Evaluation of the hydration status in professional football players through different body composition assessment techniques

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Summary

Introduction: The hydration status of the individual during sports is currently one of the most important issues in relation to the practice of physical exercise, especially in hot and long-lasting environments (>1h). In the present study, the hydration status of professional football players, members of Real Valladolid B, is analysed during a training session at different times of the year in order to check their hydration status, as well as to observe in which way the climate influences the aforesaid state. Since a variation in the hydration status, whether dehydration or overhydration, is harmful for the athlete, affecting both his physical performance and health. Thus, in order to maintain an ideal hydration status throughout the physical effort, it will be essential to accomplish a set of regulations and guidelines.
Methods: For this purpose, different hydration assessment techniques are used. These techniques comprise a double weight recording, a bioimpedance analysis before and after training, a cineantropometry before and after training, and, only after training, the measurement of the density of the urine.
Results: the results showed differences regarding the different weight obtained before and after training, as well as a variation in the weight percentage between january and may. Urine density also pointed out the manifestation of a state of post-exercise dehydration. Furthermore, the bioimpedance and anthropometry reflected significant differences and low consistency between them, being anthropometry the most accurate method.
Conclusions: the diversity of results obtained, related to the appearance of a state of dehydration in players at the post-exercise moment, suggests the necessity of advising and raising awareness among the athletes about the compliance of the individualized strategies of hydroelectricity replacement, taking into account the personal characteristics of the individual, as well as those that are external to him.

Key words:
Hydration. Football. Bioimpedance analysis. Cineanthropometry. Hydroelectrolytic replacement.

Estudio del estado de hidratación de futbolistas profesionales mediante diferentes métodos de evaluación de la composición corporal

Resumen

Introducción: El estado de hidratación del individuo durante la práctica deportiva, es uno de los temas más importantes en la actualidad en relación a la práctica de ejercicio físico, sobre todo, en ambientes calurosos y de duración prolongada (>1h). En el presente estudio, se analiza el estado de hidratación de jugadores profesionales de fútbol, integrantes del Real Valladolid B, durante una sesión de entrenamiento en diferentes épocas del año, con el fin de, además de comprobar su estado de hidratación, poder observar de qué manera influye el clima en dicho estado. Dado que una alteración en el estado de hidratación, será perjudicial para el deportista, afectando tanto a su rendimiento físico, como a su salud, el cumplimiento de una serie de normas y pautas existentes será imprescindible para mantener un estado óptimo de hidratación.
Métodos: Se usaron distintos métodos de evaluación de la hidratación. Un registro de doble pesada, una bioimpedanciometría pre y post entrenamiento, una cineantropometría pre y post entrenamiento y la medición de la densidad de orina únicamente post entrenamiento.
Resultados: Los resultados mostraron diferencias significativas en cuanto a la diferencia de peso entre el pre y post entrenamiento, y en el% de variación de peso entre enero y mayo. La densidad de orina indicó también la aparición de un estado de deshidratación postejercicio. La bioimpedancia y la antropometría mostraron diferencias significativas y una concordancia baja entre ellas, siendo la antropometría la más sensible.
Conclusiones: La diversidad de resultados obtenidos, relacionados con la aparición de un estado de deshidratación en los jugadores en el momento postejercicio, sugiere la necesidad de aconsejar y concienciar a los deportistas sobre el cumplimiento de estrategias de reposición hidroelectrolítica individualizadas, teniendo en cuenta las características propias del individuo, así como las externas a este.

Palabras clave:
Hidratación. Fútbol. Bioimpedanciometría. Cineantropometría. Reposición hidroelectrolítica.

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Introduction

The hydration status of professional sportspeople is a measurable parameter which has now been shown to have an inverse relationship with sports performance and health. Anything, therefore, which prevents athletes from being euhydrated (optimal hydration status) will negatively affect their performance and health[1-3]. According to the American College of Sports Medicine[4], different biological markers can be considered useful for assessing hydration status. See Table 1.

When doing sport, body temperature increases, causing the body to set in motion mechanisms to help lose this heat (thermoregulation): an increase in blood flow in the vessels closest to the skin (peripheral vasodilation) and the secretion of sweat. The latter mechanism is the body's main way of dissipating heat during prolonged exercise, even at submaximal exercise intensity and especially in warm climates[5].

Sweating causes the body to lose both water and electrolytes. Such loss is a determining factor and is not the same in all individuals. Sweat is obtained from both extracellular and intracellular fluids, meaning that the electrolytes and salts most affected by sweat production are sodium and chlorine. Studies published on the subject show that an average of about 3.2 g of salt are lost per litre of sweat and that the normal sweat rate stands at 1-1.5 L per hour of exercise[5].

In order to prevent disruption in sportspeople's hydration status (dehydration or over-hydration) during exercise, the Spanish Federation/Society of Sports Medicine (FEMEDE/SEMED) has established a consensus on sports drinks, their composition and fluid replenishment guidelines[6], supplying the information needed to keep athletes euhydrated.

Football is a mixed sport which calls for physical strength throughout the entire session and speed at specific moments when explosiveness is required. It is also quite specific regarding hydration, since the players can only drink before and after each match and at halftime. Proper fluid intake in line with each player's needs when doing the sport should, without a doubt, bring numerous benefits in terms of both health and sports performance. According to Monteiro CR *et al*., the mean electrolyte replenishment of players during the activity represents 50% of the loss produced[7].

The general objective of this study was to check the hydration status of sportspeople and to see if it is disrupted during the practice of team sports, in this case football. Its specific objectives were to assess whether there exist differences in hydration status depending on the weather and to verify the reliability of kinanthropometry and bioimpedance analysis as methods through which to measure and evaluate total body water.

Table 1. Biological markers of hydration status according to their usefulness, validity and cut-off point.

Measurement	Practical usefulness	Validity (Acute and chronic change)	Euhydration cut-off point
TBW Low	Acute and	<2% Chronic	
Plasma osmotic concentration	Medium	Acute and Chronic	<290 mOsmol
Specific gravity	High	Chronic	<1020 g/ml
Urine osmotic concentration	High	Chronic	<700 mOsmol
Body weight (Evidence category A)	High	Acute and Chronic	<1% (Excessive dehydration>2%)

TBW: Total body water.
Biological markers of hydration status according to their usefulness, validity and cut-off point. Source: American College Sports of Medicine, Exercise and fluid replacement. Medicine and Science in Sports and Exercise.

Material and method

Type of study

The study was observational, descriptive and longitudinal, without any type of intervention on the study variables. The players drank water on demand during the sessions, as they usually do, and did not consume any drinks other than water. All the subjects in the study were exposed in a similar manner to the study factor: sport during training at a professional level at the same points in the football season and under similar ambient conditions. The effect that physical activity and climate had on their hydration status, and, consequently, on their sports performance and health was evaluated.

The hydration statuses of professional football players belonging to the Real Valladolid B team, which currently plays in Spanish league division 2B, were analysed during training sessions in different weather conditions. Analysis was performed by measuring three variables: total body water, specific gravity of the urine and variation in body weight.

Population

Eighteen players, of whom fourteen successfully completed the study (n=14). All the players were male field players (no goalkeepers) belonging to the same professional football team, Real Valladolid B, who volunteered for the study.

The following inclusion criteria were applied for selection:

- Over 18 years of age.
- No injuries which might affect training.
- Training at the same level of intensity and in the same environmental conditions.
- Not taking any medication which might affect fluid retention or the player's physical condition.
- No metal elements in the body.
- Accepting and signing the informed consent form and consent for the collection of biological samples.

The characteristics of the participants were: age (20.8±1.76), height (180.7±4.6) cm, weight (72.8±4.1) kg and BMI (22.3±1.6) kg/m^2. Because the sample is not representative, the results of the study cannot be generalised to other professional football teams.

In order to be part of the study, the participants necessarily received clear, concise written information on it so that they could understand and accept the procedures, the use of their personal data and the collection and analysis of biological samples. The study was approved by the Clinical Research Ethics Committee of the East Valladolid Health Area, University Clinical Hospital of Valladolid.

Procedures

The study took place at two very important points in the sport season in terms of physical preparation. The mesocycles in which the measurements were taken were:

- In January, during the preparation period. Just after returning from the Christmas break.
- In May, during the last weeks of competition of the football season. (Table 2)

These mesocycles were chosen because they involve similar workloads.

The data provided by the Spanish Meteorological Agency were used to register the ambient temperature and relative humidity. The temperature and relative humidity (RH) were (3.2±2.1) ºC and (76.7±12.4) %RH when the first data were collected in January, and (13.2±6.3) ºC and (59±14.9) %RH when the second set of data were collected in May.

Test weighing and the calculation of %total body water were conducted by bioelectrical impedance analysis using a Tanita BC-601 body composition monitor, strictly observing the measuring protocol regarding the absence of metal elements in the body. Considering that the objective was to carry out an observational study of the changes in body composition produced as a result of the intake or non-intake of fluid and the performance of physical exercise, the restrictive criteria of the measuring protocol relevant to these activities were not respected[8,9].

Formula of %weight variation by test weighing:

Table 2. Distribution and conditions of the training sessions.

Moment:	Date	Time Pre	Time Post	Amb. temp. Cº	% Rel. hum.
First measurement January					
Sample 1	26/01/2017	09:00	13:00	-3ºC – 6ºC	70
Sample 2	02/02/2017	09:00	13:00	-4ºC – 7ºC	91
Sample 3	09/02/2017	09:00	13:00	-0ºC – 5ºC	69
Second measurement May					
Sample 1	27/04/2017	09:00	13:00	-0ºC – 12ºC	65
Sample 2	04/05/2017	09:00	12:30	-11ºC – 25ºC	42
Sample 3	11/05/2017	09:00	12:30	-10ºC – 22ºC	70

Amb. Temp.: Ambient temperature in degrees Celsius, %Rel. hum.: Relative humidity percentage.

[[(Starting weight (kg) - End weight (kg) + Water consumed (L)] / Starting weight] x 100

The anthropometric measurements were taken on the basis of the international consensus, International Society for the Advancement of Kinanthropometry (ISAK 2001)[8], following specific locations based on the texts of Ross and Marfell-Jones (1991), backed by ISAK and in Spain by the Spanish Kinanthropometry Group (GREC)[10], using:

- TANITA BC-601 body composition scales and monitor (accuracy: 0.1 kg).
- Holtain skinfold calliper (accuracy: 0.2 mm).
- Wall measuring rod (accuracy: 1 mm)
- Tape measure: Rosscraft (accuracy: 1 mm), metal, narrow and inextensible.
- Dermographic pencil.

The data were then entered in calculation tables to obtain data for %total body water from the anthropometry. The formulas indicated in Table 3, applying the hydration constant (73%) for fat-free mass, were used for this purpose. This constant was applied because a variation of the constant takes place throughout the exercise, meaning that pre-training can only be calculated assuming the error which not taking into account the small % of water found in the fat mass supposes.

The post-training urine specific gravity (USG) or urine density (UD) was also recorded. Urea (20%), sodium chloride (25%), sulphate and phosphate account for most of the specific gravity of normal urine. Normal adults with an adequate fluid intake produce urine with a specific gravity of 1016-1022 g/ml for a period of 24 hours; however, healthy kidneys are capable of producing urine with a specific gravity which oscillates between 1003 and 1035 g/ml. If a random sample of urine has a specific gravity of 1023 g/ml or more, the concentration capacity can be considered normal. The minimum specific gravity after a standard load of water should be less than 1007 g/ml. Urine with a low specific gravity of less than 1007 g/ml is known as hyposthenuric urine[4,11,12].

Table 3. Formulas used to calculate body density, fat mass and total body water using the hydration constant of muscle mass.

Durnin/Womersley formula, Body Density, for males aged 20-29:
1.1631-0.0632* LOG(Σ4skinfolds)
Siri's formula for %FM:
[(4.95/Db) -4.5] x 100
Use of the hydration constant for FFM as a method to obtain TBW:
$\dfrac{(100 \text{ x}[0\text{-}73 \text{ x(Weight kg - } \dfrac{\text{\%FM x Weight kg}}{100})]}{\text{(Weight Kg)}}$

%FM: Percentage of fat mass, FFM: Fat-free mass, TBW: Total body water.

Formulas used to calculate body density, fat mass and total body water using the hydration constant of muscle mass.

In general, normal urine density values are:

- 1001 g/ml: Low density.
- 1001 - 1020 g/ml: Normal density.
- 1020 -1030 g/ml: Indicator of dehydration.
- More than 1030 g/ml, not ingesting enough fluids.

The data were collected by inserting Health Mate DUS-10 urine analysis test stick strips into the sterile sample collection containers for 2 seconds and reading them 60 seconds later, as indicated by the protocol. Values of <1020 g/ml were considered normohydration and >1020 g/ml as indicators of hypohydration and/or dehydration[13].

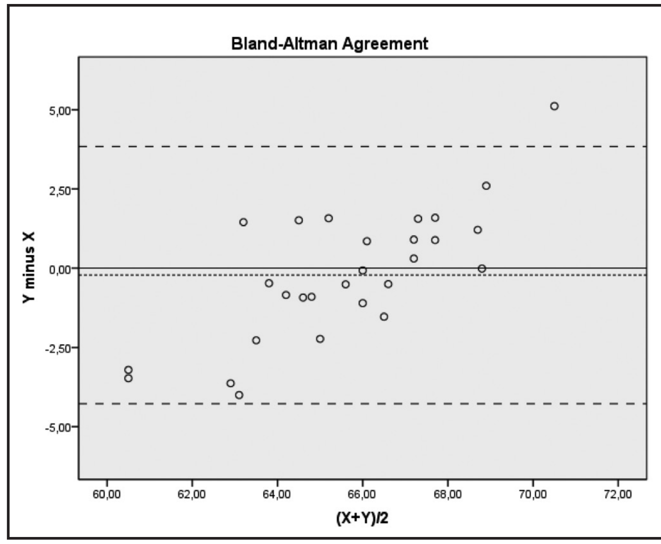
Statistical analysis

The statistical significance used in the study was p<0.05. Statistical analysis was performed with the statistical package IBM SPSS 1.0.0.407 for MAC. The normality of the variables was determined using the Shapiro-Wilk test (n<30).

Given the normality of the variables, Student's t-test for related variables was used to see if there were significant differences between the different variables (weights, total body water). The Wilcoxon test was used for urine density because it did not follow a normal distribution.

The Intraclass Correlation Coefficient (ICC), with a confidence interval of 95%, was used to compare the concordance between the different total body water measurement techniques. Agreement was also expressed graphically with a Bland–Altman plot.

Figure 1. Representation of Bland-Altman for the analysis of concordance between BIA and Cineanthropometry.



Representation of Bland Altman for the qualitative analysis of the agreement between cineantropoemtría (Siri) and bioimpedanciometría as methods for the estimation of Total Body Water. The mean (X axis) and the difference (Y axis) of the measurements are performed to perform the representation.

Results

Description of the sample

14 members of the Real Valladolid B football team were selected. Their weight, body water and urine density data for January and May are given in Table 4.

In general terms, it was observed that:

- They consumed more fluid in January than they did in May.
- The %body weight loss was greater in May than it was in January.
- Urine density hardly varied between the two measurements.

Statistical analysis was then performed to check whether the results were significant or not.

Table 4. Data of the different variables measured.

Data	January	May
Pre-tr weight (kg)	(72.8±4,1) [65.7-79.8]	(73.4±3.8) [65.7-78.6]
Post-tr weight (kg)	(72.5±4.1) [65.5-79]	(72.5±3.8) [65.1-77.9]
Water intake (ml)	(750.3±281.0) [388-1260]	(586±197.4) [86-975]
%Weight loss (Not counting water)	(0.44±0.55) [-0.71-1.3]	(1.18±0.47) [0.6-2]
%Weight loss (counting water)	(1.47±0.31) [0.94- 2.22]	(1.99±0.55) [1.24- 3.24]
TBW by anthropometry Pre-training (L)	(66.06±1.53) [62.99-68.81]	(65.56±1.66) [61.75-68.03]
TBW by BIA Pre-training (L)	(65.77±2.43) [60.5- 68.90]	(65.41±2.49) [60.5-70.5]
TBW by BIA Post-training (L)	(66.06±3.11) [60.6- 72.5]	(66.39±2.67) [63.3- 71.8]
Post-tr urine density (g/ml)	(102.,5±2.6) [1025-1030]	(1026.8±4.2) [1015-1030]

Pre-tr: Pre-training, TBW: Total body water, BIA: Bioimpedance analysis, Post-tr: Post-training, Data of the different variables measured in January and May. (Me±SD) [Min-Max].

Statistical significance

Save urine density, the variables evaluated followed normal distributions.

Weight variable

Statistical analysis of the pre- and post-training weight data showed a significant difference between the two measurements: January (p = 0.000; p < 0.05); and May (p=0.000; p<0.05).

Analysis of the data relating to %weight variation between January and May also showed a significant difference between the two measurements (p = 0.001; p <0.05).

Total body water variable

Statistical analysis of the pre- and post-training TBW data taken in January and May, measured by bioelectrical impedance analysis, did not yield a significant difference in January (p = 0.577; p > 0.05), but did in May (p = 0.003, p < 0.05).

Statistical analysis of the data relating to %TBW variation between January and May did not reveal any significant difference between the two measurements (*p* = 0.183; *p* <0.05).

Urine density variable

Both in January (1027.5±2.6 g/ml) and May (1026.8±4.2 g/ml), the UD results obtained were well above the reference euhydration value (1020 g/ml), indicating that the players finished training in a state of dehydration.

Statistical analysis of the post-training urine density data did not show a significant difference between the densities of January and May (*p*=0.317; *p*>0.05). Since they did not follow normal distribution, the Wilcoxon test was used.

Concordance analysis

Concordance of TBW measurements (ICC) between BIA and anthropometry:

The pre-training TBW data taken by means of anthropometry and BIA were analysed to see the relationship between them.

The Intraclass Correlation Coefficient (ICC) was used to measure the degree of agreement or consistency between the two measurements.

ICC values fall between 0 and 1, with agreement increasing the closer the value is to 1. The ICC obtained was:

CCI=0.494 with *p*=0.004

The results show a significant difference and low concordance between the two measurement instruments (anthropometry and BIA). This is represented graphically below with a Bland-Altman plot (Mean (Y-X) = -0.219; CI 95% (-4.277 a 3.838).

Discussion

The principal objective of this study was to check the hydration status of sportspeople and to see if it is disrupted during the practice of team sports, in this case football. Since football matches last 90 minutes, hydration status was evaluated following training lasting a similar period of time. Taking into account that hydroelectrolytic replenishment is easier during training than it is in competitive matches (given the restrictions placed on players both by the rules of game and the availability of drink), the results obtained from training sessions may be better than those obtained during competition.

The results obtained for the change in body weight variable are statistically significant, thereby validating this method of determining players' hydration status[4]. The cut-off point of the state of dehydration taken as a reference[4,11] was a loss of >1%, while >2% would indicate excessive dehydration. The means of the weight variation results obtained were (1.47±0.31) and (1.99±0.55)% weight loss in January and May, respectively.

In both months, the players presented a state of dehydration. It should be noted the % loss approached excessive dehydration in May.

Both Da Silva AI *et al.* in their study of footballers in 2011[14] and Da Silva RP *et al.* in 2012[15] obtained similar results in terms of % weight loss (2±0.2) and (1.6±0.8) during matches lasting 90 minutes. However, Aragon LF *et al*. in 200916 and Duffield R *et al*. in 2012[17] published higher %weight loss results: (3.4±1.1) and (3.4±0.7), respectively. The disparity in the data found in different studies may be due to diverse factors which directly or indirectly influence player hydration[18], such as temperature, relative humidity, fluid intake before and during the activity, the state of the players prior to exercise, ingestion beforehand, the availability of fluid during the sports activity, exertion at that particular moment, etc. In general, however, the studies show that football players end both training and competition matches in a certain state of dehydration, as demonstrated by the %weight loss variable (Table 5).

- Total body water was analysed using two different instruments, kinanthropometry (Siri's formula, applying the hydration constant) and bioimpedance analysis. Kinanthropometry was only used prior to training and so no comparative study was conducted, as indicated in Material and Methods.
- Bioimpedance analysis did not yield significant results in terms of TBW variation during the January session (90 min), but it did in May. This may be due to differences between the two measurements regarding temperature, humidity, clothing worn by the players or other factors.
- Urine density variable. Values indicative of normohydration (<1020 g/ml) and hypohydration and/or dehydration (>1020 g/ml)[4,11] were taken as reference values:
  - January: UD= (1027.5±2.6 g/ml)
  - May: UD= (1026.8±4.2 g/ml)

Both indicate the existence of a state of dehydration at the end of the training session (90 min). The results are consistent with those obtained in previous studies in which it has been demonstrated that football players finish training sessions and matches in a state of dehydration[14-17]. Previous studies have also shown on the basis of urine density data that players present a state of dehydration prior to sporting activity[14-16,19,20]. Pre-training data were not taken in this study, so the state in which the players arrived at training cannot be deduced, only the state in which they finished.

As for the secondary or specific objectives:

- Of the variables measured in the present study, the only one that gave significant results regarding the influence of the weather on hydration status was comparison of the weight difference percentage between January and May. Accordingly, the weather may influence players' hydration status. This is consistent with existing evidence that hot climates have a more significant negative impact on the hydration status of athletes than cold climates[3-5,19,21].
- The second specific objective of the study was to verify the reliability of kinanthropometry and bioimpedance Analysis as methods to measure and evaluate total body water.

The results obtained in the statistical analysis yielded low concordance (ICC=0.494) between the two measuring instruments. These results are similar to those of Portao *et al.*, who analysed concordance between different BIA appliances and the kinanthropometric method

Table 5. Comparison of the study with similar studies.

Estudios	n/Level of players /Sex	Type of activity/duration/ environment	Fluid intake (ml)	Dehydration (% weight variation)
Aragón-Vargas *et al.* 2009	17 professionals Male	Official match, 90 min/ 35 ± 1ºC, RH = 35 ± 4%	1948 ± 954	3,4 ± 1,1
Da Silva & Fernández 2003	6 referees and 6 assistants Male	Match, 90 min/ 20 ± 1ºC, RH = 77 ± 4%	Referees: 320 ± 60 Assistants: 250 ± 90	Referees: 1.6 ± 0.1 Assistants: 0.6 ± 0.2
Da Silva *et al.* 2011	10 referees Male	Match, 90 min/ 23 ± 1ºC, RH = 67 ± 4%	480 ± 90	2,0 ± 0,2
Da Silva *et al.* 2012	15 professional youth Male	Official match, 90 min/ 31 ± 2ºC, RH = 48 ± 5%	1120 ± 390	1,6 ± 0,8
Duffield *et al.* 2012	13 professionals Male	Game simulation, 100 min/ 27 ± 0.1ºC, RH= 65 ± 7%	1166 ± 333	3,4 ± 0,7
Gibson *et al.* 2012	34 professional youth Female	Training practice, 90 min/ 10 ± 3ºC, RH = 63 ± 12%	200 ± 20	0,8 ± 0,7
Kiding *et al.* 2009	13 professionals Female	2 training practices, 90 min each/ T1: 14 ± 1ºC, RH = 71 ± 3%; T2: 6 ± 1ºC, RH = 74 ± 3	T1: 450 ± 250 T2: 379 ± 142	T1: 0.6 ± 0.5 T2: 0.5 ± 0.5
Maughan *et al* 2007	20 professionals Male	Friendly match, 90 min/ 6-8ºC, RH = 50-60%	840 ± 470	1.1 ± 0.6
Shirreffs *et al.* 2005	26 professionals Male	Training practice, 90 min/ 32 ± 3ºC, RH = 20 ± 5%	972 ± 335	1.6 ± 0.6
Williams & Blackwell 2012	21 professional youth Male	Training practice, 100 min/ 11 ± 1ºC, RH = 50 ± 3%	807 ± 557	0.5 ± 0.5
Casas *et al.* 2018	14 professional youth Male	Training practice, 90 min/ 3.2 ± 2.1 ºC, RH = 76.7 ± 12.4%	750.3 ± 281	1.47 ± 0.31
	14 professional youth Male	Training practice, 90 min/ 13.2 ± 6.3 ºC, RH = 59 ± 14.9%	586 ± 197.4	1.99 ± 0.55

Min: Minutes, %RH: Relative humidity.

Comparison of the study with similar studies on the hydration status of professional football players. Source: Hydration science and strategies in football. Sports Science Exchange[18].

in 2009[18,22,23], their results also failing to reflect concordance between the two methods.

In addition to the concordance analysis performed, observation of the other results obtained shows that measuring skinfolds is more sensitive to changes in body composition and total body water than BIA. The kinanthropometric method, even taking into account the difficulty of implementing it correctly (trained staff and right equipment) and the inherent technical errors of measurement which can be committed, is a benchmark method for estimating body composition and is more sensitive when it comes to detecting changes in the body composition of sportspeople, as seen in previous studies. However, the BIA methods are an alternative to bear in mind when the means, material or qualified personnel to carry out the measurements of the different anthropometric parameters are not available, always bearing in mind the errors in measurement associated with their use, using them under the same conditions and applying the same equations in order to minimise such errors[18,22,24].

The broad range of results obtained in terms of weight variation, total body water and urine density suggest the need to individualise players' hydroelectrolytic replenishment strategies, taking into account the specific characteristics of each individual and factors external to him/her: temperature, relative humidity, duration of exercise, etc.

According to the above, the following conclusions can be reached.

Conclusions

– Incorrect hydration status is common in young professional footballers. This leads to different levels of hypohydration during the 90-minute sports activity they carry out.

- The percentage variation in body weight as a measurement to predict hydration status proved more sensitive to acute changes than measurement of total body water.
- Urine density analysis can be considered a correct, practical way to evaluate a sportsperson's hydration status.
- Hot environments have a negative effect on hydration status.
- It is essential to give footballers suitable guidelines concerning hydroelectrolytic replenishment and raise their awareness about its importance in order to achieve, at minimum, a state of euhydration during their sports activity.
- There is no concordance between bioimpedance analysis and kinanthropometry, the latter proving to be more sensitive. Consequently, the two methods are not comparable to each other.

The appearance of different degrees of hydration in players after exercising suggests the need to advise them as to individualised hydroelectrolytic replenishment strategies which take into account the characteristics of each individual and factors external to him/her, and insist on their importance.

Conflict of interest

The authors declare that they are not subject to any type of conflict of interest.

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