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Fluid balance and dehydration in futsal players: goalkeepers vs. field players

Reposición hídrica y deshidratación en jugadores de fútbol sala: porteros vs. jugadores de campo

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Abstract

Dehydration higher than 2% can adversely affect performance. The purpose of this study was to determine and to compare fluid balance in elite futsal players in relation to playing position. We tested three goalkeepers (GK) and nine field players (FP) during 3 official matches (22-24 ºC and 39.33-42% RH). Body mass changes, fluid intake (ad libitum) and urine loss were calculated. To analyze this data the statistics used are descriptive and no parametric. Sweat lost in FP (2450±774.63 ml.) was higher than in GK (2195±557.64 ml.). Fluid intake in FP (1650.42±774.74 ml.) was higher than in GK (1205±333.31 ml.). Dehydration in GK (1.27±0.60%) was higher than FP (1.00±1.15%). There were no significant difference in body weight loss and sweat lost replaced (p>0.05) in relation to playing position. Even GK and FP dehydration status are not associated with a reduction in performance. In these players, independently of position, hydration status can be seen to maintain itself through regular substitutions and also the correct fluid intake.

Key words: dehydration; fluid intake; competition; futsal.

Resumen

Un nivel de deshidratación superior al 2% puede afectar negativamente al rendimiento. El objetivo de este estudio ha sido determinar y comparar la reposición hídrica en jugadores profesionales de fútbol sala según su posición. 3 porteros (GK) y 9 jugadores de campo (FP) fueron estudiados durante 3 partidos oficiales (22-24 ºC y 39,33-42% HR). Se registraron los cambios en el peso corporal, líquido ingerido (ad libitum) y orina excretada. Para el análisis de datos se aplicó estadística descriptiva y no paramétrica. El sudor perdido en FP (2450±774,63 ml.) fue mayor que en GK (2195±557.64 ml.). El líquido ingerido en FP (1650,42±774,74 ml.) fue mayor que en GK (1205±333,31 ml.). La deshidratación en GK (1,27±0,60%) fue mayor que en FP (1,00±1,15%). No existen diferencias en los valores de deshidratación y líquido perdido (p>0,05) en función del puesto específico. El nivel de deshidratación alcanzado en GK y FP no se asocia con una reducción en su rendimiento. En estos jugadores, independientemente de la posición, el nivel de hidratación puede mantenerse por medio de sustituciones regulares y una correcta ingesta de líquido.

Palabras clave: deshidratación; líquido ingerido; competición; fútbol sala

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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 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 (Guyton, 1987, 177; Jeukendrup & Gleeson, 2010, 213) and it is common when athletes do not ingest enough fluid to match their sweat lost (Marín-Fernández, 1997, 326; Maughan & Gleesom, 2004; Roses & Puyol, 2006, 71; Wilmore & Costill, 2007, 460; Palacios, Franco, Manonelles, Manuz, & Villegas, 2008, 246).

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, p115; Sawka et al., 2007, 377; Palacios et al., 2008, 246; Watson, 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 (5º - 30º centígrados), 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 weight changes is a simple, non-invasive and valid approach to estimate hydration changes in team sports, by calculating the difference in body weight pre- and post-exercise (Barbero, Castagna, & Granda, 2006, 99; Harvey, Meir, Brooks, & Holloway, 2008).

A body water deficit greater than 2% of body weight marks the level of dehydration that can adversely affect physical performance (Casa et al., 2005, 115; Sawka et al., 2007, 381; Wilmore & Costill, 2007, 461; Manore, Meyer, & Thompson, 2008, 246; Montain, 2008; Palacios et al., 2008, 246; Jeukendrup & Gleeson, 2010, 287), and to reduce the athlete's cognitive function as perceptual discrimination or reaction time (Cheuvront et al., 2003; Coyle, 2004; Sawka et al., 2007, 381, Watson, 2008). This data is particularly relevant to our study because the performance of a futsal player, independently of playing position, 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, 2; Sawka et al., 2007, 378), the results of the players depending on the specific position, can vary considerably in intensity and duration of exercise performed during a match, changing hydration levels (Burke, 1997; Harvey et al., 2008). For this reason, our work has focused on comparing results between goalkeepers and field players.

Our investigation has studied elite futsal players during official games. The team analyzed is considered one of the best in the world, and the analysis of its players provides valuable information about futsal hydration habits during real competition. 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, Aragón-Vargas, Chamorro, Maughan, Serratosa & Zachwieja, 2005; Martarelli et al., 2009).

The aim of this study has been to determine and to compare the fluid balance and level of dehydration in elite futsal players in relation to playing position (goalkeepers and field players) during three official matches, through the measurement of weight loss, urine loss and total fluid intake.

Methods

Participants

We tested twelve male futsal players (three goalkeepers and nine field players), from the first team squad of a professional club. They were informed of the procedures associated with the study and signed and informed consent form prior to testing. The study was approved by the Institutional Review Board at the University of Murcia (Spain). Table 1 shows physical characteristics of players.

Table 1. Physical characteristics of players

Playing position	Goalkeepers (n=3)		Field Players (n=9)	
Variable	Mean±SD	Range	Mean±SD	Range
Age (years)	27.6±5	(23-33)	24.5±3	(21 - 30)
Height (cm.)	184±2	(182-185)	180±12.3	(169 - 192)
Body mass (kg.)	78.6±6.5	(82.6-74)	76.5±6.8	(72.8 - 85)

Due to the difficulty to study other teams in the same level to get a representative sample, selection 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 research to other futsal teams.

Data were collected during three official matches in the Spanish Futsal League (LNFS), corresponding to gameweeks 19, 21 and 23 (table 2).

Table 2. Timing and climate conditions of matches*

Gameweek	Date	Time	Temperature (ºC)	Relative Humidity (%)
19	4/02/2006	18'30h.	22	42
21	18/02/2006	13'45h.	24	39.33
23	4/03/2006	18'30h.	22	40

* 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 mean 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. Players were weighed without clothing before the warm-up and 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, 101) in their study.

The percentage of dehydration was calculated using the next formula (Martins, Aparecida, Kleverson, Works, Wagner, Bohn & Coppi, 2007, 29):

% Body weight lost: [(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 introduced into each bottle was previously measured in a graduated test-tube KARTELL PP-1082 (Kartell®, Noviglio, Italy), 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 liquid 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 warming-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 ATEMPRANA (Atemprana®, Madrid, Spain), prepared for 24 hours urine collection.

Total sweat loss was calculated using the formula (Murray, 1996, p250):

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 (standardized to 30 minutes).

Statistical 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, weight loss, fluid intake and excreted urine) are presented as mean, ±SD and range, in relation to playing position (goalkeepers or field players). A non-parametric statistical analysis was applied, using the Kruskal-Wallis test to determine differences between specific position of players. Spearman´s Rho statistic has been applied to establish the correlation between game time and body weight lost, with a statistical significance of $p \leq 0.05$.

Results

Table 3 shows that mean sweat lost were higher in field players (2450±774.63 ml.) than in goalkeepers (2195±557.64 ml.). Fluid intake was lower in goalkeepers (1205±333.31 ml.) than in field players (1650.42±774.74 ml.). Goalkeepers replaced less fluid lost (56.55±17.56%) than field players (71.10±35.09%), so they incurred a mean body mass deficit of 1.27±0.60%, higher than field players (1.00±1.15%).

Table 3. Game time and fluid balance summary data in relation to playing position

	Goalkeepers (n=3)		Field Players (n=9)	
Variable	Mean±SD	Range	Mean±SD	Range
Game time (min.)	60±11.54	(50 - 70)	49.13±3.30	(42-54)
Body mass loss (gr.)	990±480.69	(300-1400)	799.58±862.26	(-905 - +2100)
Fluid intake (ml.)	1205±333.31	(850-1630)	1650.42±774.47	(650-3200)
Excreted urine (ml.)	100±70.71	(0-150)	240±144.64	(100-750)
Sweat loss (ml.)	2195±557.64	(1580-2830)	2450±774.62	(860-4485)
Percentage of sweat lost replaced (%)	56.55±17.56	(43.09-81.01)	71.10±35.09	(29.02-156.98)
Dehydration (% Body weight lost)	1.27±0.60	(0.38-1.69)	1.00±1.15	(-1.31 - +3.02)

Mean game time in goalkeepers (60±11.54 min.) is higher than filed players (49.13±3.30 min.). In addition, there is a positive relation between game time and level of dehydration (Spearman's Rho=0.385, p=0.043).

In the three matches studied, the percentage of sweat lost replaced by goalkeepers was lower than field players (fig.1).

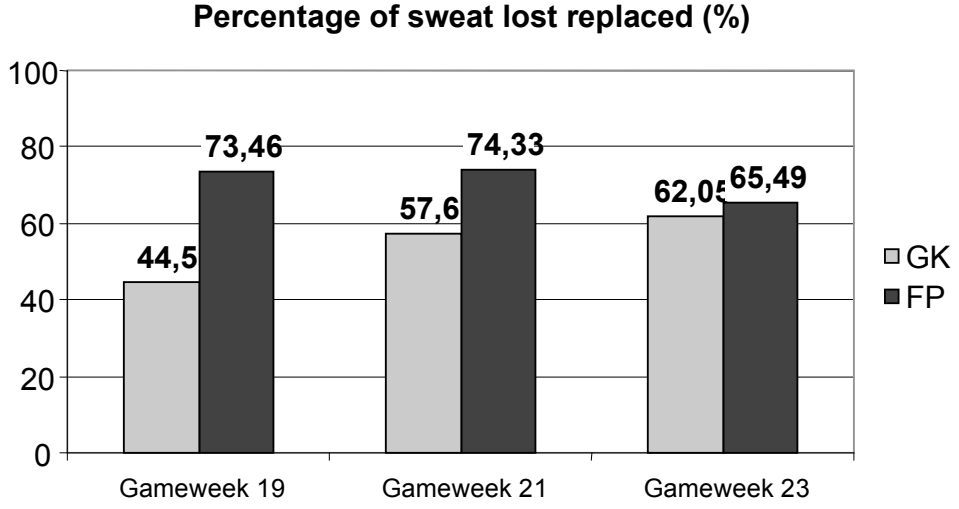

Fig.1. Fluid replaced in relation to playing position*

*GK = Goalkeepers; FP = Field players

However, there is no significant differences in the values of fluid replaced and dehydration obtained in relation to player's position, as indicated by the values p>0.05 after applying the Kruskal-Wallis test (table 5).

Discussion

In this study we have obtained the level of dehydration in elite futsal players during official matches in relation to playing position. The results show that, in these players, fluid replacement in goalkeepers is lower than in field players, resulting in higher levels of dehydration.

Futsal played at highest level demands an excellent physical condition in players due to the physiological 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 (goalkeeper or field 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 (Marín-Fernández, 1997, 321; Barbero et al., 2006, 105; Sawka et al., 2007, 384; López-Román, Martínez, Luque, & Villegas, 2008, 436; Palacios et al., 2008, 249; Refoyo, Sampedro, & Sillero, 2009, 8; Jeukendrup & Gleesom, 2010, 182).

As a result of fluid loss through sweat players incurred a mean body mass deficit of 1.27±0.60% in goalkeepers and 1.00±1.15 in field players. These values are not associated with a reduction in performance (Cheuvront et al., 2003; Casa et al., 2005, 115; Palacios et al., 2008, 246). Due to the characteristics of futsal, it is recommended not to exceed 2% of body weight lost, as dehydration is associated with decreased aerobic performance and increased cardiac work (Murray, 1996, Casa et al., 2005, 115; Sawka et al., 2007, 381; Montain, 2008; Jeukendrup & Gleeson, 2010, 287), it also affecting motor sensory reactions such as reaction time and perceptual discrimination (Casa et al., 2005, 115; Montain, 2008; Watson, 2008).

Mean dehydration in goalkeepers (1.27±0.60%) is lower than dehydration assessed by Barbero et al. (2006, 102) in futsal goalkeepers during official matches (1.7±0.5%). Purvis and Cable (2002) examined the physiological responses of 7 soccer goalkeepers during the training of a match. The weight loss produced by dehydration was 0.8%, lower than dehydration found in the goalkeepers in our research (1.27±0.60%).

In relation to field players, Barbero et al. (2006) assessed 13 elite futsal players, where mean percentage weight loss after three official matches was 1.1±0.9%, similar to that obtained from our research (1.00±1.15%).

Hamouti, Estévez, Del Coso, & Mora (2007), obtained 1.2±0.3% body weight lost in elite futsal players after a training session. The mean weight loss rate is higher than that obtained by the players in our study (1.00±1.15%).

The study conducted by Martins et al. (2007, 28) in futsal players shows values of 0.43±0.41% weight lost after assessing 6 players (15-18 years) in training session. These results are lower than those obtained by the players in our study (1.00±1.15%).

In other team sports, in an investigation of percentage of weight lost in elite basketball players, Broad et al. (1996) finds mean results were 1% loss in body weight, similar to those obtained in our study (1.00±1.15%). Similar to this, Coelho, Souza, Barbosa, & Oliveira (2007, 123) found a mean 0,99±1,12% weight loss in handball players during game training.

In relation to playing position, dehydration in goalkeepers (1.27±0.60%) was higher than in field players (1.00±1.15%). Game time is considered as modifying factor of the dehydration achieved by players (Spearman's Rho=0.385, $p \leq 0.05$). However, various publications recommend to pay attention to environmental conditions, level of physical condition,

intensity of effort or fluid intake to explain losses caused by dehydration, and not taking exclusively into account game time (Casa et al., 2005, 116; Sawka et al., 2007, 378, Montain, 2008; Palacios et al., 2008, 246).

The environmental conditions in which the matches were played were similar (22-24° C and 39.33-42% RH) because they were played in the same sports hall, which has cooling system.

To identify physical demands on players in team sports, we must study their specific characteristics and their specific position, because tactics of each position involve different levels of distance covered or intensity of effort between goalkeepers and field players (Hencken & White, 2006; Zúñiga & De León, 2007, 34). In a study of elite futsal players, goalkeepers covered less than half of the distance covered by field players (3030.71 mt. versus 6885.06 mt.), associating this data with lower-intensity efforts (Hernandez, 2001, 38).

In our study, sweat losses in goalkeepers were lower (2195±557.64 ml.) than in field players (2450±774.62 ml.).

Fluid intake in our study was *ad libitum*. Even goalkeepers and field players average dehydration shows that fluid intake was sufficient to offset dehydration. Goalkeepers replaced 56.55±17.56% of sweat lost, versus 71.10±35.09% replaced by field players.

Mean fluid intake by players in our study (GK 1205±557.64 ml. and FP 1650±774.47 ml.) exceeds results by Barbero et al. (2006, 106) in elite futsal players. Along these lines, another study with elite futsal players (Hamouti et al., 2007) obtained an average of 800 ml. intake after a training session, less than the total fluid intake by our players.

In other team sports, Schröder, Navarro, Mora, Seco, Torregrosa & Tramullas (2004) assessed fluid intake during training and competition sessions in 55 elite basketball players, which mean result was 882±486 ml., less than that obtained in our study.

In team sports like futsal, players have ample opportunities to get hydrated, due to the substitutions and interruptions of the match. Barbero et al (2006, 105) calculated that every futsal field player had 7.4 opportunities to hydrate per match. However, these opportunities are reduced for goalkeepers, because their substitutions during matches are not common, and they can only go to the bench to drink during time-outs or long interruptions in the game (half time, injuries, etc.). Goalkeepers should place their bottles near their position, to increase their chances of hydration without being replaced.

Differences in fluid balance and level of dehydration between goalkeepers and field players are in accordance with ACSM's Position Stand (1996, 2), which tells of the difficulty 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.

Conclusions

Independently of playing position, fluid intake in these elite futsal players was enough to offset losses caused by sweat. In team sports like futsal, hydration status can be well maintained with regular substitutions and correct fluid intake. Results allow individualising player's hydration strategies, and not taking exclusively into account playing position or game time.

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