



HYDRATION SCIENCE AND STRATEGIES FOR BASKETBALL

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INTRODUCTION

Body water loss through sweating occurs during exercise to dissipate body heat and, therefore, prevent sharp rises in body core temperature. Thermoregulatory sweat losses can be large, particularly during high-intensity or prolonged activity such as a ~2 h basketball practice or game. When fluid intake is less than sweat loss, a body water deficit, or dehydration, occurs. The purpose of this chapter is to 1) provide an overview of the effect of dehydration on basketball performance, 2) discuss what is currently known about off-court and on-court hydration practices of basketball players (to determine the most common

hydration issues that need to be addressed), and 3) recommend practical hydration strategies that can be implemented by coaches and trainers to ensure players are well-hydrated before, during, and after practice/competition. Throughout this chapter, dehydration will be expressed as a percentage of body weight deficit (e.g., 2% dehydration is equivalent to 2% loss of body weight, which is 3 lb in a 150 lb player). The term euhydration will be used to denote “normal” body water content or maintenance of baseline body weight by ingesting fluid to completely replace sweat losses incurred during a workout.

KEY FINDINGS

- Research indicates that $\geq 2\%$ dehydration could impair performance of basketball-specific skills (field-goal shooting) and basketball-specific movements (on-court sprinting and defense).



- Multiple indices should be used and interpreted collectively to obtain an estimate of hydration status. Practical assessment techniques, such as monitoring urine (color, concentration, and frequency) as well as changes in body weight, can be useful in guiding fluid intake needs before, during, and after training or competition (see Table 1).

- The descriptive literature indicates that relatively low levels of dehydration accrue in most players during basketball practice/games as long as drink breaks are provided. However, it appears that off-court/pre-practice hydration may be inadequate, especially in male athletes.

EFFECT OF DEHYDRATION ON PERFORMANCE

Basketball is a sport characterized by intermittent bouts of high-intensity activity interspersed with periods of low activity repeated over a prolonged time. Thus, success in the game of basketball is dependent upon both aerobic and anaerobic performance as well as sprinting, strength, and jumping ability. Research suggests that some, but not all, of these components of the game may be impacted by hydration status. Dehydration (>2%) has been found to consistently impair aerobic performance; however, mild to moderate dehydration (up to 2—5%) does not appear to affect athletes' muscular strength, jumping, short-term sprinting, or anaerobic performance.^{17,18}

The game of basketball also involves the execution of complex sport-specific skills, which are dependent upon motor skill and cognitive function. There is evidence from studies in the general population and with athletes that dehydration (>2%—3%) impairs postural balance,^{9,11,12} cognitive performance, mood, and mental readiness.^{17,18} Cognitive research specific to basketball is limited; however, one study has found that dehydration (1%—4%) impairs vigilance-related attention in male high school and college basketball players.³

A few studies have also tested the impact of dehydration on basketball-specific skills during a simulated game. In 2006, Dougherty et al¹⁰ compared the effect of 2% dehydration vs. fluid replacement to maintain euhydration on skill performance of 12—15 year old competitive basketball players. Performance was assessed during four quarters of basketball drills designed to incorporate various aspects of the game, including field-goal and free-throw shooting, repeated sprints, vertical jumps, and defensive slides. Compared to the players' performance during the euhydration trials, 2% dehydration resulted in significantly slower total sprinting (78 ± 9 s vs. 83 ± 10 s) and lateral movement (68 ± 8 s vs. 73 ± 8 s) times as well as a lower shooting percentage ($53 \pm 11\%$ vs. $45 \pm 9\%$) over the course of the entire simulated game. In 2007, Baker et al⁴ employed a similar basketball protocol to investigate the effect of progressive (1% to 4%) dehydration vs. euhydration on performance in skilled 17—28 year old basketball players. In this study, the players' total game performance deteriorated as dehydration progressed from 1% to 4%. Compared to euhydration, the players' total number of shots made during the simulated game were 5, 6, 8, and 10 fewer, and the total time to complete sprinting and lateral movement drills were 7, 20, 26, and 57 sec slower with 1%, 2%, 3%, and 4% dehydration, respectively.

One additional study has tested the effect of dehydration vs. euhydration on basketball performance.¹³ In this study, ten male players completed a 40-min simulated "2 on 2 full court" game with or without drinking. During the fluid-restricted trial, players accrued 1.9% dehydration throughout the simulated game, whereas euhydration was maintained with water during the fluid-ingestion trial. No statistically significant differences in field-goal or free-throw shooting performance were observed between trials. However, during the fluid-restricted trial, players experienced an 8.1% decrease in field-goal percentage between the first and second half of the simulated game. By contrast, field-goal percentage increased by 1.6% in the fluid-ingestion trial.

Although this difference did not reach statistical significance, a net 9.7% difference in shooting performance would almost certainly be of practical significance to players and coaches, and could even determine the outcome of a game. All of the aforementioned performance studies involved male players, but similar detrimental effects of dehydration would be expected in female basketball athletes.

FLUID BALANCE IN BASKETBALL PLAYERS

OFF-COURT HYDRATION HABITS

Fluid intake habits off the court are important in determining how well-hydrated an athlete is at the start of a training session or game. There are no data available on the pregame or pre-practice hydration status of teen basketball players. However, observational studies have consistently found that young (9–16 year old) athletes in various other sports commonly show up to practice or competition already in a dehydrated state,^{8,19} as indicated by pre-exercise urine specific gravity (USG) measurements ≥ 1.020 .¹⁷ Studies with professional male basketball players have found similar results; Osterberg et al¹⁵ observed a USG >1.020 in 15 out of 29 players' pre-game samples during NBA summer league competition. However, it is interesting to note that female players may not follow the same trend. Brandenburg & Gaetz⁵ assessed pre-game USG in 17 female (24 ± 3 years) Canadian national-level players and found that players were well-hydrated prior to each game (average USG of 1.005 ± 0.002 and 1.010 ± 0.005 before two separate games).

ON-COURT HYDRATION HABITS

Once exercise begins, fluid losses occur from thermoregulatory sweating. Thus, fluid intake is needed to prevent significant dehydration (i.e., $\geq 2\%$ body mass loss) during training or competition. Sweating rates can vary considerably among players (and even from day-to-day within players) because of differences in genetics, body size, heat acclimation status, exercise-intensity, and environmental conditions. One study observed sweat losses of 16–18 year old basketball players training at the Australian Institute of Sport.⁶ The male players' sweating rate was 1039 ± 169 mL/h (35.1 ± 5.7 oz/h) and 1371 ± 235 mL/h (46.4 ± 7.9 oz/h) during winter and summer training sessions, respectively. Their sweating rate during competition was 1587 ± 362 mL/h (53.7 ± 12.2 oz/h) and 1601 ± 371 mL/h (54.1 ± 12.5 oz/h) in the winter and summer sessions, respectively. The female players' sweating rate was 687 ± 114 mL/h (23.2 ± 3.9 oz/h) and 680 ± 139 mL/h (23.0 ± 4.7 oz/h) during winter and summer training sessions, respectively. Their sweating rate during competition was 976 ± 254 mL/h (33.0 ± 8.6 oz/h) and 917 ± 253 mL/h (31.0 ± 8.6 oz/h) in the winter and summer sessions, respectively. Thus, for both sexes, sweating rates were higher in games compared to practices, perhaps due to higher exercise intensities during games. However, despite differences in gym temperature (~ 63 – 68°F in winter and ~ 74 – 81°F in summer), there were minimal seasonal variations in sweating rate during in-door practices and games.

Despite the large sweat losses incurred during training and competition, the descriptive literature suggests that most basketball players do a

relatively good job of drinking enough fluid to prevent significant fluid deficits. For example, Broad et al,⁶ found that less than 10% of the athletes accrued $\geq 2\%$ dehydration throughout a training session or game and most players (~50%—70%) accrued $< 1\%$ dehydration. Similar findings have been reported in other observational studies with male and female adolescent basketball players.^{7,14} The volume of ad libitum fluid intake by an athlete during exercise is largely dependent upon fluid availability.¹⁶ Thus, the lack of significant in-game dehydration found in basketball is likely related to the structure of the game, which is conducive to frequent stoppage of play, allowing opportunity for fluid intake during time-outs, player substitutions, and halftime.

HYDRATION STRATEGIES

PRACTICAL HYDRATION ASSESSMENT TECHNIQUES

Practical indices of hydration status include body weight (e.g., fluctuation in morning body weight or change from before to after exercise), urine (e.g., color or USG), and thirst. Although each of these indices is somewhat limited in their precision and accuracy (compared to more-expensive, laboratory-based techniques), they can still be effective in estimating fluid intake needs, especially when used/interpreted collectively and in the proper context.¹⁷ For example, first morning nude body weight can be a useful indicator of hydration status. For a euhydrated individual who is in “energy balance,” morning body weight (after voiding) is stable and not expected to deviate by $> 1\%$.¹ Thus,

when a first morning nude body weight deviates from “normal” morning body weight (established by regular measurements over a period of several days) by $> 1\%$, the individual may be hypohydrated, especially if accompanied by dark/concentrated urine and thirst. As previously discussed, body weight assessments can also be used to gauge an athlete’s sweat loss during a workout. Acute body weight change (e.g., from pre- to post-exercise of a < 3 h workout)¹⁷ represents 16 oz of water loss per 1 lb of body weight loss.¹

RECOMMENDATIONS

Because of the deleterious effects of dehydration on basketball performance, it is recommended that athletes start practice well-hydrated, drink enough fluid to prevent $\geq 2\%$ body weight deficit during a practice session or game, and rehydrate to replace any remaining body-fluid deficit after a workout. Rapid and complete rehydration is especially important if the athlete is participating in a practice session or game within the same day.^{17,18}

Table 1 contains detailed hydration strategies to aid proper hydration before, during, and after training/competition. Considerations for the composition of the fluid replacement beverage are also provided. It is recommended that sodium be consumed with water to help simulate thirst, replace sweat electrolyte losses, and retain ingested fluids. Providing a chilled beverage with the addition of flavor and sweetness can also improve beverage palatability and voluntary fluid intake.¹⁷

TABLE 1. HYDRATION STRATEGIES BEFORE, DURING, AND AFTER TRAINING/COMPETITION

OCCASION AROUND TRAINING/COMPETITION	HYDRATION ASSESSMENT TECHNIQUE	DEFINITION	RECOMMENDATIONS
BEFORE	Morning body weight	<ul style="list-style-type: none"> In a euhydrated individual who is in “energy balance,” morning body weight (after voiding) is stable and not expected to deviate by $> 1\%$. 	<ul style="list-style-type: none"> If morning body weight has dropped by $> 1\%$ from “normal,” then drink fluid to reestablish baseline body weight. Slowly drink beverages (e.g., ~5–7 mL/kg) at least 4 h before the exercise task. If no urine is produced, or urine is dark or highly concentrated, slowly drink more fluid (e.g., another ~3–5 mL/kg) about 2 h before the event. Consuming beverages with sodium (110–270 mg/8 oz) and/or small amounts of salted snacks or sodium-containing foods will help retain the consumed fluids.
	Urine Specific Gravity	<ul style="list-style-type: none"> Determine “normal” (euhydrated) baseline body weight by taking daily measurements (over a period of ≥ 3 days). Specific gravity is a measure of urine concentration. A urine sample < 1.020 is indicative of euhydration. This technique requires an instrument called a refractometer. 	
	Urine color	<ul style="list-style-type: none"> Light yellow (like lemonade) is indicative of euhydration. Dark yellow or brown (like apple juice) is indicative of dehydration. Clear urine is indicative of overhydration. 	
DURING	Change in body mass	<ul style="list-style-type: none"> Measure pre- and post-workout body weight to determine expected sweat loss during training and games of various intensities, durations, and environmental conditions. Body weight should be taken with minimal dry clothing or nude, if possible. 	<ul style="list-style-type: none"> Avoid significant body weight deficit (i.e., $\geq 2\%$). Also, avoid any body weight gain. Drink 16 oz of fluid for each 1 lb of sweat lost during the course of a workout. Consuming a beverage with sodium (110–160 mg/8oz) helps replace sweat sodium losses and stimulate thirst.
AFTER	Change in body mass	<ul style="list-style-type: none"> Compare post-workout body weight to pre-workout body weight. Body weight should be taken with minimal dry clothing or nude, if possible. 	<ul style="list-style-type: none"> Drink ~24 oz of fluid for each 1 lb of body weight deficit* Consuming a beverage with sodium (110–270 mg/8oz) and/or small amounts of salted snacks or sodium-containing foods helps replace sweat sodium losses, stimulate thirst, and retain the ingested fluids.

*Rapid and complete rehydration is especially important if participating in a practice session or game within the same day; otherwise normal eating and drinking practices (i.e., water and sodium intake with post-exercise meals and snacks) is usually sufficient to reestablish euhydration. Definition: Euhydration, “normal” body water content, which is maintained by drinking enough fluid to replace sweat losses, as indicated by maintenance of body weight

Source: Sawka, M.N., L.M. Burke, E.R. Eichner, R.J. Maughan, S.J. Montain, and N.S. Stachenfeld (2007). American College of Sports Medicine position stand. Exercise and fluid replacement. Med. Sci. Sports Exerc. 39:377-390.

SUMMARY

Taken together, the literature suggests that basketball players' off-court (i.e., pregame) hydration habits may be more inadequate than on-court fluid intake behavior. Dehydration by $\geq 2\%$ of body weight has been found to impair basketball skill performance, and greater levels of dehydration can further degrade performance. Furthermore, fluid intake during a game does not compensate for poor pregame hydration status. Therefore, strategies to ensure that a player begins training or competition in a well-hydrated state should be considered just as important as in-game hydration strategies.

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