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RESEARCH ARTICLE

CHANGES IN HYDRO-ELECTROLYTIC PARAMETERS AMONG A BASKETBALL TEAM PLAYERS DURING THE 4th BENIN UNIVERSITY GAMES

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ABSTRACT

This prospective study has been undertaken to determine the extent of the hydro-electrolytic changes during the Benin University Games (BUG) among student basketball players of the National Institute of Youth, Physical Education and Sport. Body weight, the Urine Specific Gravity (USG), drunk water, the electrolytes (Na^+, K^+, Na/K ratio) of 10 student players (26.5 ± 5.8 years; 181.4 ± 8.3 cm; 75.0 ± 11.3 kg) have been measured before and at the end of the first, second, and fourth matches played for five days before 10: 00 a.m. The weight loss was around 1.8% for the first two matches and 2.2% for the fourth. Before the first match, six players were dehydrated (USG > 1.020) and at the end of the fourth one, they were seven. Urinary Na^+ decreased up to 42.8% at the end of the fourth match, as well as urinary K^+ whose value was four times lower at the end of the fourth match than that of the first. The weight loss was important in these student basketball players during their matches played outdoors in the morning. Since they were in majority dehydrated prior to the competition, they may benefit from a counsel program on hydration strategies during recovery, in order to reduce the risk of dehydration.

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INTRODUCTION

Basketball is a sport with high anaerobic component (Scalan *et al*., 2012), including a series of intermittent efforts. This sport mainly brings about intense efforts made up of short sprints, jumps, dribbles, moderate efforts including slow and brisk walking, resting periods marked by standing. These different actions occupy respectively 34.1%, 56.8% and to 9.0% of the overall playing time (Narazaki *et al*., 2009). Motion analysis revealed that during a match, a basketball player undertakes on average 1752 technical actions of relatively high intensity and covers more than 5 kms (Scalan *et al*., 2012). This type of effort carried out in 40 minutes, is associated with elevated water and electrolytes loss, because of great heat production by muscular metabolism. This causes an increase in body temperature (Vanuxem *et al*., 1990). An adult or an adolescent basketball player would have on average 1 to 4.6 L sweat loss and large amounts of electrolytes during a match played in moderate environment (Dougherty *et al*., 2006). During a match or a training session played in hot summer weather, during which the players rehydrate themselves *ad libitum*, they would respectively lose 0.9% to 1% of their body weight (Broad *et al*., 1996). The competitions are played indoors in the National Basketball Association (NBA), and a high proportion of players were reported to begin games dehydrated (Osterberg *et al*., 2009). Few data are available on the hydro-electrolytic movements in African basketball players practising in hot and humid climate which has potential noxious effects on the hydric status (Candas *et al*., 1983). Indeed, dehydration by body weight loss of about 1 to 2% is enough to compromise the body physiological functions and influence negatively sports performance (Casa *et al.* (2000). The rare data available in African athletes, related to electrolytic changes during a basketball match (Tonon *et al*., 2009) or those of body weight and fatty mass in soccer players (Sarr *et al*., 2007). The conclusions of such isolated studies are of limited range. In several African countries, most of basketball competitions are indeed organized in the form of a grouped tournament, each team playing three to six matches within a week. It appears thus, necessary to know the interactions between hydro-electrolytic loss and water consumption in players during such series of matches. That will allow testing the hypothesis of a cumulative effect of many consecutive matches' loads on these losses which may lead to increased risk of dehydration, even in

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nonprofessional players. Thus, this study aims at determining the extent of the hydro-electrolytic changes during four matches, played by student basketball players during the Benin University Games (BUG) in year 2013.

METHODS

Study design and settings: It was a prospective study carried out in Porto-Novo during the 4th BUG, with student basketball players of the National Institute of Youth, Physical Education and Sport (INJEPS). A week before the beginning of the BUG which had been held in May, all the players gave their written inform consent to take part in the study. On this occasion, they filled out a questionnaire to inform on their sport practice. Research was undertaken in accordance with the recommendations of Helsinki and was approved by the Sports Science Committee of the University of Abomey-Calavi, acting as Ethics Committee. Twenty minutes before warming up, at the end of the first, second and the fourth match played by INJEPS' team, anthropometric measurements and urine collections were made on each player. The exposure temperature was also measured, as well as relative humidity, the amount of water drunk by each player during the match.

Participants

The study was carried out with a non-probabilistic sample of the INJEPS' 10 basketball players, as requested by the rules of the BUG. These students intended to become physical education and sport teachers, had thus, a general-purpose physical practice (team sports, athletics, gymnastics, nautical sports, etc.) from 2 to 4 hours per day during 25 to 27 weeks by academic year. Moreover, they took part in four hours weekly basketball training sessions throughout the year. Since no player was injured during the competition, or under drug medication likely to influence his hydric status and urinary electrolytes excretion, all the data collected were processed.

Measurements

An electronic scale measuring at the nearest 0.1 kg, and a stadiometer graduated in cm, were used to measure respectively the weight and the height of the participants. The body mass index (BMI) was calculated according to the formula BMI (kg/m^2) = weight (kg)/height (m^2). Urine was collected into dry tubes by the players themselves, 20 minutes before warming up and at the end of each match. FT4 heart rate monitors (Polar, Finland) were used to measure the resting heart rate (HRr) in the players sitting quietly for at least 10 min. A portable refractometer A 300 (Atago, Tokyo, Japan) was used to determine the urine specific gravity (USG). Any player whose USG was higher than 1.020 was regarded as hypo-hydrated or dehydrated (Armstrong *et al*., 2010). The urinary Na^+ and K^+ concentrations were essayed with an Electrolyte Analyser CSB 300 (B & E Scientific Instrument CO, China) on 5 mL of urine samples, preserved at ambient temperature and the Na/K ratio was calculated. A multifunction portable apparatus Météo-Star (hygrometer, thermometer, and altimeter) was used to measure the exposure temperature and relative humidity. Individual 1.5 L bottles of water were given to each player, in order to measure the amount of water he drank during each match.

The basketball matches

The matches were played outdoors in the morning (between 8 and 10 a.m.), on a ground with synthetic coating, under an exposure temperature varying from 30 to 37.2 °C and relative humidity fluctuating between 40 and 50%. The playing time of each match was in accordance with the rules of the International Amateur Basketball Federation (FIBA), i.e. four quarters of 10 min, with a two-minute pause and a 15-minute half-time (FIBA, 2012).

Statistical analysis

The data were processed with the software Statistica of Stat Soft Inc. (version7.0). Descriptive statistics as mean value (m) ± standard deviation (s) were calculated for each variable. Taking into account the reduced size of the study sample, the analysis of variance (Anova) of Friedman was used to compare measurements at different times. The test of Wilcoxon was used to compare two measures, whenever Anova of Friedman was significant. The level of significance of the statistical tests was settled at $p < 0.05$.

RESULTS

Biometric characteristics of the players and match results

The studied players were on average 26.5 ± 5.8 years old, with respective mean height and weight of 181.4 ± 8.3 cm and 75.0 ± 11.3 kg. They had a mean HRr of 63 ± 11 bpm at the beginning of the competition and have been practising basketball for 7 to 20 years. The INJEPS' team was the fifth among the 10 teams which participated in the JUB, by winning two matches (2nd and 4th) and losing the two others (1st and 3rd) which were more constraining physically.

Changes in weight and hydric parameters

Body weight decreased on average by 1.8% during the first two matches ($p = 0.004$) and by 2.2% between the first match and the fourth ($p = 0.026$). USG on the other hand increased non-significantly from 1.023 ± 0.008 to 1.027 ± 0.005 ($p > 0.05$) between the beginning of the first match and the end of the fourth (table 1). Before the first match, six players out of 10 were hypo- hydrated or dehydrated (USG > 1.020). They were respectively eight and seven in the case at the end of the second and the fourth matches. The players of this team drank respectively on average 2050 ± 437 mL, 2150 ± 474 mL and 1750 ± 263 mL of water during the three matches concerned with this study (Table 1).

Changes in urinary electrolytes

As the competition advanced, Na^+ was less and less excreted (Table 1), from -14.2% at the end of the first match, to -42.8% at the end of the fourth ($p = 0.046$). At the end of the 2nd and the 4th match, the decrease in urinary K^+ was four times higher than that recorded after the first, i.e. respectively -64.3% *versus* -14.8%, ($p = 0.036$) and -59.6% *versus* -14.8% ($p = 0.052$). Between the end of the 1st match and the beginning of the 2nd, an important reduction of urinary K^+ was observed ($p = 0.005$). The Na/K ratio dropped only by -5.5% at the end of the second match, whereas the reduction was more important after the first match (38.8%) and the fourth one (36.1%).

Table 1. Modifications of hydro-electrolytic parameters in basketball players during a tournament Benin (n = 10)

	M1	M2	M3	M4	M5	M6
Weight (kg)	75.0 ± 11.3	73.6 ± 10.9*	74.3 ± 10.9	73.6 ± 10.7*‡	74.1 ± 10.9	73.3 ± 10.9*‡
% Weight	- 1.8		- 1.8		- 2.2	
USG	1.023 ± 0.008	1.026 ± 0.006	1.025 ± 0.007	1.026 ± 0.007	1.023 ± 0.006	1.027 ± 0.005
Hypo-hydrated	6 (60)	7 (70)	8 (80)	8 (80)	6 (60)	7 (70)
Water drunk (mL)	2050 ± 437		2150 ± 474		1500 ± 235*†	
Na^+ (meq.L)	124.0 ± 77.3	106.3 ± 52.6	98.9 ± 59.3	86.3 ± 38.7	87.4 ± 40.6	70.9 ± 29.6*
K^+(meq.L)	83.0 ± 102.5	70.6 ± 72.2	21.4 ± 12.0†	29.6 ± 17.1†	32.7 ± 18.2‡	33.5 ± 12.4‡
Na/K	3.6 ± 3.3	2.21 ± 1.3	4.7 ± 1.9†	3.4 ± 1.6†	3.3 ± 1.9	2.3 ± 1.1‡

Numbers in the cases are mean values ± standard deviations; hypo-hydrated: players who's USG were > 1.020 g/mL; numbers in parentheses are percentages (%) preceded by absolute frequencies; water drunk: it is the average amount of water, drunk by players during each experimental match; M1: before the first match; M2: at the end of the first match; M3: before the second match; M4: at the end of the second match; M5: before the fourth match; M6: at the end of the fourth match; Na^+: sodium; K^+: potassium; Na/K: sodium to potassium ratio; *: difference with M1, significant at $p < 0.05$; †: difference with M2, significant at $p < 0.01$; ‡: difference with M3, significant at $p < 0.05$.

DISCUSSION

This study has been undertaken to determine in student basketball players, the extent of the changes observed in the hydro-electrolytic parameters during a series of four matches played outdoors for five days, under the subtropical climate.

Changes in body weight and hydric parameters

The decrease of 1.8% in body weight, observed at the end of the first match persisted all along the competition, in spite of an average water consumption of 1.9 L per match which, one can regard as sufficient in the context of this tournament. Relatively smaller amount of drinks (between 1 and 1.5 L) were reported in NBA basketball players (Osterberg *et al*., 2009) and soccer players practising in a hot and humid climate (Kurdak *et al*., 2010). The fact that the number of dehydrated players increased during the competition in spite of a theoretically sufficient rehydration during the matches, suggests that the players in question have an insufficient level of rehydration between two matches, i.e. in the recovery-period. This hypothesis is supported by the fact that at rest and prior to the first match, more than a half of the players was already dehydrated. One might also suppose that the players did not take care to improve their hydric status before beginning the competition (American College of Sports Medicine, 1996; Greenleaf and Castle, 1971; Moroff and Bass, 1965).

If it is true that the players of this study drank sufficient water during matches, it is as well true that they seem to be unaware that drinking while exercising compensate for less than a half of the water and electrolytes loss (Osterberg *et al*., 2009; Broad *et al*., 1996). They also seem to be unaware that it is recommended to go on rehydrating early during the recovery period (Casa *et al.* (2000). The consequences of body weight loss by sudation and the high level of dehydration recorded in this study are the decrease in performance capacity (Armstrong *et al*., 1985) and an increased risk of hyperthermia in players (Vanuxem *et al*., 1990). Under these conditions, the measurement of the core temperature and the assessment of the physiological thermal strain (Moran *et al*., 1998) would have permitted to better take account for the physiological impact of the loads imposed by this series of match, played 24 hours apart. The data collected confirm those of Sarr *et al*. (2007), who noted that body weight loss was recovered 38 hours after the first of a series of two matches in Senegalese soccer players. It is however reasonable to think that several very closer consecutive matches can lead to a cumulative effect and cause an incomplete body weight recovery.

Changes in electrolytic parameters

Concerning the electrolytes, the resting data recorded range within the normal values, since the urinary Na^+ concentration for example, closed to 130 mEq/L (American College of Sports Medicine, 2006). The decrease in urinary Na^+ at the end of the first match is an awaited phenomenon, since even a maximum exercise carried out under moderate climate can induce a decrease in this electrolyte by 10 – 20% of the resting value (Freund *et al*., 1991). As the competition goes on, the urinary Na^+ dropped, probably under the combined effect of several factors. It can compromise the body hydro-mineral balance, particularly in the extracellular compartment, of which Na^+ concentration determines the tonicity. The first factor likely to explain this cumulative effect (from -14.2% at the end of the 1st match to -42.8% at the end of the 4th), can be related to the relatively high Na^+ loss by sudation, caused by match playing in the hot and humid environment. This loss recorded during the intense effort would cause by reflex, the reabsorption of Na^+ by the proximal renal tubules (American College of Sports Medicine, 2006). The decrease in the Glomerular Filtration Rate (GFR) is one of the main factors contributing to Na+ conservation during exercise, but it cannot explain solely the reduction of the urinary Na^+ recorded in our series (Castenfors, 1977). The Na^+ loss would stimulate in a more increased manner, the renin-angiotensin II-aldosterone system, particularly the Renal Sympathetic Nerve Activity (RSNA), in order to accentuate the tubular reabsorption of Na^+ (Zambraski, 1996).

The second factor is probably an insufficient hydro-electrolytic compensation between two matches played only 24 hours apart. Compared to animals like dogs, men are slow hydrators and often rehydrate in two phases after an intense exercise. During the first three hours, thirst and dry mouth will lead exercisers to drink, but only 60-70% of the water loss will be compensated. Thereafter, the rate of rehydration will be determined by the specific properties of the drinks, like the temperature and the taste. The latter induces the variation of the amount of drinks, according to the cultural preferences and practices (Hubbard *et al*., 1984). It will consequently be necessary to plan how to compensate for the hydro-electrolytic loss in the different liquid compartments, whose respective deficits contribute to delay rehydration. The Na+ supply with dietary intake, even a supplementation in the cases of marked deficit, could be considered. The urinary K^+ which decreased at the end of the 1st match was awaited, since the INJEPS' players won and had been tested physically. The assessment of the electrolytes in sweat, using the technique purposed by Osterbertg *et al*. (2009), would have allowed establishing in this study, the correlation between the hydro-electrolytic loss by sudation in match and the posterior urinary excretion. It should be noted that under the same environmental conditions, Tonon *et al*. (2009) reported after a female basketball match, a decrease in the urinary K^+ of the winning team. The fact that the urinary Na^+ gradually decreased in this study and that the urinary K^+ was four times higher at the end of the 1st match than at the 2nd and the 4th, express a cumulative effect of the repeated match-efforts on the mechanism of electrolytic reabsorption. The more marked intervention of the mineralocorticoid activity by a high secretion of aldosterone (Frey *et al*., 2001) is certainly associated with the weak concentration of the urinary electrolytes recorded throughout the competition. The important decrease in the Na/K ratio considered as a marker of this activity, observed between the end of the 1st match and the beginning of the 2nd, most probably gives an account to a high secretion of aldosterone. From a practical point of view, these first results recorded during a grouped competition of basketball played in the subtropical African environment, can be used to draw the attention of the players of Benin to: 1) the risks to which they are exposed during this kind of tournament; **2)** the need for having an adequate hydration, before, during and after a training session or a match; **3)** the possibility of consuming much foods rich in Na^+ and K^+ like fruits (banana, pineapple, lemon), green vegetables (leaves of *Moringa* oleifera, cassava, etc.), biscuits, in the situations of repeated water and electrolyte loss during efforts made in hot and humid environments.

Conclusion

The basketball tournament integrated in the 4th BUG was used to test the following hypothesis: the physical loads associated with the consecutive matches played, exert a cumulative effect on the weight loss, increasing thus, the risk of dehydration in the student players. At the end of the study, it appeared that the weight loss by sudation was high in the studied players during the matches, which they played outdoors in the morning. The high decrease in the urinary electrolyte concentrations at the end of the competition, testifies in these basketball players, of a good renal response to the physical loads associated with the matches. Since most of these players were dehydrated prior to the competition, the need to benefit from a program of counsels on rehydration strategies in recovery periods, to reduce the risk of dehydration.

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REFERENCES

American College of Sports Medecine. 1996. Position stand: Exercise and fluid replacement. *Med Sci Sports Exerc*., 28(1): i-vii.

American College of Sports Medicine. 2006. Advanced exercise physiology. Philadelphia. Lippincott Williams and Wilkins. pp 508-524.

Armstrong, L.E., Costill, D.L. and Fink, W.J. 1985. Influence of diuretic-induced dehydration on competitive running performance. *Med Sci Sports Exerc*., 17; 456-461.

Armstrong, L.E., Pumerantz, A.C., Fiala, K.A., Roti, M.W., Kavouras, S.A., Casa, D.J. and Maresh, CM. 2010. Human hydration indices: acute and longitudinal reference values. *Int J Sport Nutr Exerc Metab*., 20: 145-153.

Broad, E.M., Burke, L.M., Cox GR Heeley, P. and Riley, M. 1996. Body weight changes and voluntary fluid intakes during training and competition sessions in team sports. *Int J Sport Nutr*., 6: 307-320.

Candas, V., Libert, J. P. and Vogt, J.J. 1983. Sweating sweat decline of resting men in hot humid environments. *Eur J Appl Physiol*., 50: 223-234.

Casa, D.J., Armstrong, L.E., Hillman, S.K., Montain, S.J., Reiff, R.V., Rich Brent, S.E., Roberts, W. and Stone, J.A. 2000. National Athletic Trainers' Association Position Statement: Fluid Replacement for Athletes. *J Athl Train*., 35(2): 212-224.

Casa, D.J., Armstrong, L.E., Hillman, S.K., Montain, S.J., Reiff, R.V., Rich, B.S.E., Roberts, W.O. and Stone, J.A. 2000. National Athletic trainers' Association position statement: fluid replacement for athletes. *J Athl Training*, 35(2): 212-224.

Castenfors J. 1977. Renal function during prolonged exercise. *Ann NY Acad Sci*., 301: 151-159.

Dougherty, K.A., Baker, L.B., Chow, M. and Kenney, W.L. 2006. Two percent dehydration impairs and six percent carbohydrate drink improves boys basketball skills. *Med Sci Sports Exerc*., 38(9): 1650-1658.

Freund, B.J., Shizuru, E.M., Hashiro, G.M. and Claybaugh, J.R. 1991. Hormonal, electrolyte and renal response to exercise are intensity dependent. *J Appl Physiol*., 70: 900-906.

Frey, J., Daudon, M., Raby, N., Augereau, C., Dechaux, M., Diehl, J.L., Sicallac, P. and Bonneau, C. 2001. Valeur sémiologique des paramètres biochimiques urinaires. *Ann Biol Clin*., 59: 13-25.

Greenleaf, J.E. and Castle, B.L. 1971. Exercise temperature regulation in man hypohydration and hyperhydration. *J Appl Physiol*., 30: 847-853.

Hubbard, R.W., Sandick, B.L., Matthew, W.T., Francesconi R.P., Sampson, J.B., Durkot, M. J., Maller, O. and Engell, D.B. 1984. Voluntary dehydration and alliesthesia for water. *J Appl Physiol*., 57: 868-873.

Kurdak, S.S., Shirreffs, S.M., Maughan, R.J., Ozgünen, K.T., Zeren, Ç., Korkmaz, S., Yazici, Z., Ersöz, G., Binnet, M.S. and Dvorak, J. 2010. Hydration and sweating responses to hot-weather football competition. *Scand J Med Sci Sports*., 20: 133-139.

Moran, D.S., Shitzer, A. and Pandolf, K.B. 1998. A physiological strain index to evaluate heat stress. *Am J Physiol Regul Integr Comp Physiol*., 275(1 Pt 2): R129-134.

Moroff, S.V. and Bass, D.B. 1965. Effect of over hydration on man's physiological responses to work in the heat. *J Appl Physiol*., 20: 267-270.

Murray, B. 2007. hydration and physical performance**.** *J A C Nutr*. 26(5): 542S-548S

Narazaki, K., Berg, K., Stergiou, N. and Chen, B. 2009. Physiological demands of competitive basketball. *Scand J Med Sci Sports*., 19(3):425-432.

Osterberg, K.L., Horswill, C.A. and Baker, L.B. 2009. Pregame urine specific gravity and fluid intake in National Basketball Association players during competition. *J Athl Train*., 44(1): 53-57.

Sarr, M., Mandengue, S.H., Sarr, F.B., Ba, A., Cissé, F., Gueye, L. and Samb, A. 2007. Récupération des pertes pondérales et de masse grasse chez des footballeurs au cours d'une série de matchs en milieu chaud. Cinésiologie., 231: 21-23.

Scanlan, A.T., Dascombe, B.J., Reaburn, P. and Dalbo, V.J. 2012. The physiological and activity demands experienced by Australian female basketball players during competition. *J Sci Med Sport*., 15(4): 341-347.

Tonon, B.A., Gouthon, P., Falola, J-M., Bio Nigan, I., Ouendo, E-M., Dansou, H.P. and Agboton, H. 2009. Modifications électrolytiques chez des basketteuses après un mach en milieu africain subsaharien. *Rev CAMES*., 08: 97-102.

Vanuxem, P., Fornaris, E., Makhtar, N., Amrani, N. and Commandre, F. 1990. Les problèmes liés à la thermorégulation chez le sportif. Médecine d'Afrique Noire., 37(11): 686-688.

Zambraski, E.J. 1996. The kidney and body fluid balance during exercise. In Buskirk E, Puhl S, eds. Body fluid balance. *Exercise and Sports*. New York: CRC, 75-95.

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