration, even when using electrolyte-enhanced drinks.

Athlete 2 presents a normally hydrated state with a specific gravity of 1.010 and osmolality of 235 mOsm/kg. The light-yellow urine color indicates that the sports drink effectively maintained fluid balance and electrolyte levels. This result supports the research by Mohr et al. (2021), which emphasizes the role of sports drinks in delaying fatigue and maintaining hydration. Thus, sports drinks can be effective in achieving optimal hydration without the risk of overhydration.

Athlete 3 also achieved normal hydration, with a specific gravity of 1.016 and osmolality of 443 mOsm/kg. The higher specific gravity and osmolality suggest better retention of fluids and electrolytes, which are crucial during prolonged and intense activities. This outcome is consistent with the literature by Halder and Daw (2020), who highlight that sports drinks, by replenishing lost electrolytes, can prevent dehydration and improve overall athletic performance.

HYDRATION WITH COMBINED WATER AND SPORTS DRINK

Table 03. *Results of Urine Parameters for Day 3 (Hydration with Combined Water and Sports Drink)*

DAY 3 (COMBINES)			
Urine Parameters	**Athlete 1**	**Athlete 2**	**Athlete 3**
Urine Specific Gravity	1.006	1.012	1.011
Urine Osmolality	136 mOsm/kg	328 mOsm/kg	235 mOsm/kg
Urine Color	Light yellow	Yellow	Yellow
Urine Volume	20 ML	20 ML	20 ML
VERBAL INTERPRETATION	Overhydrated	Normally Hydrated	Normally Hydrated

Table 03 presents the day 3 hydration status of athletes 1, 2, and 3, using combined water and sports drinks as their hydration strategy based on various urine parameters, including specific gravity, osmolality, color, and volume. Specific gravity and osmolality measurements indicate hydration status, with hypersthenuria (>1.012) and osmolality >900 mOsm/kg suggesting dehydration, isosthenuria (1.007-1.012) and normal osmolality (300-900 mOsm/kg) indicating minimal dehydration or normal hydration, and hyposthenuria (<1.007) with osmolality <300 mOsm/kg pointing to overhydration.

On Day 3, Athlete 1 still shows signs of overhydration, with a specific gravity of 1.006 and osmolality of 136 mOsm/kg. Despite the combined hydration strategy, the persistence of overhydration suggests that the balance between water and sports drink intake may have needed to be more optimal. This situation corroborates the findings by Tarnowski et al. (2022), who advocate for personalized hydration strategies that account for individual fluid and electrolyte needs to avoid overhydration.

On Day 3, Athlete 2 exhibits normal hydration, with a specific gravity of 1.012 and osmolality of 328 mOsm/kg. The yellow urine color indicates a well-maintained hydration status, confirming that the combined strategy of using both water and sports drinks was effective. This supports the study by Lynch (2021), which found that alternating between water and sports drinks could optimize hydration by providing both necessary fluids and electrolytes, ensuring sustained energy and recovery.

Athlete 3 also demonstrates normal hydration with a specific gravity of 1.011 and osmolality of 235 mOsm/kg. The results suggest that the combined strategy effectively maintained fluid and electrolyte balance. The literature by Belval et al. (2019) underscores the benefit of such a combined approach, which can enhance athletic performance and recovery by addressing both hydration and nutritional needs, as seen in the adequate hydration status of Athlete 3.

Analysis of Variance for Urine-Specific Gravity

Table 04. *ANOVA Results for Urine Specific Gravity*

Hydration Strategies	Mean	F-value	p-value	Decision	Remarks
Water	1.001	7.1308	0.0260	Reject Ho	Significant
Sports Drink	1.011				
Combined	1.010				

Table 04 analysis of variance revealed a significant difference in urine-specific gravity across the three hydration strategies (water, sports drinks, and a combination), with a p-value of 0.0260, leading to the rejection of the null hypothesis. The mean urine-specific gravity was lowest for water (1.001), suggesting more diluted urine compared to sports drinks (1.011) and the combined strategy (1.010). This finding aligns with the literature by Marwan and Rohayati (2020), which underscores that water alone can lead to lower urine specific gravity, indicating better hydration. However, this also suggests a potential risk of overhydration and insufficient electrolyte balance, as pointed out by Burke (2021). The significant difference observed suggests that hydration strategies significantly impact urine concentration, supporting the idea that the type of hydration method can influence the body's fluid balance and overall hydration status.

This significant difference suggests that the type of hydration strategy has a notable impact on urine-specific gravity. Specifically, the data indicates that water as a hydration method results in significantly lower urine specific gravity compared to sports drinks and the combined hydration strategy. It implies that athletes who hydrate solely with water tend to have more diluted urine, indicating better hydration status than those using sports drinks or a combination of both.

Analysis of Variance for Urine Osmolality

Table 05. *ANOVA Results for Urine Osmolality*

Hydration Strategies	Mean	F-value	p-value	Decision	Remarks
Water	77.667	2.3510	0.1762	Do not Reject Ho	Not Significant
Sports Drink	264.000				
Combined	233.000				

Table 05 shows that the analysis of variance of the urine osmolality has no significant difference among the three hydration strategies, with a p-value of 0.1762, leading to the acceptance of the null hypothesis. The mean osmolality values were 77.667 mOsm/kg for water, 264.000 mOsm/kg for sports drinks, and 233.000 mOsm/kg for the combined strategy. Despite the observable differences in mean values, the lack of statistical significance suggests that the hydration method does not markedly impact urine osmolality. It aligns with findings from Perrier (2019) and Mohr et al. (2021), which indicate that factors such as individual metabolic responses or pre-existing hydration levels may play a more substantial role in determining osmolality. Consequently, while the type of hydration strategy may affect other parameters, its influence on osmolality appears to be less pronounced, implying that urine osmolality may be a more stable indicator of hydration status across different fluid intake methods.

The lack of significant difference suggests that the type of hydration strategy does not have a notable impact on urine osmolality. It implies that while there are observable differences in the mean osmolality values, they are not statistically significant. Therefore, from a urine osmolality perspective, athletes may experience little substantial differences in hydration effectiveness whether they use water, sports drinks, or a combination of both. Factors other than the type of hydration influence osmolality, such as individual metabolic responses or the overall hydration status before the training sessions.

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