MPRI-JPAS | INTERNATIONAL JOURNAL OF PURE AND APPLIED SCIENCE
VOL. 11 NO.9 JUN-2020 ISSN: 1660-5332

# MENERALS REQUIREMENT OF ATHLETES IN HOT AND HUMID ENVIRONMENT

**OGAR, EMMANUEL EKAWU & PROF. E.A. GUNEN (COURSE LECTURER)**
*Department of Human Kinetics and Health Education, Faculty of Education, Ahmadu Bello University, Zaria, Kaduna*

**Abstract**

*Competition in a hot or humid environment is not always conducive for optimal sports performance as both dehydration and hyperthermia greatly affect the mental and physical performance of athletes. In addition, the ability to train in heat is also impaired if the nutritional requirements are lacking or inadequate in the right proportion. During prolonged exercise in a hot environment, an excess of 1 liter of body fluid per hour can be lost. Fluid intake strategies should be undertaken and should be of paramount concern to the athletes and coaches if the athlete has to perform more than one training or competition sessions in a single day. Fluid strategies, including hydration well prior to the exercise or competition, drinking as much as is comfortable and practical during the exercise or competition session, and rehydrating aggressively afterwards in preparation for the subsequent exercise, are needed to ensure an adequate water intake to prevent chronic dehydration or muscle cramps during competition in hot conditions as the body does not adapt to dehydration. Rapid recovery of fluid losses after an exercise is assisted by the replacement of some of the electrolytes (nutrients) losses. Carbohydrate is the main fuel used by the muscle during training and competition and its*

***KEYWORDS:*** *Hot, Humid, Environment, Hydration, Dehydration, Fluid, Minerals, Athletes.*

mediterraneanresearchpublications.com



**EDITOR-IN-CHIEF**
**Prof. G.O. Emerole [NIGERIA]**

*requirement for exercise in hot conditions is further increased due to the shift in substrate utilization towards carbohydrate oxidation. Daily food intake should focus on replacing glycogen stored in the muscles after active exercise. Competition diet strategies such as enhancing carbohydrate availability (carbohydrate loading) prior to endurance competition, pre-event carbohydrate intake, intake of sports drinks in events lasting longer than 45-60 minutes should be undertaken in hot conditions and practiced regularly during training to get acclimatized. Carbohydrate ingestion may not enhance performance for all events undertaken in hot environment, however, there is no disadvantage of consuming sports beverages (snacks) containing the appropriate carbohydrates and electrolytes during training and competition. There is also no good evidence to suggest that specific supplementation is necessary or will improve performance in sports activities undertaken in a hot environment. The maintenance of fluid balance is the key issue for performance of the athletes. In a hot environment, significant dehydration is inevitable during exercise activities and poses a challenge to both the health and performance of the athlete.*

## INTRODUCTION

Although the human body has some energy reserves, most of its energy must be obtained through nutrition from plants and animals. During exercise, energy requirements increase and energy provision can become critical. In athletes, energy provision can be crucial and energy depletion (particularly carbohydrate and fluid depletion) is one of the most common causes of fatigue and muscle cram.

Preventing dehydration in hot and humid climates is essential during both training and real competition. Dehydration which is the shortage of liquid in the body adversely affects one's performance during training and slows one's ability to recover for the next workout. In extreme cases of dehydration while exercising or training, you risk nausea, vomiting, diarrhea, fainting or disorientation. This should never be considered a 'normal' consequence of training in a hot climate. With proper hydration



EDITOR-IN-CHIEF
Prof. G.O. Emerole [NIGERIA]

mediterraneanresearchpub@gmail.com

and sports-specific nutritional requirements during training, athletes can easily prevent the onset of these adverse conditions (Broad, Burke, Gox, Heeley & Riley, 2016). Not only will the athlete perform better, but he/she will enjoy the training and perform better during competition proper.

According to Rabindarjeet, (2015) Competition in a hot environment is not conducive for optimal sports performance as both dehydration and hyperthermia adversely affect mental and physical performance. In addition, the ability to train in heat is also impaired if the nutritional needs are inadequate. During prolonged bouts of exercise in a hot environment, an excess of 1 liter of body fluid per hour can be lost (Broad, Burke, Gox, Heeley & Riley, 2016) . American College of Sports Medicine (ACSM), (2016), opined that, fluid intake strategies should be undertaken and should be of paramount concern to the athlete, if the athlete has to perform more than one training or competition sessions in a single day. Fluid strategies, including hydration well prior to the exercise bout, drinking as much as is comfortable and practical during the exercise session, and rehydrating aggressively afterwards in preparation for the subsequent exercise bouts, are needed to ensure an adequate water intake to prevent chronic dehydration during competition in hot conditions as the body does not adapt to dehydration. Rapid recovery of fluid losses after an exercise bout is assisted by the replacement of some of the electrolytes losses. To Balsom, Wood, Olsson and Ekblom, (2014), carbohydrate is the main fuel used by the muscle during hard training and competition and its requirement for exercise in hot conditions is further increased due to the shift in substrate utilization towards carbohydrate oxidation. Daily food intake should focus on replacing glycogen stores after exercise (Broad, Burke, Gox, Heeley & Riley, 2016). Competition diet strategies such as enhancing carbohydrate availability (carbohydrate loading) prior to endurance competition, pre-event carbohydrate intake, intake of sports drinks in events lasting longer than 45 minutes should be undertaken in hot conditions and practiced during training. Burke and Hawley, (2017), opined that carbohydrate ingestion may not enhance performance for all events undertaken in hot environment, however, there is no disadvantage of consuming sports beverages containing the appropriate carbohydrates and electrolytes during competition and training. There is

mediterraneanresearchpub@gmail.com

also no good evidence to suggest that specific supplementation is necessary or will improve performance in sports activities undertaken in a hot environment. Tthe primary aim of athletes training in a hot environment must be to ingest a source of energy, usually carbohydrate and fluid for replacement of water lost as sweat (Montain & Coyle, 2017). According to Massimo, Sara, Daniela and Angela, (2014), being well hydrated is an important consideration for optimal exercise performance. Dehydration (loss of »2% body weight) increases the risk of potentially life threatening heat injury such as heat stroke, and beyond compromise aerobic exercise and cognitive performance

**EFFECTS OF TEMPERATURE AND DEHYDRATION DURING EXERCISE IN HOT ENVIRONMENT**

The most notable effect of exercise in a hot environment is the increased loss of body fluids. In the hot environment, the main method of dissipating body heat produced by the exercising muscles or absorbed from the environment is through the evaporation of sweat. In such hot conditions, sweat losses during prolonged sub-maximal exercise may be as high as 2-3 l/h (Webster, Rutt & Wettman, 2016). The reduction of plasma volume in the body may be of particular significance and could have a significant impact on athletes' performance. During exercise, the heat generated from energy metabolism can easily increase 10-fold in active healthy persons and up to 20-fold in well-trained athletes, which will increase the core temperature and bring about premature onset of fatigue or reduced performance (Noakes, 2012). The physical work capacity for aerobic exercise of progressive intensity is decreased when a person is dehydrated (Sawka, Montain & Latzka, 2016). Physical work capacity has been shown to decrease even with marginal (1-2% body weight loss) water deficits and the reduction is larger with increasing water deficits (Noakes, 2012). Dehydration results in much larger decrements of physical work capacity in hot than in temperate climates (Webster, Rutt & Weltman, 2016). Exercise in the hot environment is also associated with a shift in substrate utilization towards a greater reliance on body carbohydrate stores. This is associated with increased respiratory ratio, muscle glycogenolysis and lactate accumulation (Febbraio, 2018).

mediterraneanresearchpub@gmail.com

INTERNATIONAL JOURNAL – PAS
VOL. 4 NO.1 MAR-2018 ISSN: 1660-5332

**FLUID STRATEGIES FOR ATHLETES' EXERCISE IN HOT ENVIRONMENT**

The maintenance of fluid balance is the key issue for performance of the athletes. In a hot environment, significant dehydration is inevitable during exercise activities and poses a challenge to both the health and performance of the athlete. The hypohydration state occurs when sweat rates are extremely high and when there is little opportunity to drink during the event or when both these factors are combined. Therefore, to sustain high work output in the heat, replacement of fluid losses are required to prevent dehydration. Strategies to minimize the degree of hypohydration during activity in the heat should be undertaken pre-, during and in the post-exercise period (Febbraio, 2018). Sports drinks are designed to deliver a balanced amount of carbohydrate and fluid to allow an athlete to simultaneously rehydrate and refuel during exercise. According to various expert position stands, to provide rapid delivery of fluid and fuel and to maximize gastric tolerance and palatability, sports drinks should be within a compositional range of 4-8% (4-8 g/100 ml) carbohydrate and 23-69 mg/100mL (10-30 mmol/L) sodium. Sports drinks provide a convenient option for simultaneously addressing fuel, fluid and electrolyte needs before, during and after exercise. Before exercise, sport drinks may be part of the pre-exercise meal or consumed immediately before exercise to top up fluid and fuel status. During exercise the major role for sport drinks is to promote hydration and re-fuelling. After exercise they may be part of post-exercise recovery snacks and meals to assist with rehydration (Massimo, Sara, Daniela & Angela, 2014). The body is made up of 2/3 water inside and outside the cells and in the blood circulation. If the body dispenses more water than is taken in, proper cell function is affected. Blood thickens and circulation deteriorates, blood pressure falls, and the brain does not receive enough oxygen. The most common result is fatigue/tiredness.

**Exercising-Training-Competing in Hot and Humid Weather**

According to Barker, (2019), athletes exercising, training, and/or during competing in hot weather have to be extremely aware and conscious about 'sweating it out' during high altitude temperatures, which means being careful about and not ignoring warnings between high temperature and humidity, and the body's internal temperature (normal

mediterraneanresearchpub@gmail.com


EDITOR-IN-CHIEF
Prof. G.O. Emerole [NIGERIA]

37-degrees). The closer these two are to each other, the more difficult it is for the body to cool itself. When body core temperature rises, athletic performance declines, and the first signs of heat exhaustion appear. 'Toughen it out' during a heat wave has led to many hospital visits because of under-estimation of the effects in 30°C. He went further to state that, the struggle to keep cool is most acutely felt by endurance athletes because the body heat accumulates over time. However, the most affected may not necessarily be elite athletes because they have most likely learned to manage hot conditions or acclimatize to the weather. It is the average athlete such as runners, cyclists, or team sport athletes (football, soccer, etc.) who are most likely at risk of heat exhaustion. The body's internal temperature starts to rise in as little as 15 minutes during hot weather workout or training and especially if the intensity is high. While the challenge to exercise and train in temperatures near 30°C has been the focus, researchers have also found that performance impairment can start as low as 21°C (69.8°F) (Lang, Gohil, Packer & Burk, 2019).

Mayo, (2019), opined that, in cooler temperatures, the body functions well at dissipating the heat generated by exercise or training through the evaporation of sweat. However, in high humidity, evaporation does not occur, and heat loss is hindered. Sweat is induced when the body sends internal heat (blood) toward the surface of the skin to cool. As core temperatures rise, more and more blood used to supply working muscles is now diverted toward the outermost skin layers. Due to reduced oxygenated blood, muscles start to fatigue. In addition, the effect of less internal blood flow affects the heart, which has to pump harder to keep circulation flowing. These physiological changes obviously affect performance (Barker, 2019). When sweat increases during exercise, fluid loss increases as well. This causes sweat production to taper off resulting in the rise of body temperature. Drinking enough water to replace lost fluids is highly recommended but it is not easy to do so, especially if athletes are 'heavy' sweaters. Moreover, athletes trying to increase their water intake frequently complain of an upset stomach, or water 'bouncing' around in their stomach, especially runners, who seem to experience that feeling with every foot contact on the ground (Mamman & Roberts, 2015). Ceu, (2018), opined that, when working out in high heat

mediterraneanresearchpub@gmail.com

and/or humidity the body must accommodate to deal with thermo regulatory strain. High heat greatly increases sweat rate, and consequently mineral loss (particularly electrolytes) from sweat. With concurrent high heat and humidity, thermoregulatory strain increases exponentially as heat loss via evaporation rapidly declines. (Sareen, Jack & James, 2015). Thermal straining combined with the accelerated loss of essential minerals increases the risk for heat-related illness such as heat cramps, heat exhaustion or heat stroke. Interestingly, cold temperatures do not seem to affect performance to the same degree, unless combined with wind chill or rain, which may induce hypothermia. Scientists have determined that a relatively cooler temperature range of 50-54°F is actually optimal for elite-level endurance athletes as it aids in temperature regulation. He went further to state that, If heat dissipation is limited as seen while training in the heat and humidity, the loss of bodily fluids via sweat results in a reduction in blood plasma and a subsequent drop in stroke volume, cardiac output and maximal aerobic capacity (VO2max). Training in the heat can also affect the brain and its functions as a central governor of the body. (Sareen, Jack & James, 2015). Elevation of core and brain temperature is believed to have an effect on neurotransmitters which may expedite the perception of fatigue (higher rate of perceived exertion [RPE] levels) when compared to training in moderate temperatures. The accelerated perception of fatigue can be mediated with appropriate hydration strategies, carbohydrate (CHO) intake, and electrolyte intake/supplementation (Sareen, Jack & James, 2015). One may think that no major changes need to be made to dietary intake if heat acclimation has already been obtained – but this is not the case as sweating rates (and consequent mineral losses) actually increase with heat acclimation. As ambient temperature increases, cooling via convection is reduced, so another form of thermo - regulation, perspiration/evaporation, must increase to expedite cooling. The quicker an individual starts to sweat indicates they are more adapted to the heat. Sweating rates among athletes can range from 0.5-2.0 L/hour (Sareen, Jack & James, 2015). Heat acclimation is attained by training at high intensities (70%- 100% of VO2max) in a hot environment over a course of a few weeks (approximately 7-12 training sessions). With heat acclimation the participant may experience an increase in blood volume,

mediterraneanresearchpub@gmail.com

sweat gland size/activity, sweating rate and capacity for hot blood from the core to disperse to the skin for accelerated cooling. These factors certainly help deal with thermoregulatory strains but adequate, and potentially elevated, mineral intake may still be required, especially for those who engage in high-volume training outside or who are heavy sweaters (Sareen, Jack & James, 2015).

**Heat Management Strategies by athletes in hot environment**

- Keep workouts or training short or shorter (i.e reduced the intencity of training)
- Keep intensity moderate to reduce the accumulation of body heat which may lead to crams
- If possible, schedule early morning or end of the day workouts when the heat is less intense
- Maintain workout pattern for 5-10 days to get more efficient at managing the heat or get acclimatize
- As acclimatization improves the body's cooling system; the body's cooling mechanisms start working earlier in the workout (sweating sooner and in greater quantities), extending the time it takes for internal temperatures to build and heat-related fatigue to set in
- When heading for workout or training, top off fluid to reduce the overall volume of water needed while exercising or training
- Bring enough water/fluids or plan a route to access public water fountains, local corner stores, sprinklers, or hoses (if running a marathon race or cycling) for a quick top-up on fluids
- Overheated skin adds to discomfort, pouring water over the head creates a more comfortable feeling during endurance races

**Exercising/Training in Heat, Potential Mineral and Vitamin Loss**

According to Keen, (2013), heat-exposed training can lead to a large amount of sweat and thereby a loss of water-soluble vitamins and minerals, affects the level of micronutrients required and an increase of vitamins and minerals. In addition to water loss, the body also casts off electrolytes such as potassium, sodium, and minerals in the blood, urine, and bodily fluids that contain an electric charge. There has been

mediterraneanresearchpub@gmail.com

INTERNATIONAL JOURNAL – PAS
VOL. 4 NO.1 MAR-2018 ISSN: 1660-5332

increasing interest in the idea that individuals engaged in strenuous exercise may have an increased need for several essential minerals. The idea resulted in a widespread perception that mineral supplements may be advantageous. This concept is based on two basic views: (a) individuals engaged in strenuous exercise have a higher requirement for some minerals compared to sedentary ones due to increased rates of urinary and sweat losses of selected minerals, and (b) the perceived inadequate intake of some minerals results in a lowering of endurance capacity and ultimately leading to the development of some disease states. Although a significant number of athletes, coaches, and professionals in sports medicine believe in the beneficial effects of mineral supplements, few data support a positive effect of dietary mineral supplementation on athletic performance. Nevertheless, strenuous exercise does influence the metabolism of several minerals, and the number of minerals lost via sweat (due to either intense heat or exercise) can be significant (Sport Resource Information Centre, 2019).

**HYDRATION FOR ATHLETES COMPETING IN HOT & HUMID CLIMATES**

According to Morgans, (2017), preventing dehydration in hot and humid climates is essential during both training and during competition proper. Dehydration adversely affects your performance during training and slows your ability to recover for your next workout. In extreme cases of dehydration while exercising, you risk nausea, vomiting, diarrhea, fainting or disorientation. This should never be considered a 'normal' consequence of training in a hot climate. With proper hydration and sports' specific nutrition while you train, you can easily prevent the onset of these adverse conditions. Not only will you perform better, but you will enjoy your activity far more.

**How does athletes' body react in hot environment?**

1. One of the worst conditions an athlete can face is a hot, humid and windless environment, in which exercise occurs at a high rate of intensity. This can put the body under extreme pressure, which can in turn affect performance. Our bodies usually deal with extreme heat through thermoregulation. This helps the body to stay at a consistent core temperature


EDITOR-IN-CHIEF
Prof. G.O. Emerole [NIGERIA]
mediterraneanres-archpub@gmail.com

(i.e 36 to 37.5°C). However hot and humid conditions can disrupt thermoregulation. We can help to prevent this stress on our bodies by correctly hydrating and refueling. So if you as an athlete is out exercising in these type of conditions, you need to alter your nutrition strategy compared to when you train in humid climates, applicable to coaches or instructors. This will help to ensure the athlete's body continues to correctly thermoregulate, even with the added stresses of the climate and their training intensity. The way athlete's body deal with increased temperatures or humidity is by sweating. Sweat is evaporated on the skin surface and heat is lost, therefore our core temperature remains regulated. When you sweat, your blood volume decreases, so less blood returns to your heart (Mayo, 2019). As a result, the amount of blood your heart pumps with each beat decreases; consequently less oxygen-rich blood reaches your working muscles. Your rate of aerobic energy production decreases, and you must exercise at a slower pace. However in hot and humid climates, heat exchange between the body and environment is substantially impaired, which can lead to serious performance reductions and increase risk of heat illness. If we don't prepare ourselves for this sweat loss then our core temperature usually increases and this can lead to negative side effects such as dizziness, nausea, and disorientation(Mayo, 2019) . Definitely, not what athletes or coaches want during competition! When athletes sweat, the body loses the essential electrolytes (mineral salts) sodium, potassium, magnesium and calcium. These electrolytes are important for maintaining normal muscle function of an athlete (e.g. preventing muscle cramps) and for supporting your immune system. Therefore your ideal nutrition strategy for training in hot and humid climates should be focused on 3 key elements combined (not at the exclusion of each other):

1. Water
2. Electrolyte replacement

mediterraneanresearchpub@gmail.com

3. Carbohydrates

Adequate intake of carbohydrates and electrolytes during long or intense events can help to prevent these nasty side effects and maintain a safe core temperature so our bodies can work more effectively and efficiently.

**How to prevent dehydration by athletes in hot environment**

Adolph, (2013), state that, the requirements for water in a hot environment depends on the amount of fluid loss, which in turn depends on such factors as exercise intensity, exercise duration, environmental conditions (dry heat versus humid heat), state of training and heat acclimatization, sex, and age. Along with exercise intensity, sweat rate is related to environmental conditions, clothing, and acclimatization state. In hot, dry conditions, water loss from the skin and respiratory surfaces can be as much as 2 to 3 liters per hour (Morgans, 2017). In hot, moist (humid) conditions, sweat losses are measurably less than in hot, dry conditions. As well as having effective carbohydrates during training and competition, attention should also be placed on appropriate fluid intake. This is especially important in hot environments. When we are in a cool and dry environment such as in an office or when we are not training, it is much easier for our bodies to stay at a steady core temperature and thermoregulation is less important. However when we train or compete most especially during outdoor activities in a hot and/or humid climate, our bodies are put under more stress and preasure, so we need the right fluid and fuel to cope with this stress. This means that you need to alter your hydration strategy when you are exercising outdoors compared to when you are indoors within a climate controlled environment. For these reasons, plain water by itself is usually not enough to prevent dehydration while exercising longer than 1 hour in hot conditions. Increased physical activity in hot environments can result in severe hypohydration. This is particularly true when fluids are in short supply or not very palatable. Hypohydration can cause large decrements in performance and can greatly increase the risk of heat casualties. The risk of hypohydration is reduced in individuals who have been acclimatized to the heat and who are physically fit (Samman & Roberts, 2015). Your body needs proper fuel to continue functioning at peak

mediterraneanresearchpub@gmail.com

performance over the prolonged or intense period of time. Tips for maintaining hydration while training in hot environment:

- Start your exercise well hydrated (such as having a minimum of 750ml of water prior to your exercise).
- Drink plenty of fluids from the time you wake up and keep drinking to a plan all day. Steady drinking throughout the day/night will have you better prepared than drinking large amounts of fluid irregularly. Taking fluids immediately prior to exercise will only make you feel bloated and your body won't have enough time to process the fluids effectively for performance gains.
- Include carbohydrate-rich beverages, such as sports drinks to continually top up carbohydrate stores and maintain fluid balance. The carbohydrates are essential to replace glycogen stores in your muscles which are lost during exercise.
- Ensure your sports nutrition includes electrolytes, to replace those lost during sweating. This will help your muscles perform effectively during exercise and assist with preventing muscle cramp.
- Keep fluids cool with ice (alternatively, freeze drinks the night before allowing them to defrost slowly over the day of competition). Cooled drinks will help regulate your core temperature during hot weather.

"Still" beverages (e.g. sports drinks, cordial, water) may be better tolerated than carbonated drinks, especially if you find you are nervous before the event (Morgans, 2017).

**Baseline strategies for training in the heat and humidity by athletes:**

•**Pace:** Gradually increase intensity and training volume to provide for adequate acclimation
(7-12 exposures).

•**Fluids:** Consume fluid equal to 125-150% of losses experienced during training for proper
rehydration with proper osmolarity, 16-20 oz directly prior to exercise; 16-32 oz/hour of training; 20 oz/lb lost following exercise

•**CHO and electrolytes:** CHO and electrolyte beverages can optimize fluid absorption and



EDITOR-IN-CHIEF
Prof. G.O. Emerole [NIGERIA]

mediterraneanresearchpub@gmail.com

prevent central fatigue (6-8% CHO). Primary electrolytes lost in sweat include sodium, chloride, potassium, calcium and magnesium, 20-70 g/hour of mixed CHO sources for intense training and competition lasting upto 90 min.

• **Sodium:** Losses can range from 200-1,700 mg/L of sweat depending on the degree of
heat acclimation. Ingest 500-700 mg per hour of activity in hot environments (Sareen, Jack & James, 2015). **intense summer training the following minerals may require extra attention:**

**Minerals that may require extra attention during hot environment:**

Appropriate dietary intake of minerals is necessary for optimal health and physical performance. Some minerals (e.g., calcium and phosphorus) are the building blocks for body tissues, including bones and teeth. A number of minerals (e.g., magnesium, copper, and zinc) are essential for the normal function of enzymes that are involved in the regulation of metabolism, and some minerals (e.g., iron and zinc) have an essential role in the functioning of immune cells. Several other minerals (e.g., sodium, potassium, and chloride) exist as ions or electrolytes dissolved in the intracellular and extracellular fluids. Like the vitamins, minerals cannot be used as a source of energy. Regular exercise, particularly in a hot environment, incurs increased losses of several minerals in sweat and urine, which means that the daily requirement for most minerals is increased in athletes engaged in heavy training. However, with the exception of iron and zinc, isolated mineral deficiencies are rare (Junge, Langevoort & Pipe, 2016). Some of the essential mineral requirements are as follows:

**Sodium:** Excess sodium losses are the primary threat with training during hot weather. As mentioned previously, losses can range from 200-1,700 mg/L of sweat. Research suggests ingesting 500- 700 mg per hour of activity in hot and humid environments (Ceu, 2018).

Meeting sodium requirements is generally a flavor enhancer and preservative in various foods. Some vegetables as well as milk contain naturally occurring sodium but most additional needs can be met with a well-formulated sports drink or electrolyte tablets.

mediterraneanresearchpub@gmail.com

**Potassium:** Potassium losses capable of creating physiological issues are not common simply from accelerated sweating rates, unless the individual is taking certain medications which increase losses in urine or they are dealing with diarrhea or vomiting from illness. Nonetheless, potassium is an important mineral-based electrolyte that works synergistically with sodium to regulate nerve and muscle activity, so some attention to adequate intake is advised. Good sources of potassium include avocados, sweet potatoes, spinach, coconut water, white beans, and well-formulated sports drinks or electrolyte tablets.

**Magnesium:** Magnesium is another important electrolyte commonly provided in sports drinks for training in the heat. Losses during intense, prolonged training in the heat can induce a mild deficiency, so good dietary sources such as spinach, dark chocolate, almonds, avocado, figs and bananas should be a go-to as available during hot weather.

**Zinc:** Minor zinc deficiency is relatively common among athletes and those who engage in vigorous, high-volume training programs. Research has shown that notable losses are experienced in urine and sweat among endurance athletes who train in hot environments, and female athletes in particular are at risk for acute deficiency as their storage capacities are lower. This risk is exacerbated further among vegetarian athletes (making female vegetarians at the greatest risk) due to a low absorption rate when consumed in plant foods. An altered zinc status will compromise immune function, basal metabolic rate and even thyroid hormone function; all of which have a significant impact on performance. Therefore, good dietary sources such as oysters, beef, almonds, pumpkin seeds, chicken and chickpeas should be sought out (Ceu, 2018).

**Iron:** Inadequate intake of iron is the most common among all of the essential minerals. It helps facilitate oxygen delivery and energy (ATP) production during exercise. Research has shown that needs among those who exercise frequently may be up to 70% higher than those who do not exercise due to physiological variances such as higher red blood cell mass and increased losses via sweat. Further losses may be expedited due to mechanical reasons such as repeated impacts during sprinting foot strikes. Risk for deficiency is higher in vegetarians and females due to lower iron absorption rates in non-heme sources and the menstrual cycle, respectively. Good food sources include beef, chicken,

mediterraneanresearchpub@gmail.com

oysters, tofu, lentils, and cashews. A few other minerals are important for supporting exercise performance but are not necessarily expedient to reducing the strains of training in the heat in humidity such as selenium (antioxidant to support immune function and reduce free radical damage), calcium (serves key functions during muscular contractions, losses are incurred in sweat) and copper (functions with iron to form red blood cells and aid oxygen delivery). Including the aforementioned as well as food rich in these nutrients will enhance performance and reduce risk when training throughout hot environment (Ceu, 2018).

***Glycerol:*** Hyperhydration prior to exercising in hot conditions can improve hydration status and increase heat tolerance. Hyperhydration with water alone directly increase urine output which can be ineffective. However, adding glycerol to water has been shown to promote hyperhydration (by as much as 50%) decrease thermoregulatory strain, and improve exercise performance. For example, athletes exercised for 19% and 72% longer when hydration included glycerol ingestion, compared with water only and non-fluid trials, respectively (Robergs, 2018). ***Hydration:*** During intense exercise, fluid intake recommendations are at least 0.5 $L \cdot h^{-1}$, and likely greater in hot conditions. Fluids that also include carbohydrate (<10%) or sodium are also encouraged to assist with both intestinal absorption of water and muscle glycogen replenishment, respectively. However, it is important for athletes not to ingest beverages that have high carbohydrate concentrations as these may decrease fluid delivery to the gut, and increase GI (glucose level) underperfusion. Therefore, it is also recommended to advise athletes about the dangers of drinking too much water, and to refrain from carbohydrate rich fluid replacements.

*Precautionary strategies:* While various supplementation strategies have been investigated to maintain GI integrity under exercise induced heat stress, GI integrity can be compromised by over-the-counter anti-inflammatory medications (De Oliveira & Burini, 2011).

**Energy balance in hot and humid environment**

The energy balance is usually calculated over longer periods of time, days or weeks, and represents the difference between energy intake and



EDITOR-IN-CHIEF
Prof. G.O. Emerole [NIGERIA]

mediterraneanresearchpub@gmail.com

energy expenditure. When energy intake exceeds energy expenditure, the energy balance is "positive" and will result in weight gain. When energy intake is below energy expenditure, the energy balance is "negative" and weight loss will result. Over the long term, energy balance is maintained in weight-stable individuals even though on a day-to-day basis this balance may be either positive and or negative (Junge, Langevoort & Pipe, 2016). Some physical activities have higher energy outputs than others, Tennis, for example, has relatively low energy expenditure if played recreationally and could be classified as a light-to-moderate activity. Although during a game, the exercise can sometimes be very intense and energy expenditure during that short burst of intense exercise can be very high. However, because this high intensity is typically followed by a longer period of relatively low intensity, walking or even standing, the average energy expenditure for this activity is relatively low. Tennis played at a high level will have shorter periods of rest and the average intensity is much higher. In continuous sports such as cycling and running, in which there is usually little or no recovery during the activity, energy expenditures can be relatively high. The energy requirements of an individual are influenced by factors such as body size, body composition, movement efficiency, goals and the energy cost of training (Junge, Langevoort & Pipe, 2016).

**Sports Supplements for athletes during hot and humid weather**

Dietary supplements can play a meaningful role in helping athletes consume the proper amount of calories, carbohydrate, and protein in their diet (Junge, Langevoort & Pipe, 2016). However, they should be viewed as supplements to the diet, not replacements for a good diet. While it is true that most dietary supplements available for athletes have little scientific data supporting their potential role to enhance training and/or performance, it is also true that a number of nutrients and/or dietary supplements have been shown to help improve performance and/or recovery. Supplementation with these nutrients can help augment the normal diet to help optimize performance. Sports nutrition specialists must be aware of the current data regarding nutrition, exercise, and performance and be honest about educating their clients about results of various studies (whether pro or con). Care should also be taken to make sure they do not contain any banned or prohibited

mediterraneanresearchpub@gmail.com

nutrients and/or substances with any adverse effects (Junge, Langevoort & Pipe, 2016). Sports foods such as sports drinks, bars, gels, ready to drink supplements (RTD's), and meal replacement powders (MRP's) offer practical and convenient options to help athletes meet their special nutritional needs. When used appropriately, these products are useful addition to the nutrition program of many athletes. They are typically fortified with vitamins and minerals and differ on the amount of carbohydrate, protein, and/or fat they contain. They may also vary based on whether they are fortified with various nutrients purported to promote weight gain, enhance weight loss, and/or improve performance. According to Massimo, Sara, Daniela and Angela, (2014), sports drinks are designed to deliver a balanced amount of carbohydrate and fluid to allow an athlete to simultaneously rehydrate and refuel during exercise. Sports drinks provide a convenient option for simultaneously addressing fuel, fluid and electrolyte needs before, during and after exercise. Before exercise sport drinks may be part of the pre-exercise meal or consumed immediately before exercise to top up fluid and fuel status. During exercise the major role for sport drinks is to promote hydration and re-fuelling (Jeukendrup & Gleeson, 2014). Sports bars provide a low-fibre, easily consumed form of carbohydrate and protein for use in different situations: pre-event meal/snacks, where the athlete is at high risk of gastrointestinal problems during exercise; following a training session or competition to contribute to carbohydrate needs for re-fuelling (and if the protein content is adequate, to contribute to protein synthesis goals); and as a snack to provide energy/macronutrient intake without need to prepare or eating additional food or meals (Robergs, 2018). Adolph, (2013), state that, for situations which require a high rate of carbohydrate delivery to working muscle, gels containing "multiple transportable carbohydrates" (a blend of carbohydrates such as glucose and fructose which use different intestinal transporters) may overcome the usual limitation of gut uptake.

| Daily Recommendations | Punctual intake related to training and Competition |
|---|---|
| Carbohydrates **7-12 g/kg Weight** | Previous meals: Breakfast 2-4 h before training/competition: Meals rich in CHO which enables to reach the daily recommendation |
| | The last 2 h before exercise: 30 g CHO/h minimum |
| | During training (lasting >1 h) and competition: Solutions 6% CHO (6 g/100 ml) or 500-1000 ml/h isotonic beverage (30-60 g CHO/h) or |



EDITOR-IN-CHIEF
Prof. G.O. Emerole [NIGERIA]

mediterraneanresearchpub@gmail.com

| | |
|---|---|
| | solutions 2-3% CHO with addition of solid/semisolids foods rich in CHO until reaching 30-60 g/h |
| | Immediately post-exercise: 1 g/kg weight post exercise (when the aim is to replenish muscle glycogen at maximum levels: e.g.: two training session in the same day) or 0.8 g/Kg weight (when the aim is to stimulate muscle fiber recovery: e.g.: hypertrophy) (no more than 30 min. after) |
| Proteins<br>**1,4-1,7 g/kg weight** | Immediately post-exercise: 20-25 g ór 0.25 g/kg weight along with CHO (no more than 30 min. after) To distribute, if possible, in 0.25 g/kg weight at different meals, every 3-4 h throughout the day including proteins that contain all the essential amino acids and rich in leucine. |
| Fat<br>**20-35% of total daily energy intake** | Distributed during the different meals throughout the day, taking into consideration to not overload with fat on the meals nearest to exercise. |
| Vitamins and minerals<br>**To meet recommendation for general population as a minimum level** | Ensure the supply of micronutrients through a varied diet rich in vegetable, fruits, white meats, whole grain, non-fat dairy and non-fried vegetable oil. This allows meeting optimum levels in general. To consider supplementation in individual cases of deficiency or risk of one or more micronutrients. |
| Hydration | Weigh athletes before and after training and competition and measure fluid intake during exercise for determining an individual recommendation of fluid. |

Table 1: Daily nutritional recommendations for athletes training in hot and humid environment.
(Bonfanti & Jimenez, 2016).

**Conclusion and Recommendation**

Sports nutrition has received considerable attention over the past few decades, and it is likely to get even more attention, given that nutrition plays such an important and sometimes crucial role in an athlete's

performance. Indeed, nutrition influences nearly every process in the body involved in energy production and recovery from exercise. To understand and apply the basic principles of sport nutrition, some basic understanding of nutrition, exercise physiology and sport science are necessary. The nutritional approach for training and competition is one of the most important concerns of sport nutrition science. Exercise produces several molecular, biochemical and physiological responses and the aim of a well designed diet is to guarantee a correct intake of energy, carbohydrates, proteins, fats, vitamins, minerals and water in order to support basic nutrition requirements as well as pre-, during and post-exercise specific nutrition phases. Carbohydrate requirements for exercise are increased in the heat, due to the increase of carbohydrate utilization. Training diets should focus on replacing glycogen stores after exercise including strategies to enhance carbohydrate availability during exercise. Dehydration as little as 2% of body weight significantly degrades exercise performance in the heat. In order to minimize the adverse consequences of dehydration on exercise performance, it is recommended that athletes training in a hot environment ingest a source of carbohydrate and fluids for replacement of water as sweat. Athletes are encouraged to drink more than their urge and equivalent to their weight loss. Although carbohydrate ingestion may not enhance the performance of all events in a hot environment, however, there is great advantage in consuming beverages containing 4-8% carbohydrate and electrolytes. After exercise, complete restoration of fluid balance and glycogen stores is an important part of the recovery process.

**REFERENCES**

Adalph, E.I. (2013). *Physiology of man in the desert*. New York, N.Y Interscience.

American College of Sports Medicine. (2016). Position stand: Exercise and fluid replacement. *Journal of Medical science and Sports Exercise, (28), 1-8.*

Balsom, P.B., Wood, K., Olsson,p., &Ekblem, B.(2014). Carbohydrate intake and multiple sprint sports: with special reference to football. *International Journal of sports medicine, 20:48-52.*

Barker, J. (2019). *Don't sweat the weather-adapt to it*. The Calgary Herald, C2.

Bonfanti, N., & Jimenez, S.L. (2016). *Nutritional recommendations for sports team athletes*. Spain. European University of Madrid Press.

mediterraneanresearchpub@gmail.com

Broad, E.M., Burke, L.M., Gox, G.R., Heeley, P., & Riley, M. (2016). Body weight changes and voluntary fluid intakes during training and competition session in team sports. *International Journal of Sports Nutrition, 6: 307-320.*

Burke, L., & Hawley, J. (2017). Fluid balance in team sports: guidelines for optimal practices. *Journal of Sports Medicine, 24:38-54.*

Ceu, Q. (2018). Key minerals for hot and humid summer training-and where to get them. Journal of Personal Training. Retrieved from http://www.ncsf.org/continueded/on/ineceuaspx.

De-Oliveira, E.P., & Burini, R.C. (2011). Food-dependent, exercise-induced gastrointestinal distress. *Journal of International Social Sports Nutrition; 8:12.*

Febbraio, M.A. (2018). *Temperature, muscle metabolism and performance in exercise science and sports medicine*. Japan, Carmel press.

Jeukendrup, A., & Gleeson, M. (2014). *Sports nutrition*: An introduction to energy production and performance. Ed. Human Kinetics.

Junge, A., Langevoort, G., & Pipe, A. (2016). Injuries in team sports tournament. *Journal of sports Medicine. 34 (4):565-576.*

Keen, C.L. (2013). *The effects of exercise and heat on mineral metabolism and requirements*. Nutritional needs in hot environments. Washinton, National Academies Press.

Lang, J.K., Gohil, K., Packer, L., & Burk, R.F. (2019). Selenium deficiency, endurance exercise capacity and antioxidant status. *Journal of Applied Physiology, 63: 2532-2535*

Massimo, N., Sara, R., Daniela, B., & Angela, F. (2014). Sports nutrition science: An essential overview. *Journal of Progress in Nutrition. (9), 673-680.*

Mayo, C. (2019). Heat and exercise: keeping cool in hot weather. Healthy lifestyle, fitness. Retrieved from https://www.mayoclinic.org/healthy-lifestyle/fitness/in-depth/%20 exercise/art-20048167.

Montain, S.J., & Coyle, E.F. (2017). The influence of graded dehydration on hyperthemia and cardiovascular drift during exercise. *Journal of Applied Physiology. 73:1340-1350.*

Morgans, B. (2017). *Hydration for competing in hot and humid climates*. Washinton. Brent press.

Noakes, T.D. (2012). Hyponatremia during endurance running: a physiological and clinical interpretation. *Medical Science Sports Exercise,* 24:403-405.

Rabindarjeet, S. (2015). Nutritional requirements of athletes exercising in a hot environment. *Malaysia Journal of Nutrition, 11,(2), 189-198.*

Robergs, R. (2018). Glycerol hyperhydration to beat the heat. Retrieved from http:sportsci.org/trainintech/glycerol/rar.htm.

Samman, S., & Roberts, D.C. (2015). The effects of zinc supliments on lipoproteins and copper status. *Atherosclerosis. 70:247-252.*

Sareen, S.G., Jack, L.S., & James, L.G. (2015). *Advanced nutririon and human metabolism (5th Edition)*. Wadsworth. Pre-Press PMG.

mediterraneanresearchpub@gmail.com



**EDITOR-IN-CHIEF**
**Prof. G.O. Emerole [NIGERIA]**

Sawka, M.N., Montain, S.J., & Latzka, W.A. (2013). *Body fluid balance during exercise heat exposure*. In: Body fluid balance, Exercise and sports. Boca Raton, CRC press.

Sport Resource Information Centre. (2019). *Canadian athletes prepare for extreme temperatures*. Canada SIRC News.

Webster, S., Rutt, R., & Weltman, A. (2016). Physiological effects of a weight loss regimen practiced by college wrestlers. *Medical Sciences Sports Exercise. 22:229-234*.

mediterraneanresearchpub@gmail.com



**EDITOR-IN-CHIEF**
**Prof. G.O. Emerole [NIGERIA]**