Original Article

Body mass changes and ad libitum fluid replacement in elite futsal players during official compe-tition

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ABSTRACT

García, J.V., Yuste, J.L., García, J.J., & Hellín, M. (2015). Body mass changes and ad libitum fluid replacement in elite futsal players during official compe-tition. *J. Hum. Sport Exerc., 10*(4), pp.891-903. The aim of this study was to calculate sweat loss, voluntary fluid replacement and levels of dehydra-tion in elite futsal players during official competition. Measurements were made in 12 male elite futsal players during six official matches in the Spanish First Division (22-26 ºC and relative humidity 32-42.33%). Participants were weighed before the warm up and they reweighed immediately after the games. Sweat loss was assessed through changes in body mass after taking into account fluid intake and urine loss. To analyze this data the statistics used were descriptive and non parametric. Mean sweat loss of players amounted to 2.29 litres (s = 0.73). Mean fluid intake was 1.5 litres (s = 0.74), re-placing 68.37% (s = 32.44) of total fluid loss. Players incurred a body mass deficit of 1.04% (s = 1.06), which is not seen as affecting their performance. There were no significant difference in sweat lost replaced and dehydration in relation to analyzed match ($P > 0.05$). There is a correlation between game time and body mass loss ($r = 0.323$, $P = 0.016$). From the results, we conclude that the level of hydra-tion in studied players can be seen to maintain itself through a correct level of fluid intake. However, these measurements allow an individualisation of player hydration strategies, not taking exclusively into account game time. **Key words**: BODY MASS CHANGES, DEHYDRATION, FLUID INTAKE, FUTSAL, COMPETITION.

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INTRODUCTION

Elite sport and especially futsal have reached a position with an important professionalization of its members (players, coaching, doctors and managers). This situation has motivated an increased interest in the use of resources to boost player's performance. One of those tools is the quantification and modification of fluid replacement strategies for athletes.

Dehydration occurs when fluid loss by sweating is higher than fluid intake (Jeukendrup & Gleeson, 2010) and it is common when athletes do not ingest enough fluid to match their sweat loss (Maughan & Gleesom, 2004; Roses & Puyol, 2006; Wilmore & Costill, 2007; Murray, 2007; Palacios, Franco, Manonelles, Manuz & Villegas, 2008).

Because dehydration is a limiting factor for mental and physical performance during sport and physical activity (Cheuvront, Carter & Sawka, 2003; Coyle, 2004; Casa, Clarkson & Roberts, 2005; Sawka et al., 2007; Palacios et al., 2008), it is extremely important to understand athletes hydration habits, and to intervene when necessary.

A simple way to determine the level of dehydration achieved in futsal players is to weigh the athlete before and after performing the exercise, as the average loss of water through respiration in intermittent activity lasting less than 3 hours, and normal weather conditions, is barely significant compared to the loss through sweating (Maughan, Shirreffs & Leiper, 2007). The use of pre- to post-exercise change in body mass provides an estimation of total fluid loss due to sweating (Burke, 1997; Maughan & Gleesom., 2004; Maughan et al., 2007; Murray, 2007). Therefore, measurement of body mass changes is a simple, non-invasive and valid approach to estimate hydration changes in team sports, by calculat-ing the difference in body mass pre- and post-exercise (Barbero, Castagna & Granda, 2006; Harvey, Meir, Brooks & Holloway, 2008).

A body water deficit greater than 2% of body mass marks the level of dehydration that can adversely affect physical performance (Casa et al., 2005; Shirreffs, Sawka & Stone, 2006; Sawka et al., 2007; Wilmore & Costill, 2007; Manore, Meyer & Thompson, 2008; Montain, 2008; Palacios et al., 2008; Jeukendrup & Gleeson, 2010), and to reduce the athlete's cognitive function as perceptual discrimina-tion or reaction time (Cheuvront et al., 2003; Coyle, 2004; Sawka et al., 2007).This data is particularly relevant to our study because the performance of a futsal player will depend on both their physical condition and cognitive abilities to make right decisions in the shortest time.

In team sports, in addition to individual differences in sweat rates of players like body weight, genetic predisposition or heat acclimatization state (ACSM, 1996; Shirreffs et al., 2006; Sawka et al., 2007), exercise performed by each player can vary considerably in intensity and duration, changing hydration levels (Burke, 1997; Harvey y cols., 2008).

In our research we have selected futsal because of the possibility of analyzing physiological responses of elite players in real competitive situations, since in similar articles published by studying first-level players, researchers are required to simulate competitive situations in training sessions (Broad, Burke, Cox, Heeley & Riley, 1996; Cox, Broad, Riley & Burke, 2002; Maughan, Merson, Broad & Shirrefs, 2004; Shirrefs et al., 2005; Martarelli et al., 2009).

The aim of this study was to calculate sweat loss, voluntary fluid replacement and levels of dehydra-tion in elite futsal players during six official matches, through the measurement of body mass changes, urine loss and total fluid intake.

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MATERIAL AND METHODS

Participants

Twelve male futsal players, from the first team squad of a professional club, were informed and gave their written consent to participate in this study, after the details had been explained to them. The study was approved by the Institutional Review Board at the University of Murcia (Spain). Physical characteristics of the players were: age 27.12 years, s = 3.46; body mass 76.41 kg, s = 6.54 and height 1.77 m, s = 0.06.

Due to the difficulty to study other teams in the same level to get a representative sample, the se-lection was done using non-probability sampling, having performed the selection for convenience. Therefore, and because the sample is not representative, we can not extrapolate the results of this re-search to other futsal teams.

Data were collected during six official matches in the Spanish First Division, corresponding to gameweeks 19, 21, 23, 25, 27 and 29 (Table 1).

Table 1. Timing and environmental conditions of matches*.

GAMEWEEK	DATE	TIME	TEMP	RH
19	6/02/2010	18’30h.	22	41.33
21	20/02/2010	13’45h.	24	39.33
23	6/03/2010	18’30h.	22	40
25	20/03/2010	18’30h.	22	40
27	3/04/2010	13’45h.	26	32
29	17/04/2010	18’30h.	24.8	42.33

TEMP: Air temperature (ºC); RH: Relative humidity (%)
* All matches were played in Murcia – Spain

Procedures

A meteorological station OREGON SCIENTIFIC WMR-80 (Oregon®, Hunghom, China), was used to record temperature and relative humidity, using the average value recorded since the start of warm-up to the final whistle.

To measure body weight we followed the protocol developed by the International Society for the Advancement of Kinanthropometry (Norton et al., 1996). We used a scale TANITA BC-350 (Tanita®, Illinois, USA) with 97% reliability, accuracy 0.1 kg. and a measurement range from 0 to 150 kg. Play-ers were weighed without clothing before the warm up and immediately after the match. Players were asked to micturate and defecate if necessary prior to the pre-warm up measurement. Before weighing the players at the end of the match, perspiration was wiped of the player's legs, body and face with a towel, as indicated by Barbero et al. (2006) in their study.

The percentage of body mass loss was calculated using the formula (Martins et al., 2007):

% Body mass loss: [(Pre-match weight – Post-match weight)/Pre-match weight] x 100

Each player was provided with two individual 500 ml. drinks bottles. The volume of fluid intro-duced into each bottle was previously measured in a graduated test-tube with capacity of 1000 ml. and 1000:10 calibrated. The players were instructed to drink only from their own numbered bottles, just as they were told that in case they need more liquid they should advise the researcher so that he could fill the bottles. Fluid intake was ad libitum. Once the match concluded, by subtracting the amount of liq-uid remaining in the player's bottle from the amount given to them, the total value for liquid consumed is yielded.
The volume of urine excreted by the players was measured since the warm-up to the end the match. After the first weighing of the players, and there after, the player had to urinate in a sterile and personal container, 1000:10 calibrated and prepared for urine collection.

Total sweat loss was calculated using the formula (Murray, 1996):

Sweat loss = (Pre-match weight + Fluid intake – Post-match weight – Urine excreted)

Each player's game time was obtained by adding up the minutes played and warm-up time. The warm-up had a 30' duration, including movility and stretching activities followed by technique exer-cises about pass and shot. The intensity of the warm-up was gradually increasing and the last part was a small-size match 5vs5.

Analysis
A 2-way ANOVA was applied to determine reliability (intraclass correlation coefficient, ICC Rs), and repeated measures ANOVA for the measurements of the researchers to check the systematic error. In addition, the design of this research is descriptive correlational. Data (game time, body mass loss, fluid intake and excreted urine) are presented as mean, ±SD and range. A non-parametric statistical analysis was applied, using the Kruskal-Wallis test to determine differences between the results of the various matches. Pearson's correlation coefficient has been applied to establish the correlation between game time and weight loss, with a statistical significance of $P \leq 0.05$.

RESULTS

Table 2 shows that after 51.04 minutes (s = 6.17) of game time, body mass loss was 0.82 kg, (s = 0.8). Mean excreted urine was 0.21 litres, s = 0.14, and the calculated mean sweat loss by players was 2.29 litres (s = 0.73). Total fluid intake by players was 1.5 litres (s = 0.74), on average replacing 68.37% (s = 32.44) of total fluid loss during the matches.

Table 2. Game time and fluid balance summary data.

n=12	GT (min)	BML (kg)	EU (l)	FI (l)	SL (l)	SLR (%)	DHY (%)
Mean	51.04	0.82	0.21	1.57	2.29	68.37	1.04
SD	6.17	0.8	0.14	0.74	0.73	32.44	1.06
Min	42	-0.9	0	0.65	0.57	28.42	-1.31
Max	70	+2.1	0.75	3.3	4.4	156.98	+3.02

GT: Game time; BML: Body mass loss; EU: Excreted urine; FI: Fluid intake; SL: Sweat loss; SLR: Percentage sweat loss replaced; DHY: Dehydration (%body mass loss)

The mean level of dehydration in these players at the end of the matches was 1.04% (s = 1.06) of the pre-match body mass, ranging from -1.31 to 3.02%. In the Figure 1 we can see the number of play-ers who finished the games in every dehydration range, from -1% to 3%.

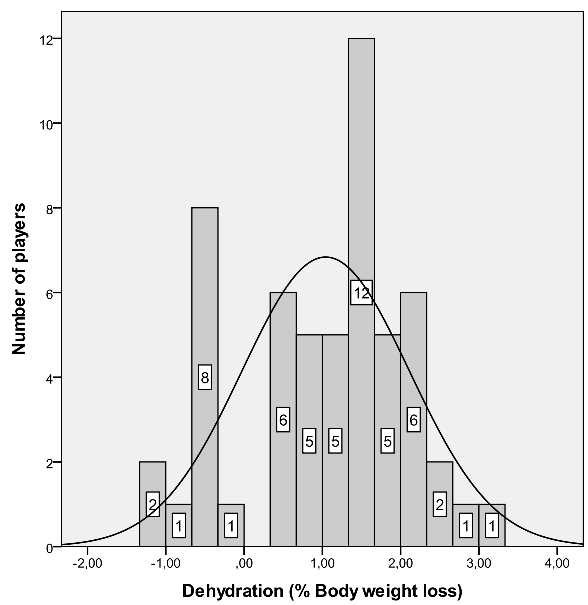

Figure 1. Distribution of % dehydration at the end of the matches.

There were no significant differences in the values of percentage of sweat loss replaced and level of dehydration obtained in six matches analyzed, as indicated by the values *P* = 0.971 and *P* = 0.999 respectively after applying the Kruskal-Wallis test.

There was a correlation between game time and level of dehydration (r = 0.323, *P* = 0.016). This means that the values of dehydration were greater when player's game time increased (Figure 2).

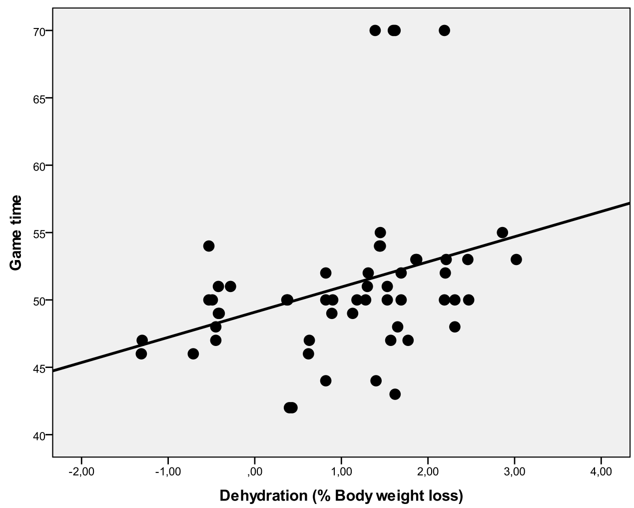

Figure 2. Relationship between game time and level of dehydration (r = 0.385, *P* = 0.016).

DISCUSSION

In this study we have calculate sweat loss, voluntary fluid replacement and levels of dehydration in elite futsal players during official competition.

Futsal played at highest level demands an excellent physical condition in players due to the physi-ological demands involved in competition (approximately 90% of maximum heart rate) (Barbero, Soto, Barbero-Álvarez & Granda-Vera, 2008; Castagna, D'Ottavio, Granda-Vera & Barbero, 2009). A high performance player needs an excellent ability to perform high-intensity intermittent exercise, and a rapid recovery during low-intensity activities. In this sense an adequate fluid replacement strategy is essential to avoid reduced performance (Burke, 1997; Coyle, 2004; Barbero et al., 2006; Shirreffs et al. 2006; Sawka et al., 2007; Murray, 2007; Palacios et al., 2008; Jeukendrup & Gleeson, 2010; García-Jiménez et al., 2014).

In this study, as a result of fluid loss through sweating players incurred an mean body mass deficit of 1.04% (s = 1.06). These values are not associated with a reduction in performance (Cheuvront et al., 2003; Casa et al., 2005; Palacios et al., 2008; López-Román, Martínez, Luque & Villegas, 2008). Due to the characteristics of futsal, it is recommended not to exceed 2% of body mass lost, as dehydration is associated with decreased aerobic performance and increased cardiac work (Casta et al., 2005; Saw-ka et al., 2007; Murray, 2007; Montain, 2008; Jeukendrup & Gleeson, 2010, García-Jiménez et al., 2014), it also affecting motor sensory reactions such as reaction time and perceptual discrimination (Casa et al., 2005; Montain, 2008).

The large individual differences in dehydration levels of players (ranged from -1.30% to 2.86% are in accordance with ACSM´s Position Stand (1996) and Shirreffs et al. (2006), which tell of the diffi-culty in giving a universal recommendation that adequately supplies for the needs of players due to the high variability of results obtained, even among members of the same team.

In similar researches, Barbero et al. (2006), Hamouti, Estévez, Del Coso & Mora (2007) and Mar-tins et al. (2007) studied the level of dehydration in futsal players. Barbero et al. (2006) assessed 13 elite futsal players, where mean percentage body mass loss after three official matches was 1.1% (s = 0.9), similar to that obtained from our research (1.04%, s = 1.06).

Hamouti et al. (2007) obtained 1.2% (s = 0.3) dehydration in elite futsal players after a training session. The mean body mass loss rate is higher than that obtained by the players in our study (1.04%, s = 1.06).

The study conducted by Martins et al. (2007) in futsal players show values of 0.43% (s = 0.41) body mass loss after assessing 6 players (15-18 years) in training session. These results are lower than those obtained from the players in our study (1.04%, s = 1.06).

In a recent study, García-Jiménez et al. (2014) obtained an average dehydration of 1.23%, (s = 1.10) in futsal forwards and 0.59%, (s=1.10) in futsal defenders during competition.

In other team sports, in an investigation about dehydration in basketball players, Broad et al. (1996) finds mean results were 1% loss in body mass, similar to those obtained in our study (1.04%, s = 1.06). Similar to this, Maughan et al. (2004), found a mean 1.37% (s = 0.54) body mass loss in elite soccer players during training. Also during a training session with professional soccer players, Shirreffs et al. (2005) results were 1.59% (s = 0.61). In both publications, percentage weight loss was higher than in our study (1.04%, s = 1.06).

Game time is considered as modifying factor of the dehydration achieved by players (r = 0.385, P = 0.016). However, various publications recommend to pay attention to environmental conditions, in-tensity of effort or fluid intake to explain losses caused by dehydration of athletes, and not taking ex-clusively into account game time (Casa et al., 2005; Sawka et al., 2007, Montain, 2008; Palacios et al., 2008). The environmental conditions in which the matches were played were similar (22-26 °C 32-42.33% RH) because they were played in the same sports hall, which has a cooling system. There-fore, in the first analysis, the results agreed with studies that warn that progressive dehydration during exercise is common because many athletes do not get enough fluids to replace sweat losses (Burke, 1997; Casa et al., 2005; Sawka et al., 2007; Wilmore & Costill, 2007; López-Román et al., 2008; Palacios et al., 2008).

Mean fluid intake by players in our study (1.57 litres, s = 0.74) exceeds results by Barbero et al. (2006) in elite futsal players. Along these lines, another study with elite futsal players Hamouti et al. (2007) obtained an average of 0.8 litres intake after a training session, less than the total fluid intake by our players.

In other team sports, Broad et al. (1996) assessed fluid intake in 12 basketball players during a match, which mean result was 1,08 litres, less than that obtained in our study (1.57 litres, s = 0.74). In a similar study, Schröder et al. (2009) assessed fluid intake during training and competition in 55 elite basketball players, which mean result was 0.88 litres, less than fluid intake by futsal players in our re-search.

Compared to studies with soccer players, fluid intake in our research (1.57 litres, s = 0.74) was higher than calculated by Maughan et al. (2004) and and Shirreffs et al. (2005), who obtained a mean fluid intake of 0.9 litres (s = 0.3) and 0.97 litres (s = 0.33) respectively after analysing soccer players during training sessions.

In the sport of our study, a futsal player has ample opportunities to hydrate, due to substitutions and breaks in play during the match. Barbero et al. (2006) calculated that every field player had 7.4 opportunities to hydrate per match.

Fluid intake in our study was ad libitum, replacing players 68.37% (s = 32.44) of the losses caused by sweat. Mean levels of dehydration (1.04%, s = 1.06) shows that intake was sufficient to offset losses caused by sweat lost.

CONCLUSIONS

First we would like to thank the coaches and athletes of the German national junior rowing team and the German Rowing Federation (DRV) for their cooperation. Many thanks go to the engineers of the Institute for Research and Development of Sports Equipment (FES) for the development of the measuring device and the technical support. Special thanks were addressed to the German Federal Institute of Sport Science (BISp) for supporting the project financially over the years. Finally, we also want to thank Bruce Grainger for critically proof reading the manuscript.

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