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Hydration Status during a Routine Practice Session in a Hot Humid Environment amongst Professional Football Players in Yenagoa, Bayelsa State, Nigeria

Justice Patani Akpotu[1,*], Hamilton C. Opurum[2], Datonye Victor Dapper[3]

[1]Department of Sports Medicine, Faculty of Clinical Sciences, University of Port Harcourt, Port Harcourt, Nigeria
[2]Department of Medical Biochemistry, Faculty of Basic Medical Sciences, University of Port Harcourt, Port Harcourt, Nigeria
[3]Haemorheology and Immunology Research Unit, Department of Human Physiology, Faculty of Basic Medical Sciences, University of Port Harcourt, Port Harcourt, Nigeria
*Corresponding author: justiceakpotu@gmail.com

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Abstract Hydration status is a major concern as it affects the health and performance of athletes. This study was aimed at evaluating the hydration status of professional football players in Yenagoa, Bayelsa State of Nigeria. 30 male and 30 female professional football players and 30 male and 30 female physically active persons aged 18 to 35years were randomly selected for the study. Pre-training urine specific gravity, percentage change in body weight post-training and body mass index (BMI) were evaluated using reagent strips and standard protocol respectively. Results obtained showed that: 90% each of male and female professional football players were found to be minimally to significantly dehydrated prior training; similarly, 60% of physically active males and 53.3% of physically active females were found to be minimally to significantly dehydrated prior training. Percentage change in body weight post training was 3.18± 0.21% for male professional football players and 3.27±0.14% for female professional football players; 2.37±0.10% for physically active males and 2.06±0.11% for physically active females. Percentage change in body weight post training was significantly higher in professional football players compared to physically active persons: male professional football players versus male physically active persons (t= 3.50, p=0.001); female professional football players versus female physically active persons (t=7.67, p=0.001). Our findings are a cause for concern on account of the potential to impair athletic performance and endanger the health of athletes and non-athletes.

Keywords: *dehydration, exercise, hot humid environment, sweating*

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1. Introduction

Exercise in hot humid environment may lead to inadequate hydration and may pose various physiological and health challenges to the athlete. [1] Adequate hydration is needed for temperature regulation; if the body is unable to dissipate heat sufficiently as a result of dehydration, heat illnesses such as cramps, heat exhaustion, heat stroke and death can possibly occur. [2] It is important that coaches and sports physicians ensure optimal performance and the overall optimum health of players during a match. One way to achieve this goal is to ensure adequate hydration before, during and after training or competitions. [3] More so, football being a rigorous sport, training in hot and humid conditions can predispose players to dehydration when intake of fluids before and during training do not match fluid lost from sweating. [3] Proper fluid replacement is therefore, needed during exercise especially in hot humid conditions and/or for events lasting longer than an hour in duration or of high intensity. [4]

Recent reports suggest that dehydration in athletes results from insufficient fluid intake and/or excessive sweating during training or competition. [3] Other factors that may lead to dehydration include: high intensity training, environmental conditions including relative humidity and atmospheric temperature, and availability of fluids during training. [4] Studies have also shown that dehydration can cause a marked decrease in the performance of football players. [5,6,7] A loss of 2% body weight from fluid loss causes noticeable decrease in performance which becomes more significant with greater levels of dehydration. [4] In addition, loss of 2% body weight has been shown to decrease performance by as much as 10 to 20% and when fluid losses exceed 3-5% body weight there is decrease in performance and impaired reaction time, judgement, concentration and

decision making which are vital in all sporting events especially football. [8] The hydration state of athletes can be evaluated using different biological markers: plasma osmolality, urine specific gravity or pre- and post-exercise weight changes; however, urine specific gravity is the most commonly used in evaluating football players. [9,10] The hydration status of athletes depends to a high extent on the initial hydration condition before training and the fluid intake during and after training or competition. [11]

Therefore, it is essential to evaluate the hydration status of football players especially those that practice in hot humid environment as this will help in preventing dehydration and guide in appropriate fluid replacement for the players in such environments. The present report describes the hydration status of professional football players in a hot humid environment in Yenagoa, Bayelsa State located in the Niger Delta region of Nigeria. Previous reports on the hydration status of football players in Africa in general and particularly Nigeria have been relatively scanty; most reports have emanated from Europe and America. The present report aims to bridge this gap and also serve as baseline for future investigations.

2. Materials and Methods

2.1. Study Area

The study was conducted in the city of Yenagoa, the administrative, economic and political capital of Bayelsa, a state located in the Niger Delta of Nigeria. The study was conducted during the Nigerian 'dry season' between January to February 2018. The climate of Yenagoa is tropical rainforest typical of the Niger Delta with ambient temperature ranging between 24°C and 33°C and average relative humidity of about 59%.

2.1.1. Ethical Approval

Ethical approval was obtained from our Institutional Research Ethics Committee vide a memorandum referenced UPH/R&D/REC/04. All subject participation was entirely voluntary. Informed consent was sought and obtained from each participant before recruitment; study was conducted in accordance with the Helsinki Declaration of 1975 as amended in 2000. Written approval was also obtained from the football teams whose players were used for the study.

2.1.2. Participants

A total of 120 participants aged between 18 and 35years were randomly selected for the study. This consisted of 60 professional football players (30 males and 30 females) and 60 physically active persons (30males and 30 females). All the physically active persons were apparently healthy with no evidence of metabolic or hematologic diseases likely to influence any of the parameters under investigation and served as control. All professional football players who reported any ill health or conditions that might influence fluid and electrolyte balance were promptly excluded from the study. All pregnant participants were also excluded. Participants were allowed a training session of a total of 2hours consisting of 15minutes warm-up period followed by two halves of 45minutes of play; separated by a 15minutes half-time. The mean atmospheric temperature and relative humidity all through the training period was 31.1°C and 68% respectively.

2.1.3. Determination of Urine Specific Gravity

A spot urine sample was first collected from each participant 10 minutes before commencement of physical training for the determination of urine specific gravity. Urine specific gravity was determined using the Medi-Test Combi 10® SGL reagent strips (Macherey-Nagel GmbH and Co. KG). The hydration status of each subject was then determined using urine specific gravity (USG) values as proposed by Casa *et. al.,* 2000 [4]: well hydrated=USG less than 1.010; minimal dehydration=USG of between 1.010 and 1.020; significant dehydration=USG of between 1.021 and 1.030; severe dehydration=USG greater than 1.030.

2.1.4. Determination of Body Mass Index (BMI)

Height and weight were measured in meters (m) and kilogram (kg) respectively, with all participants barefooted and wearing light clothing, using a standard scale (seca model). The body mass index was calculated by dividing body weight in kilogram by square of the height in meters (kg/m^2). [12]

2.1.5. Determination of Percentage Change in Body Weight

The weight of each subject was determined pre-and post-physical training session. Hydration status was estimated using percentage change in body weight. The percentage change in body weight was calculated using the formula proposed by Silva *et. al.,* 2011. [13]

$$\text{Percentage change in body weight} = \frac{\left[\begin{array}{l}\text{Pre-training body weight (kg)} \\ -\text{post training weight (kg)}\end{array}\right]}{\text{Pre-training weight (kg)}} \text{x100.}$$

2.1.6. Statistical Analysis

Results obtained are presented as mean ± standard error of means (SEM) in Table 1 and Table 2 and Figure 1. Statistical significance was determined, as appropriate, using the Student's t-test. A p value less than 0.05 was considered statistically significant.

3. Results

Table 1 shows the mean age, body mass index (BMI) and hydration status: urine specific gravity and percentage change in body weight of all male participants. The mean age was 22.07±0.52years for male professional football players and 28.00±0.94years for male physically active persons. The differences in age were statistically significantly: male physically active persons were older compared to the male professional football players ($p< 0.001$). Body mass index (BMI) was higher amongst male physically active persons; but the differences were not statistically significant ($p>0.001$). The mean urine specific gravity (USG) was higher amongst the male

professional football players: 1.020±0.001 compared to male physically active persons: 1.010±0.001; these differences were however, not statistically significant (p>0.001). The mean percentage change in body weight was significantly higher amongst male professional football players: 3.18±0.21% compared to male physically active persons: 2.37±0.10% (p<0.001).

Table 2 shows the mean age, body mass index (BMI) and hydration status: urine specific gravity and percentage change in body weight of all female participants. The mean age was higher: 26.33±0.91years amongst female physically active persons compared to female professional football players: 24.13±0.70; the differences were however, not statistically significant (p>0.001). Body mass index (BMI) was also higher amongst female physically active persons; but the differences were not significant (p>0.001). The mean urine specific gravity (USG) was also higher amongst female professional football players: 1.020±0.01 compared to female physically active persons: 1.010±0.001; these differences were also not significant (p>0.001). The mean percentage change in weight was significantly higher in female professional football players: 3.27±0.14% compared to female physically active persons: 2.06±0.11% (p<0.001).

Table 1. Age, body mass index (BMI) and hydration status: urine specific gravity and percentage change in body weight of all male participants

	All male participants (n=60)	Male professional football players (n=30)	Male physically active persons (n=30)	t-test and p values
Age (years)	25.03±0.66	22.07±0.52	28.00±0.94	5.50; 0.001
Body mass index (kg/m^2)	23.22±0.32	22.83±0.32	23.60±0.56	1.19; 0.24
Pre-training urine specific gravity	1.010±0.001	1.020±0.001	1.010±0.001	1.94; 0.06
Percentage change in body weight (%)	2.78±0.13	3.18±0.21	2.37±0.10	3.50; 0.001

All values are mean ± SEM.

Table 2. Age, body mass index (BMI) and hydration status: urine specific gravity and percentage change in body weight of all female participants

	All female participants (n=60)	Female professional football players (n=30)	Female physically active persons (n=30)	t-test and p values
Age (years)	25.23±0.58	24.13±0.70	26.53±0.91	1.93; 0.06
Body mass index (kg/m^2)	22.60±0.38	22.51±0.50	22.53±0.57	0.17; 0.86
Pre-training urine specific gravity	1.020±0.001	1.020±0.01	1.010±0.001	1.83; 0.07
Percentage change in body weight (%)	2.66±0.11	3.27±0.14	2.06±0.11	7.67; 0.001

All values are mean ± SEM.

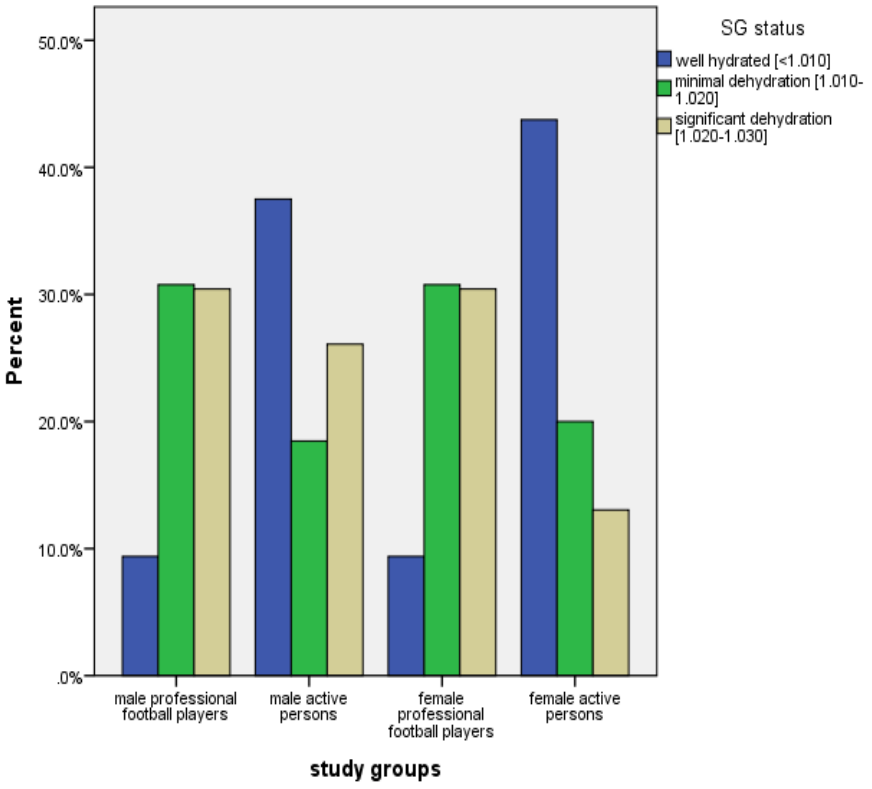

Figure 1. Hydration status of study groups using urine specific gravity (USG)

Figure 1 shows the percentage distribution of the hydration status of the subjects in the various study groups prior to commencement of physical training using values of urine specific gravity (USG) described by Casa *et. al.,* 2000 [4]. As shown by the blue bars, only 10% (3) each of both male and female professional football players were found to be well hydrated (USG<1.010) prior to commencement of training; compared to 40% (12) and 46.7% (14) respectively of male and female physically active persons. Conversely, only 60% (18) and 53.3% (16) respectively of both male and female physically active persons were found to be either minimally (USG=1.010-1.020) to significantly (USG=1.021-1.030) dehydrated; compared to 90% (27) and 90% (27) respectively of both male and female professional football players. Furthermore, chi-squared analysis showed significant association in these proportions ($\chi 2>18.11$; p=0.006).

4. Discussion

Reagent strips were used for determination of urine specific gravity in the present study on account of ready availability at our center. Despite reported limitations, [14] the use of reagent strips for the determination of urine specific gravity are still considered valid [15] and therefore, do not detract from the implications of our findings.

The results of our study suggest that majority of male and female professional football players were fluid deficit prior to commencement of physical training. Although, both professional football players and physically active persons were dehydrated prior to and after completion of physical training, the level of post training dehydration was predictably higher amongst the professional football players. This finding suggests that both professional football players and the physically active persons were not voluntarily taking adequate fluids before and during physical training to ensure optimal hydration and athletic performance. These findings are consistent with most previous reports. For instance, Kilding *et. al.,* 2009 [16], reports a mean urine specific gravity of 1.014±0.005, suggesting minimal dehydration in professional female soccer players. Furthermore, Al-Jaser and Hassan (2006) [17] reports a mean urine specific gravity of 1.026±0.002 in male soccer players also suggesting a significant level of dehydration. In comparison to the present study, the higher values of urine specific gravity reported by Al-Jaser and Hassan (2006) [17] may be due to differences in ambient temperature: 45.6±2°C in Kuwait versus an average of 31.1°C in Yenagoa. Results of the present study are also consistent with the report of Castro-Sepulveda *et. al*., (2015) [10]: a higher level of proportion of subjects with dehydration (98%) amongst male Chilean football players prior training. However, Kurdak *et. al*., (2010) [18] reports lower levels of dehydration: 13.64% amongst male football players prior training. The higher proportion seen in the present study compared to the report by Kurdak *et. al.,* (2010) [18] may perhaps be due to a lower ambient temperature reported by Kurdak *et al*., (2010). Gibson *et. al.,* (2012) [19] found that 45.4% of young female footballers started training dehydrated despite the much lower ambient temperature in Canada of 9.8°C compared to the present study. In a recent study, Castro-Sepulveda *et. al.,* (2016) [20] also reports that 98.04% of female players were dehydrated prior training; much higher than the present study: perhaps differences in drinking habits may account for this variation.

The generally acceptable level of dehydration using percentage change in body weight should not exceed 2% of body weight. [21,22,23] The present study however reports a higher percentage change in body weight in all our study groups. A significant reduction in body weight following exercise which results possibly from dehydration could cause an increase in body temperature, cardiovascular strain and a reduced desire to continue training. [23] Shirreffs *et al*., (2005) [24], Gibson *et. al.,* (2012) [19] and Kurdak *et. al.,* (2010) [18], all reported much lower percentage change in body weight compared to the present study. Kurdak *et. al.,* (2010) [18] reported percentage dehydration of 2.2%, 2.2% and 2.6% on different occasions in male Turkish football players while Shirreffs *et al*., (2005) [24] reported a percentage of 1.6% amongst elite professional soccer players. Also, Gibson *et al*., 2012 [19] after evaluating female Canadian football players reported a percentage of 0.84±0.07%. The variations may be due to differences in fluid replacement protocols of the athletes since the atmospheric temperature in Kurdak *et. al.,* 2010 [18] and Shirreffs *et. al.,* [24] studies were higher than that of present study. However, the differences seen in Gibson *et. al.,* (2012) [19] study may be due to much lower temperature of 9.8°C versus that of present study 31.1°C.

5. Conclusion

Minimal dehydration is the prevalent hydration status before training amongst most professional football players involved in the study. This finding is a cause of concern on account of the potential to impair performance and endanger the health of both athletes and non-athletes. Football players therefore need to take more fluids before, during and after training to correct and prevent possible dehydration. In addition, players need to be educated on the importance of adequate fluid intake for optimum hydration and athletic performance.

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Statement of Competing Interest

The authors declare that there are no competing interests.

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