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Physiological and hormonal data of soccer during a Tough Match in Hot and Humid Environment

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Abstract: *The present study aims was to evaluate the physiological and hormonal match parameters of elite soccer in a warm and humid environment. Hormonal parameters were evaluated before and after football match in a hot and humid environment. Physiological parameters were taken during the match. It is of heart rate, water loss and energy expenditure. The hormonal parameters were stress hormones and hydrominerals. The physiological data indicates a decrease in intensity of play during the match in a warm environment. A water loss more than 3% was noticed despite the amount of water consumed by soccer during the match. A decrease in blood cortisol levels was observed while catecholamines increased at the end of the match. Hydromineral hormones involved in physical exercise, indicated an increase in aldosterone and antidiuretic hormone values at the end of the match. The results show the importance to evaluate physiological and hormonal match data of footballers for hight performance.*

Key Words: *hot and humid environment - physiological hormonal – parameters.*

1. INTRODUCTION :

Football is characterized by long-lasting efforts of varying intensity. These efforts are interspersed with periods of incomplete recovery. In hot environment, water loss caused antidiuretic and stress hormones stimulation (1). Ineffective adaptation of the body to exercise in heat can lead to significant weakness or even death from heat stroke (2). Endurance exercise in a hot environment induces pronounced catecholamine and cortisol, as well as anti-inflammatory responses that influence tissue damage (3). Moreover, hormones are most often the mediators of these coordinated and adapted responses. The body's response does not stop at the end of physical exercise (4). The recovery phase of muscular exercise also represents a dynamic phase on the hormonal and metabolic level. During this phase, organism moves towards the reconstitution of energy reserves. A renal disturbance was observed during two match of football in West Africa (5). Footballers must rigorously rehydrate before, during and after each match to compensate for water loss in the body. A recent study carried out on the variability of heart rate and hormones on the evaluation of the acclimatization state of athletes showed that short-term acclimatization to heat was characterized by early reductions in heart rate, cortisol and an increase in epinephrine (6). The study conducted by on environmental impact and physiological mechanisms. Sawka et al (7) showed that physiological changes induced by exercise in hot environments result in hypohydration highter than 2% of body mass. This water loss impairs aerobic performance when body temperature exceeds 27°C in a warm environment.

In elite sport, the repetition of intense training sessions followed by short periods of recovery lead to an increase in energy expenditure and simulate the new metabolic pathways and variations in hormonal levels and other biochemical parameters (8). As a result, individualized and permanent medical follow-up is necessary to maintain, preserve or improve the state of health of athletes in order to perform under optimal conditions. Physiological, biological, biomechanical, psychological and nutritional care contributes to optimizing the athlete's performance and to the early detection of possible health problems. It requires the intervention of a multidisciplinary team that can help the coach optimize his training plan (9). In most developing countries, particularly those in sub-Saharan Africa,

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biological monitoring of athletes is non-existent. The interest of this study is to evaluate the physiological and hormonal parameters of elite footballers in a hot and humid environment.

2. MATERIALS AND METHODS :

2.1. Study population and sampling

A football team was selected by a non-random method among the top five in the Congolese elite national football championship. 12 footballers aged 27.00 ± 0.58 years with a body mass index of 22.46 ± 1.25 kg/m2 was selected to participate in the study. The participants had any known neurological or cardiovascular diseases. All participants were elite players who had been participating in the national elite football championship for more than 2 years and residing in the Republic of Congo. Soccer who were absent during the various blood collection phases, those taking medication, smokers, and those with traumatism were excluded from the sample.

2.2. METHODS :

Experimental Protocol

Data collection was conducted in three phases during the day at the beginning of the winter break of the senior elite national championship. In the first phase, rest blood is collected. The second phase was an experimental match during the winter period. The blood is collected in tle third phase after match. The match took place during the day, at an ambient temperature of 38°C, a relative humidity of 50% and a wind speed of 3000km/h during the great rainy season. Cortisol, catecholamines, aldosterone and antidiuretic hormone were measured. The players were allowed to drink according to their thirst during stoppages of play and during the extra break allowed due to the heat. The activity profile during the game was assessed using a Garmin Forerunner R15 Quick Start accelerometer (USA). It provided the effort heart rate, energy expenditure and total distance traveled during the match. The match intensity was 60.78% of the average heart rate of the footballers. In this study, we determined the percentage of fluid loss by weighing the players before and at the end of the match semi-naked (with underwear on) using an impedance meter (TANITA Corporation BC-545N, JAPAN) (10 ; 11). The amount of water scored during the match and at warm-up was accounted for using the mineral water bottles labelled for each player. The blood is collected before and after match.
This investigation was approved by the scientific committee of University Marien Ngouabi (Brazzaville) and was conducted according to ethical recommendations in accordance with the revised Declaration of Helsinki (2008).

3. STATISTICAL ANALYSIS :

Wilcoxon test was used to compare the values of hormonal parameters taken before and after match. The statistical analysis of the data was made possible by the statistical software SPSS IBM (version 22.0, SPSS Inc., Illinois, USA). The level of significance is considered at $p < 0.05$.

4. RESULTS :

The mean values of the physiological parameters were 160.4 ± 3.43 bpm for exercise heart rate and 794.80 ± 0.11kcal for energy expenditure. During the match, the average values of physical performance were 7.88 ± 0.44 km for the total distance and 60.78% for match intensity (table 1).

Table 1 : Physiological parameters and intensity of match

Parameters	Topics (N = 12)
AW (L)	2.00 ± 0.29
EE (Kcal)	794.80 ± 0.11
D (km)	7.88 ± 0.44
EHR (bpm)	160.4 ± 3.43
%FC	60.78 ±1.82
WL (%)	3.33 ± 0.36

AW : Amount of water; DE : Energy Expenditure ; D : Distance ; EHR : Exercise heart rate ; %FC : match intensity ; WL = water loss

These results show a positive variation of catecholamine after match with a significant difference at p = 0.116 and p = 0.028 respectively. A decrease in cortisol values was obtained one hour after match with a significant difference at p = 0.028 (figure 1).

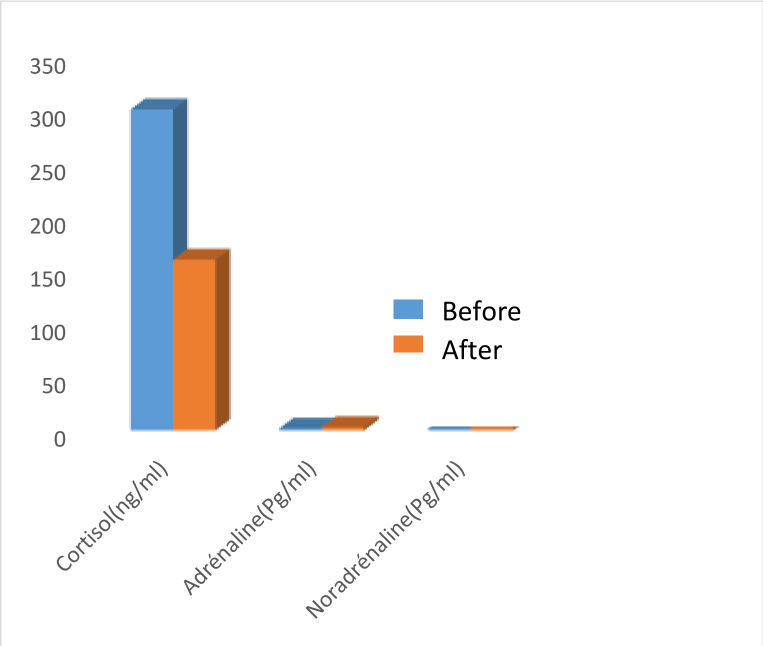

Figure 1 : Stress hormones variation during the match

The DHA increased by 5.14 Pg/ml after match with a significant difference at p = 0.028. The average Aldosterone values of footballers were 140.16 ± 1.50 Pg/ml before match and 111.33 ± 1.50 Pg/ml after match. Aldosterone increased by 28.83 Pg/ml after match with a significant difference at p = 0.027 (figure 2).

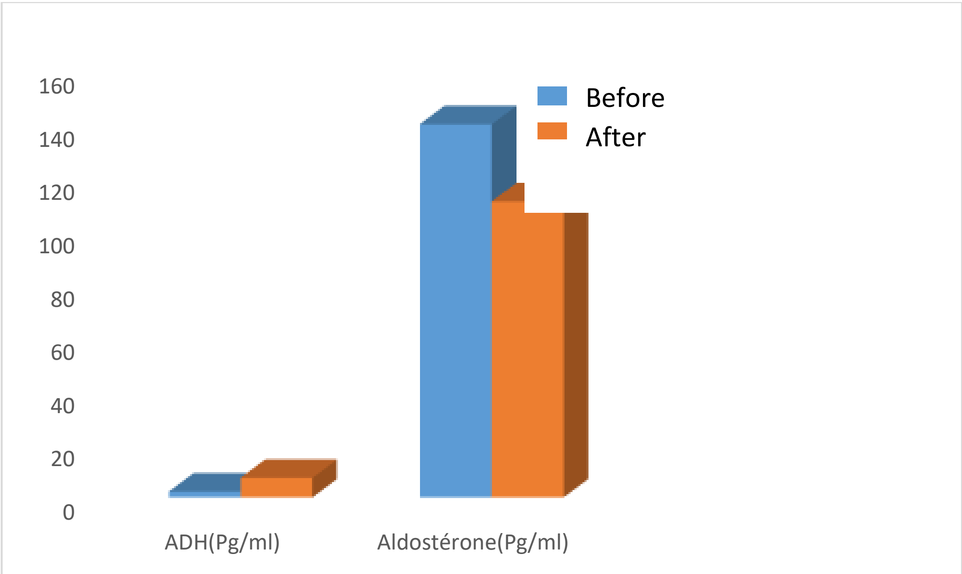

Figure 2: Aldosterone variation during the match

5. DISCUSSION :

The study carried out during the winter break in April 2019. The match took place at 2pm under a temperature of 38°C and a relative humidity of 50%. The high thermal stress did not allow the soccer to have a high intensity of the match. These results corroborate those of Bazaba et al (12), which evaluate water loss of soccer in a hot and humid environment. High water loss in soccer resulted in a decrease in match intensity. Exercise-induced low hydratation resulted in increased plasma volume reduction (10 ; 13). When body temperature increases during exercise, it increases the rate of dehydration (14). In aggressive conditions, the athlete's body is faced with a problem of arterial blood flow, which must deliver oxygen to active muscles, while skin blood flow must also be increased to maintain core body temperature by increasing sweating. A competition takes place between these two major needs: that of motor performance and that of central thermal regulation. Normally, in order to avoid fatal hyperthermia, the need for thermal regulation takes precedence, which explains the collapse of performance by lowering muscle blood flow (15).

Moreover, dehydration alone does not justify this drop in intensity of the match. Other factors are associated, in particular the disruption of stress-related hormones and those involved in the hydromineral balance. The progressive drop in cortisol levels one hour after the match in a hot environment indicate an adaptive mechanism of the body to recovery for the reconstitution of energy reserves (16). According to Hoffman al (17), changes in cortisol concentration after exercise appear to be affected by several mechanisms. These include stimulation of the sympathetic nervous system, an increase in body temperature and lactate accumulation. The results are accoording with those obtained by these authors. A study conducted on blood cortisol concentration in male cyclists showed that cortisol levels are higher in the morning than in the evening (18). They considered the adrenal cortex response in men as necessary with positive effects in adaptation to stress (19). In this study, we also measured catecholamines before and after match in order to identify their effect on physical performance during match in warm environment. The results obtained show an increase in catecholamines at the end of match with a significant difference. During physical exercise, catecholamines induce physiological changes in the body, including an increase in heart rate (20). Some authors do not find any difference between the values before and after physical exercise of catecholamines (21). On the other hand, others observed a decrease in basal noradrenaline values during exercise. Several methodological factors may help to explain the discrepancies in the results, such as the timing of blood sampling and the intensity of exercise (22). According to Kraemer et al (23), catecholamines are elevated when blood is drawn immediately at the end of exercise. The high concentrations of catecholamines measured at the end of the match lead to a significant increase in the physiological stress responsible for the decrease in intensity (24). In this study, adrenaline and norepinephrine values increased significantly and a decrease in match intensity was also observed (25). In addition, there was an alteration of the aerobic energy system during the match. These results are also according with the study showing that a decrease in match intensity is accompanied by a slight decrease in the contribution of the aerobic energy system especially (26).

In addition, the hormones involved in hydromineral balance were measured before and after football match in order to understand renal function during the match. The results show an increase in vasopressin values and a decrease in aldosterone after match in hot and humid environment with a significant difference. The antidiuretic hormone (ADH), also called vasopressin, is involved in the reabsorption of water by the body. This hormone plays a important role in regulating blood volume and water concentration in the body. The increase in vasopressin and aldosterone observed in this study can be explained by a high water loss in players of more than 3%. This results in reduced blood flow to many organs (27). The reduction in renal blood flow induces transitory dysfunction in the kidney (28). Our results are corroborate those of the literature (29 ; 30).

6. CONCLUSION:

Cortisol and catecholamines varied positively during the match in the heat. The secretion of these hormones is naturally linked to thermal and physiological stress. This stress which is felt by the footballer before the match can be incriminated in the determination and commitment of the footballer to achieve a good performance. The antidiuretic hormone and aldosterone, hormones of the hydromineral balance, also experienced a transitory disruption. These results provide a better understanding, from physiological and hormonal mechanisms responsible for the decrease in the performance of footballers in hot environment.

Conflict of Interest: None
Contribution of the authors
Realization of the study: JM. BAZABA KAYILOU, Judith F. AHOUNOU AÏKPE
Statistical analysis: H. B. AKAKPO, L.M. KOTIN
Writing of article: JM. BAZABA KAYILOU, Judith F. AHOUNOU AÏKPE
Supervision: Joachim D. GBENOU and Pierre H. DANSOU

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