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Research article

THE INFLUENCE OF FLUID INGESTION ON PERFORMANCE OF SOCCER PLAYERS DURING A MATCH

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ABSTRACT

The purpose of this study was to verify the effects of a carbohydrate-electrolyte drink on soccer performance. Twenty soccer players volunteered to participate in the study. Players were allocated to two assigned trials according to their positional roles in the team: CHO group (ingesting a 6% carbohydrate-electrolyte solution at regular 15 minutes intervals) and NCHO (ingesting no fluid) during 75 min on-field soccer game. During the trials, body mass loss, heart rate, time spent running, number of sprints and core temperature were measured. There were statistically significant changes ($p < 0.05$) in body mass loss (CHO: 1.14 ± 0.37 kg vs. NCHO: 1.75 ± 0.47 kg) and number of sprints performed (CHO: 14.70 ± 4.38 vs. NCHO: 10.70 ± 5.80) between groups. The main finding of the present study indicates that supplementation with a carbohydrate-electrolyte drink during a soccer match is beneficial in helping to prevent deterioration in performance.

KEY WORDS: Sports drink, carbohydrate, soccer performance, heart rate, core temperature.

INTRODUCTION

Soccer is characterized by intermittent high-intensity exercises (Reilly, 2000) and it is well established that the loss of only 2% of body mass is sufficient to impair performance and cognitive function (Shepard, 1999). Besides that, without an adequate fluid intake during exercise players can experience an increase in core temperature and heart rate (Casa et al., 2000; Murray 2000). Fatigue during a soccer match is often associated with carbohydrate depletion and, depending on the level of competition and fitness level of the player, his body carbohydrate reserves (muscle glycogen) will decrease in proportion to the duration and intensity of the game (Bangsbo, 1992; Castagna and O´ttavio, 1999; Hargreaves, 1994; Hawley, 1994).

It has been observed that when players ingest a fluid that contains carbohydrate during a simulation or in a real match, they cover a greater distance, have higher muscle glycogen concentration after the game, perform better and feel less fatigued than those players that do not ingest any fluid (Leatt and Jacobs, 1989; Mc Gregor et al., 1999; Nicholas et al., 2000). According to soccer's rules, during the game there are no formal breaks that allow players to ingest fluids and if the game is played under warm environmental conditions they face heavy demands upon both body fluid and carbohydrate reserves (Monteiro et al., 2003; Sanz-Rico et al., 1996; Shepard, 1990). However, there is little information available investigating the influences of carbohydrate-electrolyte drinks on performance of players during soccer match. Therefore, the aim of this study was to examine the effects of a carbohydrate-electrolyte drink on soccer performance.

METHODS

Subjects

Twenty male soccer players of São Paulo Futebol Clube participated in the study, which had university ethical committee approval (Research Ethics Committee from University of São Paulo). All participants were informed verbally and in writing about the nature and demands of the study, as well as the known health risks. The physical characteristics and % body fat (Jackson and Pollock, 1978) of the players are shown in Table 1.

Table 1. Selected physical characteristics of the players (n = 20).

Variables	Mean (±SD)
Age (years)	16.06 (1.11)
Height (m)	1.80 (0.05)
Body mass (kg)	68.5 (4.81)
∑ 7 skinfolds (mm)	59.5 (9.73)
% body fat	10.6 (1.29)

Protocol

The game consisted of one 45 min half, 15 min of interval and another 30 min half. The environmental conditions were measured using a wet bulb globe temperature, which is a convenient index to assess it, by the following equation: 0.7 (T_{wb}) + 0.2 (T_g) +0.1 (T_{db}), where T_{wb} is the wet bulb temperature, T_g is the globe temperature and T_{db} is the dry bulb temperature. Before the game players were allocated to two randomly assigned trials considering their positional roles: ingesting carbohydrate-electrolyte drink (CHO) or not ingesting carbohydrate-electrolyte drink (NCHO). During the trial, the ambient temperature was 28° C. Every 15 min the game was interrupted and the fluid trial ingested 300 ml (ACSM, 1996) of a commercially available carbohydrate-electrolyte drink (6% tangerine-flavored carbohydrate Gatorade solution). During the interval all players were allowed to ingest water *ad libitum*; this was monitored by an observer.

Body weight was determined prior and after the game with a digital scale, accurate to 50 g. Subjects wore minimal clothing during weighting and did not wear taping, ankle guards, or jewelry.

Heart Rate measurements

Heart rate was monitored every 15 minutes during the match using short-range radio telemetry (Polar Sport Tester ™ S610, Finland). Mean heart rate for the match was used as a marker of the load imposed to the cardiovascular system due to the intensity of performance and to the environmental heat stress.

Performance measurement

Twenty volunteers observed each player during the entire game and used a stopwatch to determine the time each player spent with or without the possession of the ball, no matter the direction. They also observed the number of sprints each player performed during the game. Those measurements were divided along the first and the second halves. Those volunteers were previously trained for that job.

Core Temperature

The core body temperature was determined by an ingestible "thermometer-pill" (Cor Temp Disposal Temperature Sensor) which together with the recorder (Cor Temp 2000 ™) provided continuous and accurate real core body temperature data. Once swallowed the sensor passed harmless through the subject's gastrointestinal tract at his normal rate of motility and then was eliminated naturally from the body after 24 – 72 hours. The CorTemp ™ Disposable Temperature Sensor utilizes a temperature sensitive crystal which vibrates in direct proportion to the temperature of the temperature of the substance surrounding it. This vibration creates an electromagnetic flux which continuously transmits harmlessly through the surrounding substance. The CT 2000 recorder receives this signal, which is then displayed on the unit and simultaneously stored to memory. Each CorTemp ™ Disposable Temperature Sensor is individually calibrated at the factory, and the calibration adjustment is entered into the CT 2000 prior to use, assuring a temperature accuracy of ± 0.1º C. Players ingested those pills eighteen hours before the protocol.

Statistical analyses

Data are expressed as means ± standard deviation. A probability level less than 0.05 was accepted as statistically significant. To analyze differences in heart rate, core temperature and match load in hydrated vs. no hydrated trials *t* test was performed. The data were analyzed using the statistical package SPSS, PC program, version 11.0 (SPSS Inc., USA).

RESULTS

The physical characteristics of the players are listed in Table 1. Results on body mass loss, heart rate, time spent running, number of sprints and core temperature are shown in Table 2. Body mass losses were higher in the NCHO group ($p < 0.05$). It was expected that heart rate would be higher in NCHO group during the whole match, but there were statistical differences only during the second half of the game between CHO and NCHO groups ($p < 0.05$). Players ran more during the first half of the game and there were statistically significance between the first and the second halves in both groups. Regarding the number of sprints performed the same situation occurred. However, statistically

Table 2. Body mass loss, heart rate response, time spent running, number of sprints and core temperature in CHO and NCHO groups during the soccer game. Data are means (±SD).

		Time	
	Trial	**1st Half**	**2nd Half**
Body mass loss (kg)	CHO	-	1.14 (.30)
	NCHO	-	1.75 (.47)*
Heart rate (beats·min^{-1})	CHO	151 (10)	161 (7)
	NCHO	156 (2)	171 (4)
Time spent running (min)	CHO	15.46 (3.65)*	9.85 (2.78)
	NCHO	14.23 (1.45)	10.44 (2.78)
Sprints performed (number)	CHO	14.7 (4.38)*	6.8 (3.28)
	NCHO	10.7 (5.80)	4.4 (2.94)
Core temperature (° C)	CHO	37.29 (0.59)	39.17 (.69)
	NCHO	37.32 (0.20)	39.43 (.40)

* Statistically significant at $p < 0.05$ for CHO vs. NCHO groups.

significant differences ($p < 0.05$) between CHO group and NCHO group were observed only during first half, where the CHO group performed more sprints than NCHO group. There was a trend for the core temperature to be higher in the NCHO group during the match; however, this was not significant ($p > 0.05$). During the interval the CHO group drank 340 (± 201) ml and the NCHO group 890 (± 263) ml of water.

DISCUSSION

This study compared a CHO electrolyte drink group and a no fluid ingestion group because those players in the latter group are used to spending the whole game without drinking any fluid. So it was not a problem for them to exercise without consuming fluid. The main finding of this study was that the carbohydrate – electrolyte drink improved performance during a soccer match compared with no ingestion of fluids at all. It is well established that dehydration resulting in as little as 2% body weight has a negative impact on exercise performance, impairs muscular endurance, mental functioning, thermoregulation and increases both core temperature and heart rate (Casa et al., 2000). Nicholas et al. (2000) observed a loss of 2.2 kg of body weight during a soccer match. In our study there was a loss of 1.14 kg and 1.75 kg body mass of CHO and NCHO, respectively. In this study the body mass loss of CHO group were lower than in the NCHO group, thus it would be expected that the CHO group had a better performance during the match than NCHO group. Similar data was found by McGregor et al. (1999) who studied the effects of fluid ingestion on soccer specific skills and concluded that performance was deteriorated 5% in the group that did not ingest any fluid during the trial.

Leatt and Jacobs (1986), Foster (1986), Smith (1992), Nicholas (1995), and Ostojic and Mazic (2002) reported positive effects of carbohydrate-electrolyte drinks on performance of soccer players. Carbohydrate in this situation can be helpful because: (a) by the end of a soccer match most players become depleted of muscle glycogen (Nicholas et al, 2000); (b) deterioration in specific skills might be linked to depletion of muscle glycogen stores because glucose is the main substrate for metabolism in the central nervous system (Mc Gregor et al., 1999); (c) players with low glycogen content run and perform less sprints than those with normal content, specially during the second half (Hawley, 1994).

As sprinting is considered a high-intensity activity and represents 8 to 12% of total distance covered during a match by a player, we can assume that those who have a less deterioration in performance run more sprints, particularly during the second half of the game. It is expected that during the second half of the game, players perform 5% less than during the first half (Rienzi et al., 2000). In this study we observed that the number of sprints performed were higher during the first half in CHO group, suggesting that CHO group had a better performance during the first half of the match than NCHO group. Unfortunately, we expected that CHO group would maintain a better performance also during the second half when supposedly carbohydrate would contribute to avoid or at least delay fatigue. It is well established that water can attenuate the negative effects of dehydration, but regarding performance it can not contribute as much as carbohydrate does.

Dehydration in exercise results from the need to maintain body temperature close to the normal resting value of about 37° C. As soccer is an endurance sport involving 90 minutes of activity of

varying intensities, it will present a thermoregulatory challenge (Maughan and Leiper, 1994). In soccer most of the championships are played under warm environmental conditions and as a consequence core temperature in players above 39° C are commonly observed after soccer matches (Ekblom, 1986; Sanz-Rico et al., 1996; Shepard, 1999). This was reported in our study where both CHO and NCHO groups had their mean core temperature above 39 ° C by the end of the game.

Heart rate is an important instrument to evaluate soccer players´ performance during a match although fatigue and the partial result of the game could disguise the real behavior of heart rate. In both situations the tendency is that players run less and make less effort during the match (Ali and Farally, 1991). During moderate-intensity exercise, the magnitude of the increase in heart rate was directly related to the degree of dehydration. In the present study no statistically significant was found between CHO and NCHO group probably because those groups are used to play without drinking any fluid during the match.

CONCLUSIONS

This study provides encouraging evidence that soccer players should drink a carbohydrate-electrolyte drink throughout a match to avoid the negative consequences of dehydration, especially regarding performance. Future work should examine the optimal volume of fluid needed to sustain high levels of exercise.

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KEY POINT

- Supplementation with a carbohydrate-electrolyte drink during a soccer match is beneficial in helping to prevent deterioration in performance.

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