The effect of high temperature climate on the hydration status of the Sudanese top league football players

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Abstract:

The study aimed at identifying the effect of high temperature climate on the hydration status of the Sudanese top league football players. A descriptive approach was used , and the study sample included 50 of the Sudanese top league football players who were randomly selected. Questionnaires were used for data collection. Important results were that 60% of the players didn't drink plenty of fluids one day ahead of the match, and 46% didn't drink during exercise, and also 54% didn't have instructions to drink plenty of fluids before the exercise, and also only 20% of the players were weighed by the coach before and after exercises. Moreover it was also found that only 10% of the players used rehydrating fluids during exercise. And finally reduced urine volume was the most common symptom of dehydration, since 92% of the players had it.

Important recommendations were: To raise awareness about the importance of proper hydration among the players, the staff, and others who are responsible for them, To implement the FIFA instructions regarding playing in hot climates, that is to pause a match allowing time for fluid replacement and rehydration, and finally to use this study for future visions along with other studies concerning hydrations and hot climates, with special regards that the football world cup 2022 is going to be in Qatar.

Introduction:

When players work hard, they lose sweat – in a game on a hot day, sweat losses may reach 3 liters. On a cold day though, some players will lose very little sweat. Every player's hydration needs are different and will vary with the weather over the season. Just as general training and competition strategies should be tailored for individual athletes in accordance with their unique needs and preferences, so should their drinking and eating choices during exercise.

Players should limit dehydration during training and matches by drinking water or a sports drink. Obvious opportunities to drink during a match include warm-up and at half time. During training, the coach or manager should organize drink breaks according to the weather and intensity of the session.(1)

Justification:

The researchers had found that it was necessary to focus on this topic, since the Sudanese top league football season was running during summer, in which a high temperature weather that reaches above 35^{o}C, this in turns lead to consumption of water to replace the sweat and other losses . The researchers also noticed that there was poor attention to rehydration among the clubs, which led to the inappropriate handling of the losses, this in turns causes negative physiological effects, this affect the training programs for the players. Also since the FIFA had instructed all the football associations to stop the match so as to replace the losses with the fluids in the high temperature weather that is above 32^{o}C, so it was of paramount important to do this study and to raise the suggestions to the Sudanese top league football association.

Objectives:

To identify the effect of high temperature on the hydration status of the Sudanese top league football players.

Question of the study:

What are the effect of high temperature whether on the hydration status of the Sudanese top league football players?

Literature review:

Water is the most important nutrient for your body. On average, the human body is 60 percent water by weight, depending on certain factors such as age, gender, and body weight. The average 70 kilogram (kg) (154 lb.) man is made up of 42 liters (l) (or ~11 gallons) of water while the average 55-kg (121 lb.) adult female is made up of 27.5 l (~7.2 gallons) of water.(2)

It performs numerous important biological functions in the body. First, at the cellular level, it provides structural firmness.1 Second, water makes up blood, lymph, gastric secretions, and urine. It helps lubricate our joints (synovial fluid), which allows bones to move freely against each other.(3)

Training allows opportunities for players to get a feel for sweat rates and fluid needs so that drink practices can be adjusted accordingly. It is not necessary to drink enough to match sweat loss, but the amount of dehydration should normally be limited to a loss of less than about 2% of body weight (i.e., 1.0 kg for 50 kg person, 1.5 kg for a 75 kg person, and 2 kg for a 100 kg person). The negative effects of dehydration on high intensity performance are greater in warm environment so drinking practices in these conditions should be upgraded to reduce the overall fluid deficit. This may include drinking at the side-line when match play is interrupted, or having extra drink breaks during training sessions. There should never be a need to drink more than the sweat loss so that weight is gained during exercise. This will not help performance and is likely to cause gut discomfort.(1)

Depletion of fuel stores can be an issue for football matches, especially for players in mobile positions or with a running game style. Rehydration after exercise and recovery after exercise is part of the preparation for the next exercise session, and replacement of sweat losses is an essential part of this process. Both water and salts lost in sweat must be replaced. Aim to drink about 1.2-1.5 liters of fluid for each kg of weight lost in training or matches. Drinks should contain sodium (the main salt lost in sweat) if no food is eaten at this time, but most meals will contain adequate amounts of salt. Sports drinks that contain electrolytes can be helpful, but many foods can also supply the salt that is needed. A little extra salt may be added to meals when sweat losses are high, but salt tablets should be used with caution. (1)

When working hard, the body produces heat at high rates, causing its temperature to increase. A small rise in body temperature may be beneficial, but if it increases by more than about 2-3°C, performance is likely to suffer and there is a real risk of developing heat illness. Evaporation of sweat from the skin surface is the body's most effective way of losing heat, but we can also lose heat to the environment by physical transfer provided the skin is hotter than the environment.. When the temperature is high, we need to sweat more as we gain heat from the environment. High sweat rates over prolonged periods lead to large water losses and to some loss of salts. When the humidity is also high, the sweat cannot evaporate from the skin; it drips from the skin so no heat is lost, but we continue to sweat and so water and salts are lost at high rates.(1)

During exercise, evaporation is usually the primary mechanism of heat dissipation. The evaporation of sweat from the skin's surface assists the body in regulating core temperature. If the body cannot adequately evaporate sweat from the skin’s surface, core temperature rises rapidly. A side effect of sweating is the loss of valuable fluids from the finite reservoir within the body, the rate being related to exercise intensity, individual differences, environmental conditions, acclimatization state, clothing, and baseline hydration status. Athletes whose sweat loss exceeds fluid intake become dehydrated during activity. Therefore, a person with a high sweat rate who undertakes intense exercise in a hot, humid environment can rapidly become dehydrated. Dehydration of 1% to 2% of body weight begins to compromise physiologic function and negatively influence performance. Dehydration of greater than 3% of body weight further disturbs physiologic function and increases an athlete’s risk of developing an exertional heat illness (i.e., heat cramps, heat exhaustion, or heat stroke). This level of dehydration is common in sports; it can be elicited in just an hour of exercise or even more rapidly if the athlete enters the exercise session dehydrated. The onset of significant dehydration is preventable, or at least modifiable, when hydration protocols are followed to assure all athletes the most productive and the safest athletic, experience.(4)

Even a mild deficit of water can have a substantial impact on well-being, exercise performance, and attentiveness. Defined, dehydration is the loss of body water and important ions (blood salts like potassium and magnesium). It simply means your body doesn’t have as much water and electrolytes as it should have, which interferes with normal body processes.(5)

It’s easy to become dehydrated, and you don’t have to run a marathon to become dehydrated. Each day you lose approximately two to two-and-a-half cups (450 to 600 ml) of water just going about your usual activities, so it is important to replace fluid losses throughout the day. Coffee, tea, and sodas are not an ideal choice. These beverages have a diuretic effect (*i.e.,* trigger water loss) and actually *increase* your daily fluid requirement. The current RDA for water for adults at rest under average conditions of environmental exposure is 1 ml/kcal of energy expenditure.(5)

No discussion of dehydration would be complete without an explanation of electrolytes and their respective functions. Most people, when asked, aren’t sure what electrolytes are or why they’re so important in preventing dehydration.

Electrolytes are certain minerals (*i.e.,* calcium, chloride, magnesium, potassium, sodium ions) essential to human health. As an essential mineral, an electrolyte cannot be substituted by any other nutrient in the diet. That means that your body will only accept that particular mineral or electrolyte.

Without electrolytes, you could not move, think, or live. Within the body, electrolytes are dissolved in body fluids. In terms of hydration, electrolytes are responsible for directing water (and nutrients) to the areas of the body where its needed most and maintaining optimal fluid balance inside the cells. Besides maintaining fluid balance, electrolytes help your muscles to contract and relax and assist in the transmission of nerve impulses from your nervous system to different body parts. studies show that repletion of one important electrolyte—magnesium—has a significant impact on athletic performance. Moderately trained athletes who took magnesium supplements showed decreased blood pressure, heart rate, and oxygen intake. Triathletes supplementing with extra magnesium demonstrated improved cycling, swimming, and running times.[(6)]

A balance of all electrolytes is necessary to maintain optimal hydration and endurance. Not only do you lose sodium in sweat, but you also lose other critical electrolytes like magnesium, and since most people don't get enough magnesium, serious deficits can be occurring.

The bottom line is don't count on plain water and sports drinks to meet your body's hydration and electrolyte needs. Plain water (including bottled "mineral waters") doesn't contain a substantial quantity or balance of the essential electrolytes you require to stay adequately hydrated, replace electrolytes lost in sweat, and maintain optimum performance. As for sports drinks, the high-sugar content of most of these beverages often causes bloating, stomach cramps, and can impair your hard-fought training and performance at the moment when it may matter the most.[(7)]

Athletes performing high-intensity exercise in the heat commonly have sweat rates of 1.0–2.5 L/hour, but sweat rates of >2.5 L/hour are not unusual when the ambient temperature is high.[(8)]

As a result sweat is hypotonic compared to plasma and sweat sodium concentration typically ranges from 10 to 70 mmol/L, whereas that of chloride ranges from 5 to 60 mmol/L, depending on diet, sweat rate and degree of heat acclimatisation.[(9)]

Factors Influencing Thermoregulation:

a. **The Environment:** Heat loss by radiation and convection depends on the maintenance of a large temperature gradient between the skin and the surrounding air. When the temperature of the air exceeds 36°C, the gradient for heat exchange is reversed and the body now gains heat by radiation and convection instead of losing it. Heat loss by evaporation of sweat then becomes the primary means of heat dissipation. As sweat can only be effective for cooling if it evaporates, the potential for evaporative heat loss is determined by the water vapour pressure gradient between the skin and the environment and the movement of the air over the skin. This means that when the relative humidity in the air is low (dry air), sweat will evaporate relatively fast. On the other hand, if the relative humidity of the surrounding air is high, the evaporation of sweat will be hindered and sweat will accumulate with little loss of body heat.(10)

Therefore, exercise in a hot humid environment may require levels of evaporative heat loss that exceeds the capacities of the environment to accommodates more water vapor, resulting in a critical heat load that limits further exercise and increases the risk of developing heat illness.(11)

b. **Dehydration:** When sweating becomes the primary mean of heat dissipation, sweat loss must be matched by fluid consumption to avoid dehydration. This is often difficult because the stimulus to drink is not initiated until an individual has incurred a water deficit of approximately 2% of body mass.(12)

Mild Dehydration(13)

The symptoms of mild dehydration are as follows:

• Dry lips and mouth
• Thirst
• Inside of mouth slightly dry
• Low urine output; concentrated urine appears dark yellow

Moderate Dehydration(14)

The signs of moderate dehydration include:

• Thirst
• Very dry mouth
• Sunken eyes
• Low or no urine output
• Not producing tears

Severe Dehydration(12)

Signs of severe dehydration include:

• All signs of moderate dehydration
• Rapid and weak pulse
• Cold hands and feet
• Rapid breathing
• Lethargic, comatose, seizures

Severe dehydration requires immediate hospitalization.

Consequently, when water intake during exercise in the heat is not enough some dehydration is likely to occur. The physical work capacity for aerobic exercise is reduced when a person is dehydrated by marginal (1–2% total body water [TBW]) water deficits. Dehydration resulted in much larger decrements in physical work capacity in hot than in temperate environments, and it appears that the thermoregulatory system plays an important role in the reduced exercise performance mediated by a body water deficit. It has been shown that dehydration reduces both skin blood flow and sweating responses during exercise.(8)

Because sweat is hypotonic compared with plasma, thermal dehydration results in a hyper osmotic, hypovolaemic condition. Therefore, both the singular and combined effects of plasma hyperosmolality and hypovolaemia have been proposed to mediate the reduced heat loss effecter.(13)

Although it has been shown that both conditions can adversely affect thermoregulation, core temperature responses are usually more strongly correlated with tonicity than with blood volume.**(14)**

Heat illness:

In the literature three exercise related heat illnesses are described : heat cramps, heat exhaustion, and heat stroke. The term 'heat cramps' stems from the original description of the condition by Talbot,(15) who reported muscle cramping in persons performing physical work in hot, humid environments. However, these exercise-associated muscle cramps (EAMC) do not seem to be directly related to increases in core temperature and the observation that heat stroke is not characterized by EAMC clearly supports the lack of a direct association between heat and EAMC.(16, 17)

Heat exhaustion is often described as a condition in which an athlete collapses during or after exercising in the heat. This condition is generally believed to result from dehydration-induced heat retention and is often considered to be a mild form of heat stroke that will progress to full-blown heat stroke if left untreated. However, there are a number of findings that argue against such a belief. First, in most individuals experiencing heat exhaustion, rectal temperatures are not abnormally elevated. Furthermore, there is no published evidence to support the notion that people with heat exhaustion will develop heat stroke if left untreated or they are more dehydrated than participants in the same events who do not develop the condition.(17)

Another critical finding in a study performed by holtzhausen et al.(18) was that 85% of all the studied runners collapsed after finishing the race; it is difficult to see why dehydration that is not severe enough to cause collapse during exercise (when the burden on the cardiovascular system is the greatest) should be a critical factor in the period after exercise. Therefore, it seems that the terms (heat exhaustion) and(heat syncope) are only used to describe a condition of collapse in individuals exercising in the heat and should not be misinterpreted to indicate that the collapse is caused by an elevated core temperature and is, therefore, a mild form of heat stroke. The one condition that is unquestionably a direct results of an elevated core temperature is heat stroke. Heat stroke is a life-threatening illness that is clinically defined as a body core temperature that rises above 40°C, accompanied by a hot, dry skin and central nervous system abnormalities such as delirium, convulsions, and coma.(19) During exercise, blood flow is redistributed to the skin for the dissipation of heat and this, together with the loss of fluids due to sweating, leads to a decline in central blood volume.(20)

These endotoxins cause excessive activation of leukocytes and endothelial cells, which release pro inflammatory cytokines and cell surface adhesion molecules respectively. Both pyrogenic cytokines and endothelium-derived factors can interfere with the normal thermoregulation by increasing the hypothalamic set point at which sweating and vasodilatation are activated, thereby increasing the risk that an individual can develop heat stroke.(19)

Intervention strategies for exercise in the heat:

Over the last decade athletes and their coaches have shown their increasing interest in intervention strategies designed to reduce health risks and performance decrements associated with exercise in the heat. Two strategies that have proven to be particularly effective in reducing health problems and performance decrements associated with exercise in the heat are heat acclimatization and rehydration, and they are therefore given special attention. Some basic outlines of a number of additional strategies including whole-body precooling, hyperhydration and clothing selection.

1. Whole-Body Precooling

A number of studies reported that subjects exercising in the heat reached the point of voluntary exhaustion at similar and consistent body core temperature despite different starting core temperature or rates of heat storage.(21)

Therefore it has been proposed that a critical core body temperature exists that directly accelerates exhaustion. Although the underlying mechanisms are not well understood, evidence is emerging that hyperthermia directly affects the functioning of the brain through altering the cerebral blood flow and metabolism and decreasing the level of cognitive, or neuromuscular drive which may in turn decreases the muscle function or alter the perception of effort.[22]

Given the presumed body core temperature on eliciting exhaustion, the basis of whole body precooling is to reduce the heat content of the body by cooling the periphery before exercise, thereby increasing the margin for metabolic heat production and increasing the time to reach the critical limiting temperature when a given exercise intensity can no longer be maintained. Whole-body precooling can be achieved by a variety by a variety of methods including cold air cooling cold water emersions and the use of water-cooled garment.[23]

The current body of evidence suggests that precooling is able to increase capacity for prolonged exercise at various ambient temperatures. However, regardless of the method used, the practical application at present is limited because of the time required to achieve sufficient body cooling to improve exercise performance.[24]

2. Hyperhydration:

The observation that dehydration adversely affects thermoregulation gave rise to the idea that greater than normal body water (hyperhydration) might have thermoregulatory advantages. Although many studies have examined the effects of hyperhydration on thermoregulation in the heat, a large number have had serious design problems that confound their results (e.g. the control condition represents dehydration rather than euhydration). Some investigators reported lower core temperatures and higher sweating rates during exercise after hyperhydration, while others did not.[25]

Although hyperhydration was often induced by having subjects over drink plain water it is now thought that glycerol solutions are more effective as hyperhydrating agents as they reduce the rate of water elimination.

Lyons et al.[26] gave subjects 2L of water with and without glycerol over 2.5 hour period prior to treadmill walking, in a hot dry environment. Compared with the water trial, glycerol ingestion showed a substantially lower core temperature (0.7^{O}C) a reduction in the urine output and a higher sweating rate (33%)

3. **Clothing:**

The type and amount of clothing worn can have a major impact on heat dissipation during exercise.[27]

Clothing generally represents a layer of insulation that imposes a barrier to heat transfer from the skin surface. When clothing interferes with the evaporation of sweat from the skin, increases in skin and core temperature, as well as a reduction in cooling efficiency are observed Considering that evaporation of sweat is the most important mechanism of heat loss during exercise in the heat, clothing that proposes the least amount of resistance to evaporation may prove beneficial.[28]

4. Heat Acclimatisation:

It has been well established that regular exposure to hot environments results in a number of physiological adaptation results in a number of physiological adaptations that reduce the negative effects associated with exercise in the heat. These adaptations include a decreased body core temperature at rest, decreased heart rate during exercise increased sweat rate and sweat sensitivity, decreased sodium losses in sweat and urine and expanded plasma volume.[29] Moreover, it is well established that heat acclimatisation improves the reabsorption of sodium from sweat resulting in a greater amount of solute in the plasma. This will result in a fluid shift from intra to extracellular compartment thereby causing a better maintenance of plasma volume.[30]

Another consistent finding after heat acclimatisation is the lowering of the temperature thresholds for both sweating and cutaneous vasodilatation without the occurrence of a significant change in the slope of the relations. It is postulated that regular exposure to high temperature results in a lowering of the set point in the hypothalamus at which sweating and vasodilatation are initiated.[31]

Practical Recommendations for heat acclimatisation:

The process of acclimatisation to exercise in the heat begins within a few days, and full adaptation takes 7–14 days for most individuals. It is clear from table I that the systems of the human body adapt at varying rates to successive days of heat exposure. The early adaptations during heat acclimatisation primarily include an improved control of cardiovascular function through an expansion of PV and a reduction in heart rate. An increase in sweat rate and cutaneous vasodilation are seen during the later stages of heat acclimatisation.[29]

Endurance – trained athletes exhibits many of characteristics of heat-acclimatised individuals and therefore thought to be partially adapted; however, full adaptation is not seen until at least a week is spent training in the heat.[32]

It is not necessary to train every day in the heat as it has been shown that exercising in the heat every third day for 30 days results in the same degree of acclimatisation as exercising every day for 10 days.[33]

As the maintenance of an elevated body core temperature and the stimulation of sweating appear to be the critical stimuli for optimal heat acclimatisation, it has been recommended that strenuous interval training or continuous exercise should be performed at an intensity exceeding 50% of an athlete's maximum oxygen uptake.(34)

There is evidence that exercise bouts of about 100 minutes are most effective for the induction of heat acclimatisation and that there is no advantage in spending longer period exercising in the heat.(35)

Unfortunately, heat acclimatisation is a transient process and will gradually disappear if not maintained by repeated exercise heat exposure, In general, most studies show that dry-heat acclimatisation is better retained than humid-heat acclimatisation and that high levels of aerobic fitness are also associated with a greater retention of heat acclimatisation.(36)

Rehydration:

Although athletes may be tempted to believe that the need for fluid replacement will decrease as they become adjusted to the heat, heat acclimatisation will actually increase the requirement for fluid replacement because of the earlier onset of sweating.(29)

In addition, core temperature responses after dehydration are the same for unacclimatised and acclimatised individuals confirming that the advantages conferred by heat acclimatisation are abolished by dehydration.(37)

Rehydration during exercise in the heat should be made a clear priority. Factors that influence the effectiveness of beverage as a fluid replacement include its rate of gastric emptying, intestinal absorption and how well the fluids are retained in the intra and extracellular fluid compartment.(38)

Research methodology: This was a descriptive study.

Study population : all Sudanese top league football players.

Study sample: random selection from the Sudanese top league football players, and they were 50 players.

Data collection tools: were the questionnaires.

Data analysis: using an excel worksheet

Ethical considerations: study subjects were informed that the information they gave were only used for research purposes keeping the confidentiality.

Results &discussion:

In this cross sectional community based study a descriptive approach was taken & the sample size was 50 players, to whom questionnaires were given for data collection and then those were analyzed manually using percentages.

Table number(1) shows the answers of the Sudanese top league football players about hydration &hot climates:

The question	yes	no	Total
Do you drink plenty of fluids one day ahead of the match	20	30	50
Do you have instructions to drink plenty of fluids before the exercise	23	27	50
Does the coach weigh the players before and after exercise	10	40	50
Do you dink during exercise	27	23	50
Do you use rehydration fluids during exercise	5	45	50
Does the technical team provide fluid during the exercise	30	20	50
Do you drink a lot of fluid after the exercise	25	25	50
The coach doesn't allow drinking during exercise	26	24	50
Do you feel that your mouth is dry during exercise	33	17	50
Does your urine volume decreases and becomes darker	46	4	50
Do you have muscle cramps after exercise	25	25	50
Do you have decreased attention span before and during the match.	33	17	50

Table number(2) shows the percentages of the answers of the Sudanese top league football players about hydration &hot climates:

The question	yes	no	Total
Do you drink plenty of fluids one day ahead of the match	40%	60%	100%
Do you have instructions to drink plenty of fluids before the exercise	46%	54%	100%
Does the coach weigh the players before and after exercise	20%	80%	100%
Do you drink during exercise	54%	46%	100%
Do you use rehydration fluids during exercise	10%	90%	100%
Does the technical team provide fluid during the exercise	60%	40%	100%
Do you drink a lot of fluid after the exercise	50%	50%	100%
The coach doesn't allow drinking during exercise	52%	48%	100%
Do you feel that your mouth is dry during exercise	66%	34%	100%
Does your urine volume decreases and becomes darker	92%	8%	100%
Do you have muscle cramps after exercise	50%	50%	100%
Do you have decreased attention span before and during the match.	66%	34%	100%

In this study It was found that 60% of the players didn't drink plenty of fluids one day ahead of the match, and 46% didn't drink during exercise, and also 54% didn't have instructions to drink plenty of fluids before the exercise, While 50% drank a lot of fluid after the exercise, to compare with a scientific point of view in order to maintain adequate hydration, it is generally recommended that athletes consume fluids at a rate that closely matches their loss of water through sweating and urine losses.(39) This generally requires the ingestion of 200–300mL of fluid every 10–20 minutes(40) However, as it takes 20–30 minutes for ingested fluids to be distributed throughout the body after gastric emptying, intestinal absorption and osmotic flow, the beneficial effects of fluid intake during events lasting <20–30 minutes may be small.(41) Athletes who compete in events lasting >30 minutes are advised to drink 200 – 300 ml of their preferred sport drink just before exercise and to continue drinking the same sport drink during the event until there are 20 minutes remaining after which little extra fluid is ingested.(39)

This study also searched for the possible obstacles preventing proper rehydration, including the availability of rehydrating fluids by the technical team, and only 40% reported that the technical team didn't provide fluid during the exercise. Also 48% said that the coach didn't allow drinking during exercise.

In this study it was found that only 20% of the players were weighed by the coach before and after exercise. Which is a commonly used and safe technique to determine the acute loss of body water is the measurement of body mass change. The loss of body mass over the course of exercise essentially equals water loss because no other body constituent is lost at such a high rate. When body mass measurements are made with an interval of >4 hours, the body mass difference should be corrected for the net utilization of endogenous glycogen and fat stores.(42)

This study had also found that only 10% of the players used rehydrating fluids during exercise.(43) reported that glycerol hyperhydration increased exercise time to exhaustion in temperature climates but found no significant thermoregulatory advantages. These results are in accordance with a study by Latzaka et al.(44) who found that glycerol hyperhydration extended endurance time (from 30 to 34 minutes) in subjects exposed to uncompensable heat stress, but that it had no beneficial effect on thermoregulation compared with maintenance of euhydration. In summary, there are some indications that hyperhydration reduces thermal strain during exercise, but data supporting this notion are not very robust.

Concerning symptoms of dehydration this study had found that 66% of the players felt a dry mouth is during exercise, while 92% reported that their urine volume decreased and became darker, 50% had muscle cramps after exercise, and 66% had decreased attention span before and during a match. From a scientific point of view, thirst is a signal that your body needs fluid; however, it's a poor indicator of your body's fluid needs because you can lose two percent of your body weight before you feel thirsty. A better way to gauge your hydration status is to monitor the output and color of your urine. A well-hydrated individual should void 1,000 to 1,500 ml/day, and urine color should be no darker than a pale yellow color. If your urine is darker, it is a sign you are dehydrated, and you need to increase your fluid intake.(45)

Those who work exercise in intense temperatures need to stay hydrated. Athletes should rely on urine output and color or checking their body weight both before and after each exercise session or event to
gauge water losses. Ideally, athletes should replace approximately 1 liter of water per kg of weight lost(or ~2 cups/lb).(46)

Even mild water losses can significantly impede performance. For every one percent of body weight lost, blood volume decreases by 2.5 percent, muscle water decreases by one percent, and the body's core temperature can increase 0.4 to 0.5° C. Changes in blood volume during prolonged exercise impair the body's ability to deliver oxygen and key nutrients to active muscles, organs, and glands and negatively affect thermoregulation (the body's ability to regulate core body temperature) by diminishing the body's ability to expel heat. Losses of three percent are associated with physiological changes, such as decreased blood volume, decreased urine output, diminished performance, and decreased endurance, while losses of nine to twelve percent are fatal.(47)

Recommendations:

1. To raise awareness about the importance of proper hydration among the players, the staff, and others responsible for them.
2. Adequate care to maintain good level of hydration before and during football matches and exercises.
3. Promoting the use of sport drinks and their importance as an efficient method of rehydration, and to try to make them available as well.
4. To implement the FIFA instructions regarding playing in hot climates, that is to pause a match allowing time for fluid replacement and rehydration.
5. To use this study for future visions along with other studies concerning hydrations and hot climates, with special regards that the football world cup 2022 is going to be in Qatar.

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