Journal of Sport and Health Research 2017, 9(3):291-300

Morente, A.; Yuste J.L.; Pérez, J.A.; Llorente-Cantarero, F.J. (2017). Effects of an official football-7 match on hydration status on a team of prepubertal children: Pilot Study. *Journal of Sport and Health Research*. *9*(3):291-300.

Original

EFECTOS DE UN PARTIDO OFICIAL DE FÚTBOL-7 EN EL ESTADO DE HIDRATACIÓN EN UN EQUIPO DE NIÑOS PREPÚBERES: ESTUDIO PILOTO

EFFECTS OF AN OFFICIAL FOOTBALL-7 MATCH ON HYDRATION STATUS ON A TEAM OF PREPUBERTAL CHILDREN: PILOT STUDY

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Edited by: D.A.A. Scientific Section Martos (Spain)

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Received: 17/3/2016
Accepted: 14/8/2017

Journal of Sport and Health Research 2017, 9(3):291-300

RESUMEN

Objetivos

Analizar el nivel de hidratación a través de marcadores urinarios, pérdida de peso, la tasa de sudoración y el porcentaje de peso perdido en jugadores prepuberes.

Material y métodos

Este estudio se realizó en un equipo de fútbol-7 de Córdoba (España) a las 13:00. 11 niños (de 8 a 9 años de edad) comenzaron el partido euhidratados después de un proceso de hidratación basado en el protocolo de la ACSM (2007). Se evaluaron marcadores urinarios tales como: pH, USG (g / L), concentración de Na^+ (mmol / L) y Uosm (mOsm / kg), y los cambios en la masa corporal (kg), porcentaje de masa corporal perdida y la tasa de sudoración (L / h) en el momento basal y justo al terminar el partido.

Resultados

Los jugadores mostraron valores antropométricos dentro del rango normal para su edad y sexo. No se encontraron diferencias con respecto al tiempo de juego al comparar entre sí las distintas posiciones ocupadas sobre el campo. La pérdida de masa fue superior al 2% en el grupo de jugadores al final del partido. Sin embargo, cuando se estudió por posiciones, sólo los porteros y delanteros mostraron diferencias. Por otro lado, se halló un aumento en los valores urinarios y la temperatura corporal al comparar la medición basal con la que se obtuvo después del encuentro.

Conclusiones

Un partido oficial de fútbol-7 conduce a procesos de deshidratación en los niños pequeños, incluso habiendo comenzado euhidratados y pudiendo beber *ad libitum*. Además, la defensa y los delanteros parecen ser los más afectados. A su vez, se confirmó la necesidad de motivar la ingesta de líquidos en los niños ante la ausencia una motivación propia.

Palabras clave: niños, competición, deshidratación.

ABSTRACT

Objectives

To analyze the level of hydration through urinary markers, weight loss, sweating rate and percentage of weight lost on prepubertal players.

Material and Methods

This study was conducted in a football-7 team of Cordoba (Spain) at 13:00 o'clock. 11 boys (8 to 9 years old) started the match euhydrate after a process of hydration based on the protocol of ACSM (2007). Urinary markers such as: ph, USG (g / L), Na^+ concentration (mmol / L) and Uosm (mOsm / kg), and changes in body mass (kg), percentage of body mass lost and sweat rate (L / h) were evaluated at basal time and just finish the game.

Results

Players showed anthropometric values within the normal range for their age and gender. No differences were found on playing time when it was compared the different positions occupied among them. Mass loss was greater than 2% in the group of players at the end of the match. However, when it was studied by positions, goalkeepers and forwards only showed differences. On the other hand, an increase in urinary values and body temperature by comparing the baseline measurement with that obtained after the match was found.

Conclusions

An official football-7 match leads to dehydration processes in young boys, even beginning euhydrated and being able to drink *ad libitum*. In addition, the defence and the forwards positions appear as the most affected. In turn, it was confirmed the need to motivate the intake of fluids by children considering the absence of their own initiative.

Keywords: Children, competition, dehydration.

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INTRODUCTION

Football is a long endurance sport with repeated sprints, which can lead to an increase of metabolic heat production. This change has as result a raise of body temperature which give room to the beginning of sweetening to promote the heat loss (Bangsbo et al., 2006). Football, like others sports activities, requires a control over hydration status, as fluid loss, primarily through of sweating, can easily lead to the participants to levels of dehydration that reduce their performance and progressively their welfare and health.

Dehydration processes can occur even in the presence of a good availability of liquid and regular hydration breaks (Maughan et al., 2005). In turn, sweat rates and levels of dehydration can be influenced by weather conditions, the intensity of training or clothing, among others (Aragón-Vargas, et al., 2009).

Overall, the impact that dehydration has on athletic performance, both physically and cognitively, is known. It is admitted that a loos higher to 2% of body mass (BM) is associated with a reduction on the performance (Cheuvront et al., 2003). Changes in BM are considered as a universal, valid and economic index of changes in body water (Grandjean & Campbell, 2006). BM can also be an indicator enough stable to monitor the daily balance of liquid physiological, even for long periods (1-2 weeks) involving intense exercise and acute fluid changes (Cheuvront et al., 2004).

Within the range of measurement techniques of hydration status, Shirreffs (2000) and Cheuvront & Sawka (2005) validated, for field study in sporting contexts, the use of urine biomarkers and changes in BM. Currently, these markers seems to be the ideal indicators in sports training and competitive situations because of they allow a practical and non-invasive use, mainly whether it is working with children. However, despite being a non-invasive test, the implementation in competitive situations is difficult. Still, researches conducted with indicators derived from the loss of BM (Kurdak et al., 2010) and urinary markers (Aragón-Vargas et al, 2009; Lopez-Mata et al, 2012) found an increase on levels of dehydration in adult footballers after a soccer game.

If we talk about urinary markers, specific gravity (USG) and osmolality (Uosm) have been used, so far, as the most commonly indicators of hydration status in studies of physical-sports, being considered valid both individually and collectively. Cutoffs from which it is estimated that a subject initiates the state of dehydration are >1,020 g/L for the USG and >700 mOsm/kg for Uosm (Cheuvront & Sawka, 2005).

There are physiological arguments that show a lower tolerance to heat stress in children (Sánchez-Valverde, et al., 2014). In addition, despite being able to drink at will, people tend to not cover sufficiently their fluid needs; a fact that is accentuated at childhood (Assael, et al., 2012; Gordon, et al., 2015). This stage is a period where participants are more vulnerable to sports dehydration, mainly in modalities such as the soccer where intake is limited to *ad libitum*. The aim of this study was to analyse the level of hydration of football-7 prepubertal children after a competitive match through urinary markers and changes in body weight, relating to the demarcation take up in the field.

METHODS

Participants

This study was conducted in a football-7 team of Cordoba (Spain). Participants were 11 boys (8 to 9 years old), with sufficient experience and level to establish a logical development of performance in this activity. Written informed consent was obtained from parents or legal guardians and the study was approved by the Institutional Ethics Committee at the Bioethics Committee from University of Cordoba (Spain) under the ethical norms of the Declaration of Helsinki (1975). Exclusion criteria were: older than 9 years or the presence of clinical or laboratory signs of pubertal development; disease known or detected during the study, long periods of immobilization, as well as those who were taking medications that may alter their metabolism.

Description football-7

To clarify the logic of the game, which is different to football-11, we present the next explanation to improve the interpretation of the results. Differences between football-7 and football in relation to rules: are involved 7 players instead of 11; playing time is divided in 2 periods of 30 minutes; smaller

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dimensions of the pitch; the possibility of making all substitutions that deemed appropriate, and all players have to participate during the game.

Process

Data were collected in the soccer team's facilities. The game started at 13'00 hours under a climate conditions of 24,5º C of temperature and 52% of relative humidity, quantified with a weather station OREGON SCIENTIFIC WMR-80, and using the average value collected from the start to the end of the game analyzed.

Anthropometric measurements were valued using a scale TANITA BC-350; a stadiometer HR001 TANITA; one dermographic pencil and a caliper Holtain Skinfold Caliper. Body max index (BMI) was calculated as weight (kg)/ height (m^2) and compared to growth charts for Spanish children (Sobradillo, et al. 1988). Systolic and diastolic blood pressure (SBP and DBP respectively) and heart rate (HR) were measured in the right arm in the sitting position using a random-zero sphygmomanometer (Dinamap V-100). Players' time game was registered by researchers in a document. To determine the degree of hydration of the participants before and after the game analyzed, we used the following urinary markers: ph, USG (g / L), Na^+ concentration (mmol / L) and Uosm (mOsm / kg), and changes in body mass during the match: lost weight (kg), percentage of body mass lost (%) and sweat rate (L / h).

Hydration protocol

To ensure that participants began the activity euhydrated, the following recommendations of the ACSM (American College of Sports Medicine et al., 2007) were carried out: a bottle of water of 500 ml with low mineralization was provided for each participant four hours before to star the match at the changing room. They had to take slowly a volume equivalent to ~ 5-7 ml.kg-1 of body weight, to complete intake of all content.

Collection Protocol

The collection of urine samples before and after football matches, with a prior genital grooming by players, was conducted following the method of sample clean midstream (Strasinger & Di Lorenzo, 2008) in the soccer team's toilets located inside of the changing room. As for the urine collected, 2 containers (capacity 100 ml) sterile and non-transferable were delivered to each player, one 15 minutes before to start the game (once finished the hydration protocol); and other after to finish the physical activity. They were asked to empty the bladder everything they could (at least 30 ml of urine). Moreover, for the second sample, players had to urinate without intake any type of fluid some moments before. After match, containers were transported to the hospital laboratory for analyzing the urinary variables indicated. To determine urinary chemical markers, previously collected urine was homogenized and placed in tubes without EDTA. Then they were studied in an analyzer Vitalab Merck Selecta 2. Regarding the urinary sediment, each sample was mixed and filtered in 6 ml tubes and centrifuged at 450 G for five minutes.

For the record of weight lost during the match, participants were weighed in underwear moments before to the warm-up. Previous to collect the second measurement, after the activity, players had to wipe the sweat with a towel, did not drink any liquid and proceed to drain urine bladder.

The formulas used for weight lost, sweating rate (SR) and percentage of weight lost during the match were:

- Weight lost during match (kg) = weight before - weight later.

- SR (L / h) = [(weight before - weight after (kg)) + fluid intake throughout the activity (liters)] ÷ practice time (hour) (Murray, 1996).

- Percentage of lost body mass (kg) during the game = [(weight before-weight after (kg)) / weight before] × 100.

Data analysis

Data were tested for normality of distribution and are presented as mean ± standard deviation. Descriptive statistics were used to describe the characteristics of the players. The paired samples t test was also used to determine the difference in urinary, weight and temperature measurements between basal time and the end of match. The significance level was set at

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0,05. Being a pilot project of a single match, the comparative mean by positions only take place between the midfielders and strikers which present a higher number of participants. Data analyses were conducted with SPSS (version 20.0; SPSS Inc., Chicago, IL).

Table 1. Anthropometric and demographic results in the players group.

Variables	N 11
Age (years)	8,36 ± 0,50
Weight (kg)	31,74 ± 7,39
Height (m)	1,32 ± 0,07
BMI (kg/m²)	18,06 ± 2,79
SBP (mmHg)	10,82 ± 1,51
DBP (mmHg)	6,67 ± 1,83
HR (lpm)	80,64 ± 7,51

BMI: body mass index; SBP, systolic blood pressure; DBP: diastolic blood pressure; HR: heart rate. Results are presented as M ± SD for continuous variables.

RESULTS

Table 1 shows the anthropometric and demographic descriptive results. Players showed values of weight, height, SBP, DBP and HR within normality ranges for their age and gender, being able to classify the set of players as normal-weight. Moreover, both participation time (including warm-up and football match) and the playing stance over the field did not shown influence on anthropometric variables (data not shown). The average time spent over the field by each position was such as: 30' by the goalkeepers, 60' by the defense, 54,7' by the midfielders and 29,6' by the forwards.

The lost weight (kg and percentage) and sweating rate descriptive results are showed in Table 2. As there was only one defense, it is not possible to make a comparison between positions. However, this player provided relevant information. If it is observed the group's results, they showed a loss of BM higher to 2%. However, when this loss was analyzed by positions, only the defenses and forwards presented values over 2%. Respect to SR, forwards overtake the 1 L/h. When comparing midfielders with strikers no differences were found. Although the participants could drink *ad libitum*, the amount of liquids drunk by them were lacking or non-existent.

Regarding the urinary variables and body temperature in all players, they showed an increase after the match compared to baseline levels. In turn, the total weight of the group was also lower at the end of the match (Table 3).

Finally, Table 4 present the results of urinary markers, weight and body temperature of each position on the field, showing the differences between basal measure and at the end of match from those positions with more than one player. After comparison among both measures, it was found differences in the Na^+ concentration (goalkeepers: p=0,03 and forwards: p=0,043; and a tendency in midfielder: p=0,069), weight (midfielder: p=0,026; forwards: p=0,005) and body temperature (forwards: p=0,015).

Table 2. Weight loss and sweat rate results after the match.

Variables	All n=11	Goalkeepers n=2	Defence n=1	Midfields n=3	Forwards n=5
BML (Kg)	0,69 ± 0,25	0,45 ± 0,07	1,00	0,70 ± 0,20	0,72 ± 0,29
BML (%)	2,28 ± 1,07	1,42 ± 0,00	4,40	1,92 ± 0,29	2,43 ± 1,10
SR (L/h)	0,83 ± 0,38	0,60 ± 0,09	0,80	0,59 ± 0,11	1,07 ± 0,46

BML: body mass lost; BWL %: percentage of body mass lost; SR: sweat rate. Results are presented as *M* ± *SD* for continuous variables.

Table 3. Urinary markers, weight and body temperature after comparing basal and end measurements in the players group.

Variables	Basal N: 11	After Match N:11	P
pH	5,91 ± 0,66	6,59 ± 0,92	**0,044**
USG (g/L)	1,009 ± 0,004	1,015 ± 0,008	**0,044**
Na^+ (mmol / L)	61,13 ± 39,82	145,83 ± 57,77	**0,001**
Uosm (mOsm / kg)	341,06 ± 253,86	643,68 ± 277,63	**0,004**
Weight (kg)	31,74 ± 7,31	31,05 ± 7,31	**<0,001**
BT (ºC)	36,67 ± 0,26	36,93 ± 0,24	**0,028**

USG: specific gravity of urine; Na^+ concentration: sodium from the urine; Uosm: urine osmolality; BT: body temperature. The paired samples t test was also used to determine the difference in urinary, weight and temperature measurements between basal time and the end of match. The significance level was set at 0,05. Results are presented as *M* ± *SD* for continuous variables.

Table 4. Urinary markers, weight and body temperature after comparing basal and end measurements by field position.

Variables	Goalkeepers n=2		Defence n=1		Midfield n=3		Forwards n=5	
pH	5,50 ± 0,71	7,50 ± 0,00	6,50	6,00	5,33 ± 0,55	6,17 ± 1,26	6,30 ± 0,48	6,60 ± 0,82
USG (g/L)	1,007 ± 0,003	1,015 ± 0,007	1,005	1,005	1,010 ± 0,005	1,015 ± 0,005	1,010 ± 0,006	1,017 ± 0,010
Na^+ (mmol / L)	88,15 ± 29,06	175,50 ± 22,91	30,20	83,50	38,37 ± 17,48	137,67 ± 65,24	70,16 ± 50,06	151,32 ± 67,71
Uosm (mOsm /kg)	389,45 ± 247,34	792,87 ± 322,83	137,27	313,15	240,66 ± 97,72	543,93 ± 236,05	422,70 ± 337,05	709,97 ± 295,61
Weight (kg)	31,65 ± 5,02	31,20 ± 4,95	32,80	31,80	36,03 ± 5,08	35,33 ± 4,88	31,00 ± 8,95	30,28 ± 8,93
BT (ºC)	37,00 ± 0,28	36,80 ± 0,00	36,30	36,50	36,60 ± 0,00	36,83 ± 0,25	36,66 ± 0,25	37,12 ± 0,08

USG: specific gravity of urine; Na^+: sodium from the urine; Uosm: urine osmolality; BT: body temperature. Results are presented as *M ± SD* for continuous variables

DISCUSSION

The present study aimed to analyse the state of hydration in a prepubertal football players group after playing an official football match. Although the participants presented an adequate baseline hydration state, they showed a dehydration process after match. Players showed an increase on the urinary markers, the percentage of BM loss and the SR. In turn, the dehydration was slightly accentuated depending on the position that the players occupied on playing field.

After a critical review of the scientific literature, we didn't find articles that had previously addressed the study of hydration state in competition at the prepubertal stage. Therefore, our comparisons will be referring to adolescents or young adults.

Regarding the percentage of BM loss, it is well stablished that a loss greater than 2% of BM produces a decrease on the performance of both athletic (Von Duvillard et al. 2008) and non-athletic people (Cheuvront et al., 2003). In the present study, the players group showed a loss higher than 2% (Table 2), although, it depended on their position in the football pitch, being the defence and the forwards the most affected. These differences by position might be due to the distance travelled on the pitch. Moreover, it seems that an official match, mainly in particular positions, might involve more effort than a training session, since if we compare our results with those obtained by Gordon, et al. (2015) on an adolescents group, they did not exceed the 1,4% of BM loss after training.

When it is compared the weight loss during lifespan or in several situations, it is observed differences among ages. A group of teenagers after a 40 minutes' workout with a temperature average of "26ºC" showed a loss of "1,8%" of BM (Silva R. P. et al., 2011); or "1,7%" of BM after training in a cool environment (Williams & Blackwell, 2012). However, an adults group presented a percentage average of BM loss of "2,28%" after three competitive football matches (Kurdak et al., 2010). Our participants showed results more similar to this adults group. Therefore, the percentage of BM loss might be more associated with the kind or intensity of exercises than subjects' age.

The present findings reinforce the importance of using the BM in children, since the accuracy to estimate the hydration status through BM loss has been questioned in some occasions. This doubt is based on the hypothesis that some exercise situations may lead to a significant BM loss without a negative fluid balance (Maughan, et al., 2007).

On the other hand, temperature seems to be an important mediator on the loss of weight. It was observed changes on weight in football players depending on the practice situations and the ambient. Maughan et al. (2004) and Shirreffs et al. (2005), found the following loss (1,10±0,43kg with 24-29°C and 1,23±0,50kg with 32±3°C, respectively) after 90-minute workout with professional soccer player. On their behalf, Aragón-Vargas et al. (2009) found a loss of (2,58±0,88kg with 34,9ºC) after a professional season match. Thus, when comparing the previous results with those obtained in the present study, it

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seems that the combination of high temperature with official match produce a higher loss of weight.

Maughan et al. (2010), marked the border climate between 12-15ºC from which soccer performance is affected. In addition, Micheli & Jenkins (2001) and Montfort-Steiger & Williams (2007), recommend a proper hydration although the weight loss been below 1%, since it could lead to diseases caused by heat. Hence, following these advices, those players who practice in similar conditions to the present study should be well hydrated, taking more care on the defenders and the forwards.

By other way, it is haven emphasized the need of starting euhydrated a soccer match, due to the limited opportunities for fluid intake during the match; and also, gastric emptying and intestinal absorption of the ingested fluids may be compromised during the game (Maughan et al., 2004). Numerous studies have reported that many adult athletes (Petterson & Berg, 2014; Castro-Sepulveda et al, 2015), and especially youth and children (Phillips et al., 2014; Arnaoutis et al. 2015 and Gordon et al. 2015) began their sports practices and competitions under a hypohydrated state. Keeping in mind this possibility and the basal results obtained by our players (pH <6; USG <1,010 g / L; ~ 60 mmol / L Na^+ and Uosm <700 mmol / kg), the protocol of ACSM (2007) might a useful tool to avoid starting hypohydrate. Therefore, the dehydration process underwent by our players might be, in a high percentage, as a result of played the match.

An important aspect to consider is fluid intake while it is practiced physical activity. Sánchez-Valverde et al. (2014) highlight the fact that children present an inadequate feeling on thirst and the dehydration degree. The present study's players experienced a similar situation. Although they had free access to the water (a bottle per person) and could drink ad libitum, the amount of liquid drink was lacking. This fact might have helped to increase the dehydration levels. Therefore, it would be very important that an adult, trainers or parents, will motivate to children to drink enough liquid during a match and meet with the recommendations established by Rowland (2011).

After analyzing the weight and urinary markers results after the match, they manifested a clear dehydration process. However, they did not reach the levels of severity which can be observed in other studies. Obviously, we can not make a specific comparison, but it should be take as a reference (Lopez-Mata et al., 2012; Arnaoutis et al., 2015).

The loss of BM showed by our participants may be interpreted as low (0,69 ± 0,25 kg hydrated with water) when is compared with others studies that registered further losses. Guerra et al. (2004), found in a teenagers group different levels of loss during a football match depending on the kind of drink intake. Those hydrated with carbohydrate drinks presented a loss of 1,14 kg, but those others who only took water lost 1,75 kg. However, not always appear the same loss. Phillips et al. (2014), found a decrease of ~ 0,40 kg during a workout in young players. Therefore, it seems more important the type and level of activity than the kind of drink taken to hydrate, since in the case of our players, they showed higher loss than those that practiced a workout, but lower than those others that drunk carbohydrate drinks.

Regarding SR (0,83 ± 0,38 L / h), in the present study it can be observed a similar response to the weight. The absolute magnitude is low, being surpassed by the most studies consulted, except in children and adolescents football players (0,6 ± 0,2 L / h) (Yeargin et al, 2010). However, its relation with weigh should be carefully assessed as pose negligible levels of dehydration.

Analyzing the urinary markers' results, it was found an increase in the pH, which contradicts other researchs where footballers showed a downward trend (Lopez-Mata et al., 2012), being able to relate this increase to the short time of participation in the match whether it is compared to the time spent by other categories, and together with the anaerobic nature of the physiological profile of efforts that they developed. The rise of urinary pH may be due to the conversion of blood lactate into CO_2 and subsequently into bicarbonate. This late conversion may be done in order to eliminate CO_2 from the blood more efficiently, as suggested by Moriguchi et al. (2004).

The USG and Uosm baseline results demonstrated the positive effect of applying a hydration protocol prior to the competition. After football match these biomarkers did not overtop the Breakpoints set to mark dehydration: USG> 1,020 g / L, Uosm> 700 Momol / kg (Cheuvront & Sawka, 2005), against other authors who found, after a workout or match, levels over the cut-off points, both in adults (Al-Jaser & Hasan, 2005; Lopez-Mata, et al., 2012), and youth (Gordon et al., 2015; Arnaoutis et al., 2015).

In relation to Na^+ concentration, the number of studies that used this marker as an indicator of hydration status in sport children is limit. A study on Karate competition didn't find differences between basal and after combat measures (Afshar et al. 2009). This type of practice does not show a high relationship with the present study, but it might help us to understand the response of Na^+ concentration in sport children. In relation to physiological answer and the kind of sport, our players showed an increase on the Na^+ concentration after match, being more significant on goalkeepers and forwards. Similar results were found by Duffield, et al., 2012. Therefore, it seems that football imply a higher dehydration process than other sports in children. Garcia-Jimenez & Yuste (2010), in a study with futsal professional players recommended taking into account the position occupied on the field as a specific element to consider.

CONCLUSIONS

In conclusion, it seems that play an official football-7 match leads to dehydration processes in boys, even beginning euhydrated and being able to drink *ad libitum*. In addition, it is necessary pay attention to position on the field. It would be interesting for the future research to study how the game affects on the dehydration status at different hours of the day. In turn, it was confirmed the need to motivate, by trainers or parents, the intake of fluids by children, considering the absence of their own initiative.

ACKNOWLEDGEMENTS

We want to thank to all participants and families.

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