Hydration assessment of a semiprofessional male Chilean basketball team during practice

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Basketball | Hydration | Sweat Rate | Water Intake | Body Weight Loss

Headline

Body temperature in humans is set around 37°C and controlled within a very narrow range from 33.2 to 38.2°C. An abnormal core temperature of just a few degrees can be fatal. For instance, cytotoxicity, protein denaturation, and alteration of DNA synthesis occur upon reaching 42°C (1). Muscle work is the main heat generator during exercise, (2) the vast majority of chemical energy is converted into heat, and only a small portion into mechanical work. For the production of 100 Watts of mechanical power on a cycle ergometer (considered one of the most efficient exercises), 500 Watts of energy conversion is required, meaning 400 Watts are transformed into heat and must be dissipated to prevent harmful increases in body temperature (3). During exercise, the heat generated by active muscles could raise the body's temperature to the point of incapacitating the person (4) and the most important mechanism for regulating temperature is sweat. 80% of heat produced is dissipated by its evaporation from the surface of the skin (2), with the consequent fluid loss. A study carried out with 29 NBA players during the summer league, showed that their fluid loss due to sweating was, on average, 2.2 ± 0.8 liters in 21 minutes of play, generating losses of 1.4 ± 0.6% of initial body weight. Also, approximately half of the players started games dehydrated and their fluid intake during the game was not enough to compensate for this (5). Regarding the effects of dehydration on performance, a study of 17 adult basketball players showed that, as their level of dehydration increases from 1% to 4% body weight loss, they showed progressive deterioration in shooting performance and speed on specific skills. The threshold where the drop in performance became statistically significant (p<5%) is 2% for both skill groups (6).

Aim

The objective of this article is to establish sweat rates and pre and post-practice hydration status of basketball players from Club Deportivo Universidad Católica, that compete in the Chile's National Basketball League (LNB).

Methods

The present article is a case study for 15 male basketball players. The main characteristics of the group are in Table 1.

Table 1. Group description.

	Body Weight (kg)	Height (cm)	Age (years)
N	15	15	15
Mean	87.75	185.27	26.3
SD	12.19	9.29	4.4
Max	106.5	198	34.7
Min	71.6	168	18.9

The study took place during a training session consisting of 60 minutes of resistance training (weightlifting) followed by 105 minutes of specific basketball practice (technical-tactical session), during the final part of the regular season of the 2015-2016 season of Chile's National Basketball League. The session took place between 7:00 p.m. and 10:00 p.m. at a room temperature of approximately 20°C. Just before starting weightlifting, urine specific gravity (USG) was measured with a previously calibrated with distilled water refractometer (Sper Scientific 300005). Subsequently, each player was weighed wearing only underwear and given two weighed water bottles to drink during practice. Players were instructed to drink exclusively from the received bottles, without sharing or using them for any purpose other than drinking. During training (weightlifting and basketball), for every player, urine was collected and weighted, and players were supervised and reminded to drink only from their bottles without sharing them. Between weightlifting and basketball practice, and after finishing basketball practice USG, player's body weight, and water bottle weight were measured again for every player, under the same conditions as the beginning.

Bodyweight loss, for each player, was calculated as the difference between pre and post-practice bodyweights, and water intake, for each player, was calculated as the differences between pre and post-practice bottle weight. Equations 1 and 2 were used to calculate sweat volume and sweat rate for each player (7), and a 1.00 gr/ml density was assumed and used for calculations of sweat, urine, and water intake volumes. Calculations, graphs, and tables were done in Excel 2010.

Equation 1. Sweat Volume [lt]:

$$[[Bodyweightloss[lt] + Waterintake[lt]] - Urinevolume[lt]] \quad [1]$$

Equation 2. Sweat Rate [$\frac{lt}{hr}$]:

$$\left[\frac{SweatVolume[lt]}{PracticeTime[hr]}\right] \quad [2]$$

General hydration status indexes, according to USG and relative body weight loss (%BWL), used to establish players' hydration status are shown in the following table (7). The study was conducted in accordance with the Helsinki Declaration.

Results

According to USG, two players arrived at the facility well hydrated or minimally dehydrated, ten players arrived significantly dehydrated, and three arrived seriously dehydrated (Fig. 1). Players' fluid losses were, on average, 1840,5 ml ranging between 1032 to 2706 ml. Water intakes were 959 ml ranging between 221 to 1717 ml. (Fig. 2) Through water intake, players recovered a mean of 54% of the fluid lost by sweating, ranging from 15,6% to 92,4% (Fig. 3). According to body weight losses (1,012 ± 0,539 kg, 1,14% ± 0,57%) during practice, nine players finished minimally dehydrated, and six players finished well hydrated (Fig. 4). According to USG values, two players finished practice well hydrated, two finished minimally dehydrated, seven finished significantly dehydrated, and three seriously dehydrated (Fig. 5). The average sweat

Table 2. Hydration status indexes.

Condition	%BWL	USG
Well hydrated	<1	<1010
Minimal dehydration	1 a 3	1010-1020
Significant dehydration	3 a 5	1021-1030
Serious dehydration	>5	>1030

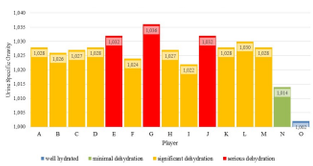

Fig. 1. Hydration status upon arrival to practice facility.

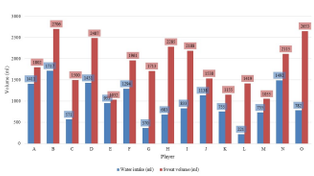

Fig. 2. Water intake vs Sweat volume.

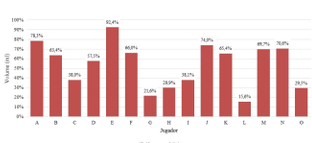

Fig. 3. Fluid Recovered.

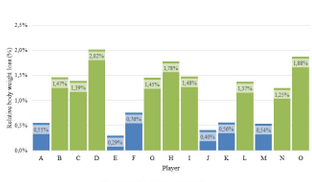

Fig. 4. Hydration status at the end of practice (according to relative weight loss).

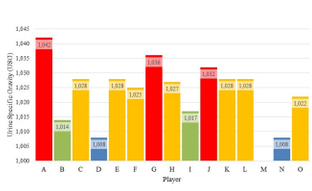

Fig. 5. Hydration status at the end of practice (according to USG).

rate found, considering only basketball practice, was 945,7 ± 340,3 ml/hr. (Fig. 6) The order of players by relative body weight loss does not seem to be related to the effect on USG (higher, same, or lower USG after practice) (Fig 7). Grouping players by the effect on their USG (higher, same, or lower USG after practice) shows practically the same bodyweight loss in each group (Fig. 8).

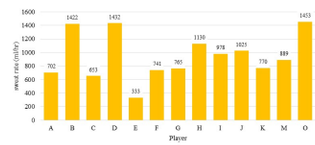

Fig. 6. Sweat rate during basketball practice.

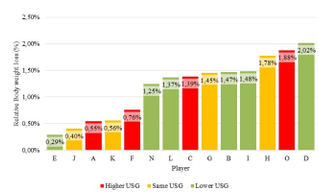

Fig. 7. Relative body weight loss and effect on USG.

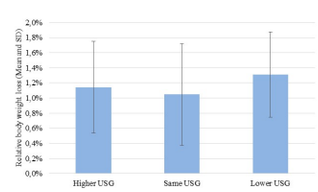

Fig. 8. Relative body weight losses grouped by effect on USG.

Discussion

The fraction of dehydrated players (13/15 players) at the beginning of practice is very high and higher than the one found in a study done in 2009 on NBA basketball players, where 59% of them started practicing in a hypo hydrated state. (5). These values show the need to educate and establish strategies that address players' individual needs to maintain sufficient hydration throughout the day. Examples of individual needs are the fact that two of the players that arrive to practice "seriously dehydrated" did not drink tap water, only bottled water. On the other hand, the two players that started practice "well hydrated" or "minimally dehydrated" were the only players whose main activity was office work, while the rest were college students.

Fluid intake compared to sweat volume suggests that players do not drink enough when allowed to drink at will. This may be explained by the fact that water intake is driven by thirst, which in turn is driven by rises in blood osmolality, which may not have been affected enough in these players, due to their low sweat volume and its electrolyte content. Besides, water in the mouth and the pharynx inhibit thirst long before water gets distributed in the body, so it is natural to stop water intake before recovering the fluid loss (8). Regardless of that insufficient intake, from a performance point of view, bodyweight losses of 1% or less are tolerable since performance losses are reported only beyond that point (6).

A hydration strategy should establish volumes and frequencies of intake according to individual sweat rates to limit body weight loss to a value between 1% and 2% and the same time,

limit intake to 1200 ml/h, the maximum gastric emptying rate (9).

Bodyweight losses match those of a 2009 study in NBA players during a summer league game, where values found were 2,2 ± 0.8 kg and 1,4 ± 0.6% respectively for absolute and relative losses (5). Bodyweight losses are not very high, their distribution shows six players well-hydrated and nine players minimally dehydrated at the end of practice. However, levels of dehydration at the beginning of practice session suggest that bodyweight loss by itself underestimates post-practice dehydration since fluid losses took place on already dehydrated players as indicated by their USG before practice, upon arrival.

Hydration statuses by post-practice USG do not match those indicated by body weight losses. Eight players show a lower USG after practice (indicating a more hydrated status) despite having lost more than 1% of their body weight. This mismatch suggests that USG may not be a good indicator of post-practice dehydration for these levels of body weight loss. UGS would not be sensitive enough to the low dehydration found by body weight losses. Another possible explanation for this mismatch is the use of water as a rehydration fluid because it stimulates urine production by lowering blood osmolality through a rapid rise in blood plasma volume (10).

The sweat rate found during basketball practice is slightly higher than the mean value found in a study done on American college-level players where sweat rate found was 872 ± 175 ml/h during specific practice sessions (11). Another study looked at sweat rates of 16 to 18 years old players at the Australian Institute of Sport and found 1039 ± 169 ml/h y 1371 ± 235 ml/h respectively during winter and summer sessions (12). Considering sweat rates found in the present study and the references cited, it seems reasonable to use values between 1000 y 1200 ml/has a general guide to establishing hydration strategies for basketball players when individual data is not available.

Practical Applications

- If you do not know players' hydration habits outside practice or think they may not be adequately hydrated, make hydration the first practice task.
- Control dehydration produced by the practice session by weighing players before and after and calculate relative body weight loss.
- Calculate the minimum water intake for each player using the following equation (if you get a negative number, it means the player does not need to drink fluid): Equation 3. Sweat Volume [lt]:

$$[[Bodyweightloss[lt] + Waterintake[lt]] - Urinevolume[lt]] \quad \textbf{[3]}$$

- If you do not have individual values for sweat rates, use a sweat rate between 1000 and 1200 ml/hr as a reference to establish hydration strategies for games and practices.
- Make sure players always have water available during the practice session.
- Prefer rehydration drinks over water because water stimulates urine production, slowing down the rehydration process.

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