COACHING & SPORT SCIENCE REVIEW

International Tennis Federation
www.itfcoachingreview.com
December 2022. 30th Year. Issue 88. 45-48
ISSN 2225-4757
https://doi.org/10.52383/itfcoaching.v30i88.360

Hydration in hot weather: Tennis exercise drink recommendations

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ABSTRACT

It is essential that tennis players have an appropriate, regular, and sufficient fluid intake. Indeed, athletes generally consume much less fluid than the losses induced by thermoregulatory mechanisms (mainly by sweating), caused by the combination of physical exercise and heat-related stress, when playing in hot condition.. This article aims to evoke the physiological and psychological mechanisms involved in the practice of tennis, training, or competition, in hot conditions (i.e., more than 25°C) dry or humid and to propose suggestions concerning the beverage use among tennis players. Applied recommendations, concerning pre- (before), per- (during) and post- (after) exercise hydration, are provided to anticipate and limit performance declines as well as prevent the risk of disorders, physiological conditions such as cramps, premature exhaustion, injuries and even heatstroke, as well as the psychological and motivational damage caused by dehydration.

Key words: drink, tennis, performance, heat.

Received: 10 October 2022

Accepted: 19 November 2022

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INTRODUCTION

Tennis is an intermittent and multifactorial sport that requires a combination of specific physical abilities such as agility, speed, power, muscular and aerobic endurance, as well as mental abilities of anticipation, reaction, and decision-making (Hornery et al., 2007). It is a very popular sport played on all continents and especially in areas of the globe in which ambient temperatures can be hot and exceed 28°C during the day, whether year-round or during summer periods such as summer, such as in countries or areas with a tropical climate (i.e., Brazil, Colombia, Congo, Vietnam, Caribbean), equatorial (i.e., Guyana, Gulf of Guinea, Central Africa, certain islands in the ocean Pacific, Indian Ocean and Southeast Asia), arid (i.e., North Africa, Middle East, Australia, deserts of India, United States) Mediterranean (around the Mediterranean, California, central Chile, Cape region of South Africa), temperate (Western Europe, part of the United States, or South America) or continental (part of North America, Eastern and Central Europe). Indeed, Misailidi et al. (2021) recently reported that 30% of ITF junior tournaments in the last ten years were held in hot, very hot or extremely hot conditions (i.e., 25°C-36°C wet bulb globe temperature: WBGT). Guadeloupe is a good example of a tropical environment, in which the ITF junior tournament in Saint-François takes place, which is in the Caribbean and has a relatively constant average temperature of 26°C with maximums of 34°C and a relative humidity around 80% (Hue et al., 2019). Playing tennis under such conditions involves managing the player's hydration status and drink intake (Fleming et al., 2018) given the combined effects of practice and heat stress that we will, now, approach.

EFFECT OF THE COMBINATION OF EXERCISE AND HEAT

The performance of a sports activity such as tennis generates the production of metabolic heat mainly resulting from the contractions of the muscles which are active during the exercise. In a neutral environment (less than 24° Celsius with a relative humidity of about 30%), this so-called compensable heat will mainly be evacuated by cardiovascular and ventilatory adaptations (i.e., increase in heart rate, respiratory rate, and blood flow towards the skin) and by the evaporation of sweat (i.e., perspiration) at the skin level (Tyler et al., 2016). To a lesser extent, the heat may be evacuated by evaporation from breathing, by convection linked to exchanges between the outside air and the skin (especially when the player is moving) as well as conduction between the latter and clothing fabrics (see figure 1). This will result in a rise in the players' core temperature, which will stabilize at around 38.5°C (Martin et al., 2018).

However, when the humidity in the air and/or the environmental heat increase, the core temperature of the players will also experience an increase which can sometimes go beyond 39.5°C (Bergeron et al., 2007). This increase in core temperature is caused by an exceedance of evapotranspiration capacities, as observed in tropical climates (about 31° Celsius and 75% relative humidity; for a review see Hue, 2011), the evaporation of the sweat is no longer sufficient to evacuate the heat which will be qualified as non-compensable. In addition, in sunny conditions, the body could experience additional heat gain caused by solar radiation (Bergeron et al., 1995), which could be accentuated by wearing dark clothing.

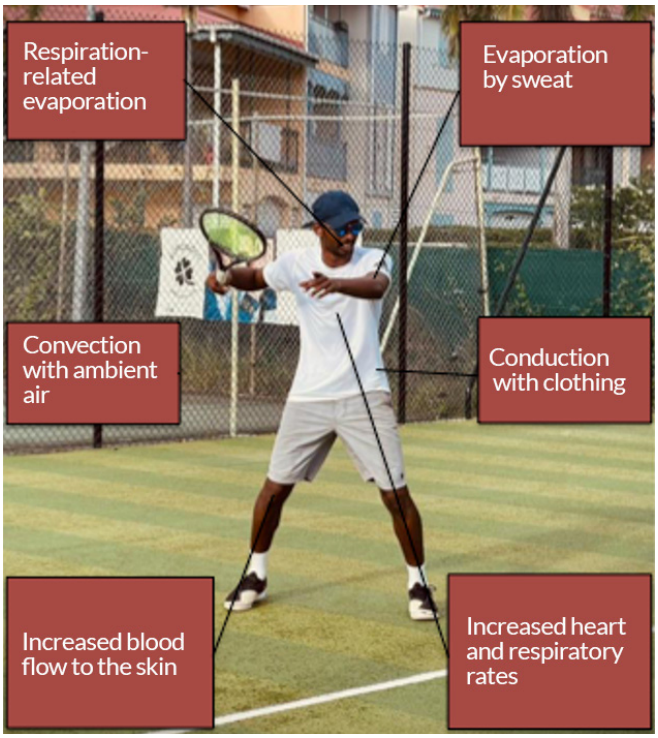

Figure 1. *Mechanisms of heat removal in tennis players*

Physiological dysfunctions (i.e., very high heart rate and core temperature), linked to difficulties in dissipating heat, can reduce sports performance (Hue, 2011; Périard & Bergeron, 2014), promote dehydration in tennis players (Kovacs, 2006) and are also likely to threaten the health of athletes in training or during competitions (Bergeron et al., 2014; Léon & Bouchama, 2015). In addition, it is important to note that playing in hot conditions can also generate psychological and cognitive constraints (i.e., increase in negative effects, limitation of attentional resources) which can promote the early onset of fatigue, amplify perceived effort, increase discomfort, and lower the motivation of athletes (Périard et al., 2014; Robin et al., in press). To limit the deleterious effects of heat, tennis players can use different cooling strategies: internal cooling (i.e., ingestion of cold drinks or crushed ice) and external (i.e., ice packs, cold towel, spray cold water) or acclimatization (Robin et al., 2021) and must ensure that they maintain a good state of hydration and limit dehydration by using appropriate exercise and recovery drinks.

IMPORTANCE OF PRE-EXERCISE HYDRATION STATUS

Body temperature regulation, cardiovascular stress, and heat tolerance during exercise in a humid and/or hot environment are modulated by the hydration status of tennis players (Périard et al., 2021; Robin et al., in press). Hydration, which must be adapted to carrying out intense physical activity and to the environment, is one of the performance factors that should not be overlooked (Guezennec, 2011). It is recommended to drink ad libitum (i.e., to satiety), to be "euhydrated" at the start of practice, and therefore to avoid being dehydrated by being thirsty before playing (Périard et al., 2014). The colour of urine, which should be quite clear, can be used as an indicator of the hydration status of athletes (Teodor, 2017). The "pre-exercise" drink that we recommend players consume is water, especially if they have had a meal sufficiently rich in carbohydrates (e.g., pasta, rice) and protein, at least 3 hours before the start of the practice (Martin, 2018).

It is important to note that tennis players should avoid overhydration, i.e., drinking too much, before playing. Indeed, hyperhydration does not improve thermoregulation or sports performance (Chabert et al., 2019) and can lead to feelings of heaviness, bloating, nausea, or force players to go to the toilet. It will also be suggested to avoid drinks that contain taurine, caffeine, or alcohol because these can accelerate the loss of fluid or to drink too sweet drinks (very rich in carbohydrates) which can cause reactive hyperglycaemia and induce hypoglycaemia at the start of practice. The recommendations will be to ingest around 6 ml of drink per kg of body mass (Martin, 2018) around 2 hours before the practice (see table 1).

Table 1

Recommendation concerning the ingestion of drink, before the effort, according to the body weight of the players, centilitre (cL).

Body mass	40kg	50kg	60kg	70kg	80kg	90kg	100kg	110kg
Beverage volume	24 cL	30 cL	36 cL	42 cL	48 cL	54 cL	60 cL	66 cL

NEED TO STAY WELL HYDRATED DURING EXERCISE

When playing tennis in a hot environment, the increase in perspiration caused by the physiological mechanisms of thermoregulation can induce bodily dehydration which will increase with the waning of physical practice (Baker, 2007), if it is not compensated by fluid ingestion. For example, it has been shown that tennis players can lose up to more than 3 litres of body fluid per hour of tennis practice, especially in hot conditions (Guezennec, 2011; Martin, 2018). However, the feeling of thirst is not a good indicator of hydration status, players are at risk of drinking too little and will not be able to compensate for body fluid losses caused by exercise and heat. Indeed, even if athletes ingest drinks as soon as they feel the urge to drink (during breaks or changing sides in competition), dehydration can still occur and will worsen as the training or match times increase (Garth & Burke, 2013). However, excessive dehydration (beyond 2% loss of body weight) can cause, in addition to reduced performance, cramps, discomfort, exercise hyperthermia (i.e., heat stroke) or even worse cause death (Bergeron, 2013). Therefore, we urge athletes to exercise the utmost caution and advise them to test and integrate fluid management (i.e., composition, volume, frequency of drink ingestion) into their training and performance routines, to compensate for losses of fluids, electrolytes such as sodium or carbohydrates.

For efforts lasting approximately one hour, several authors indicate that water may be sufficient (i.e., Bergeron, 2022; Teodor, 2017). However, the decrease in sodium in the blood plasma, caused by sweating, is an important factor in fatigue and reduced performance (Vrijens et al., 1999), which is why it is necessary to provide a moderate intake of sodium (between 500 mg and 1 g per litre, which corresponds approximately to 1 to 2 pinches of cooking salt) in the drink for efforts of more than one hour. Similarly, carbohydrate supplementation (about 20 g per litre, which corresponds to 4 teaspoons or 4 sugar cubes) will be recommended to meet the body's needs when playing in hot conditions (see Guezennec, 2011 for specific recommendations depending on the outside temperature). In addition, the use of flavoured drinks may increase the volume of drinks spontaneously ingested. Finally, it is important to remember that substances such as vitamins, caffeine, arginine, or taurine are not part of the European recommendations concerning the composition of exercise drinks in sport.

During tennis practices of more than 1 hour, carried out in hot conditions, it is recommended to have exercise drinks containing carbohydrates and electrolytes (mainly sodium), which make it possible to increase the ingestion of liquid, delay the onset of fatigue and slow down the increase in core temperature, thus limiting the impact of heat stress (Bergeron et al., 2006). Players have the option of composing their drinks themselves (see figure 2).

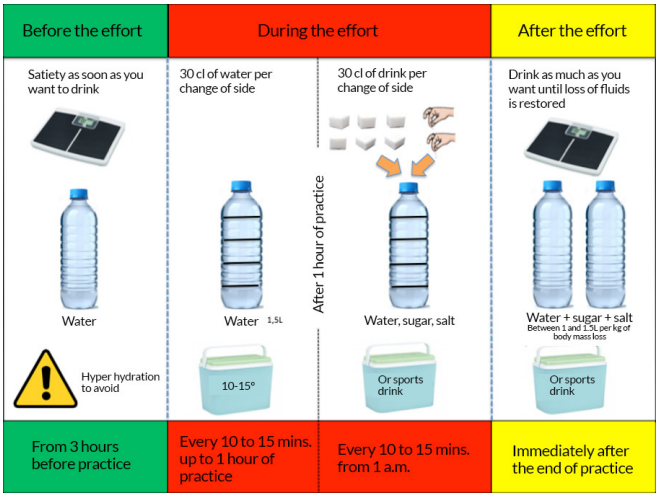

Figure 2. *Drink preparation options.*

It is generally suggested to ingest at least 30 cl of drink (Martin, 2018) during side changes, which generally take place every 10-15 minutes in matches. However, these suggestions can be adapted and personalized according to the sweating rate specific to each player (which can range from less than 1 litre per hour for those with "low" sweating to more than 3 litres per hour for athletes with a profuse sweating) and their gastric emptying (between 1 litre and 1.6 litres per hour). To allow players to drink the sufficient and recommended amount of liquid, we suggest making marks on the 1.5-liter bottle for example (see figure 2).

In addition, the temperature of the ingested liquids must be considered. Indeed, although frozen drinks could be used as an "internal cooling strategy" as reported in the literature (i.e., Douzi et al., 2020), these can have undesirable effects such as causing discomfort when ingestion, cause headaches (i.e., cold-related migraine) or even have a braking effect on thermoregulation processes by acting on deep thermal receptors (Guézennec, 2011). Therefore, we recommend the use of cold drinks at temperatures between 10°C and 15°C, stored in coolers or thermos flasks, which while promoting central cooling will be more easily consumed by players.

DO NOT NEGLECT POST-EXERCISE REHYDRATION

Immediately after exercise, the priority is to replace lost fluids, electrolytes, and carbohydrates (Bergeron et al., 1995). This can be done with water and a balanced meal rich in proteins, carbohydrates and salt which will replace the loss of sodium caused by sweating, stimulate the absorption of glucose, and promote the retention of absorbed fluids. According to Guezennec (2011), the optimum volume of drink is 1.5 litres for each kilogram of body weight lost during exercise.

However, when players must play very close matches one after the other, it is advisable that rehydration be done with a drink containing carbohydrates and electrolytes including sodium but also potassium (Kovacs, 2008). We also recommend favouring cold and flavoured drinks (i.e., using syrups of different flavours) according to the tastes of each athlete to promote ad libitum liquid absorption after exercise. A small quantity of solid and easily digestible food can be consumed at the same time as the ingestion of drinks.

If sweat losses in the previous match are excessive (significant difference between player's pre- and post-match weight), or if athletes have heat-related muscle cramps, it may be appropriate to add a little more salt to the drinks and food ingested to start the next match by being "euhydrated" and to prevent or limit the appearance of cramps. Regarding carbohydrate intake (i.e., carbohydrates) it will be recommended to consume 1.5 g per kg of body mass, which represents 60 g when you weigh 40 kg, 90 g for 60 kg, 120 g for 80 kg and 150 g per 100 kg of body mass to be ingested in solid and/or liquid form in the first hour after exercise (Kovacs, 2006).

CONCLUSION

Before starting training or a tennis match in humid and/or hot conditions, we recommend that players drink regularly as soon as they feel like it, and above all not to start playing while being dehydrated. During practice, it is suggested to regularly drink about 30 centilitres (cL) of water every 10-15 minutes for the first hour and then to use a drink containing carbohydrates and sodium when the effort lasts longer. This drink can be easily made or purchased commercially. Finally, it will be important for the player to rehydrate after exercise, to restore losses of body fluids and electrolytes. This rehydration must be done by means of drinks containing carbohydrates, sodium, and potassium and which can be supplemented with a balanced meal or a snack containing proteins.

CONFLICT OF INTEREST AND FUNDING

The authors declare that they have no conflict of interest and that they have not received any funding to conduct this research.

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