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The Effect of an Educational Intervention on the Hydration Status and Fluid Intake of Collegiate Indoor Athletes

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THE EFFECT OF AN EDUCATIONAL INTERVENTION ON THE HYDRATION STATUS AND FLUID INTAKE OF COLLEGIATE INDOOR ATHLETES

BY

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Abstract

Proper hydration allows the body to function at an optimal level. It is widely understood that dehydration causes significant deficits to athletic performance, ranging from decreases in cognitive function to decreases in sport-specific skills. Despite this knowledge, dehydration is a popular concern among athletes of varying competition levels. Hydration education has been said to be an important component to limit the prevalence of dehydration. However, the effectiveness of education within indoor collegiate athletes is unknown. Therefore, the purpose of this study is to determine if a one-time education session on the importance of hydration, the negative effects associated with hydration, and ways to determine hydration status, is effective in improving the hydration status and fluid intake practices in indoor collegiate athletes. Twenty-five female collegiate volleyball (n= 15) and basketball (n=10) athletes (mean age: 21 ± 1 years, mean height: 173.53 ± 8.67 cm, mean weight: 72.08 ± 9.98 kg) were assessed during three sport practices before the intervention and three sport practices following the intervention. Results indicated that athletes were euhydrated pre-practice (Usg 1.015 ± 0.006, Ucol 4 ± 1) and remained euhydrated post-practice (Usg 1.019 ± 0.005, Ucol 5 ± 2) during the pre-intervention period. Significant decreases ($p = .027$) in pre-practice urine color and increases ($p =.001$) hydration knowledge (via HAQ score) were found following the educational intervention. Basketball athletes had significantly higher ($p = .000$) changes in body mass after practices compared to volleyball athletes. Significant increases were found for pre- and post-practice measures of Usg and Ucol in the pre-intervention period ($p = .000$, $p = .001$) and the post-intervention period ($p = .001$, $p = .000$). No correlation was found between hydration knowledge (HAQ scores) and indices of hydration status and fluid intake. Overall, female collegiate indoor athletes are well hydrated and have a good sense of hydration knowledge. Variability is present within athletic teams, indicating that attention should be given to personalizing the needs of each athlete to incorporate education for those who lack proper hydration.

Keywords: dehydration, hydration assessment, hydration knowledge, urine specific gravity, urine color

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Chapter 1 – Introduction

According to the Centers for Disease Control and Prevention (CDC), water intake is essential to adequate daily nutrition practices. Water aids in many mechanisms involved in everyday life, such as body temperature regulation and waste elimination (CDC, 2014). Today, it is widely accepted that dehydration has negative effects, not only 27within athletics, but also in everyday life. Proper hydration allows the body to function at an optimal level (Casa et al., 2000). When the body reaches a 2% body mass loss due to fluid losses, significant deficits are seen, ranging from decreases in cognitive function to decreases in sport-specific skills (Armstrong et al., 1985; D'Anci et al., 2009; Derave et al., 1998; Dougherty et al., 2006; Ganio et el., 2011; Hayes & Morse, 2009; Jones et al., 2008; Maxwell et al., 1999; Patel et al., 2007; Walsh et al., 1994).

In an attempt to combat dehydration, the National Athletic Trainers' Association (NATA), American College of Sports Medicine (ACSM), and American Dietetic Association (ADA) have proposed recommendations regarding hydration and fluid intake. It is clear that athletes may not be following these recommendations appropriately based on the high rates of dehydration found in the current research. Research shows that pre-practice dehydration is very common in athletes of all competition levels (Arnaoutis et al., 2015; Cleary et al., 2012; Finn & Wood, 2004; Hamouti, Del Coso, Estevez & Mora-Rodriguez, 2010; Magal, Cain, Long & Thomas, 2015; Rivera-Brown & Felix-Davila, 2012; Silva et al., 2010; Volpe, Poule & Bland, 2009). The current literature, discussed further in the following chapter, also shows that exercise-induced dehydration is common in athletes due to increased sweat losses and a lack of proper fluid intake during and after experiencing sweat losses (Arnaoutis et al., 2015; Decher et al., 2008; S.

Godek, J. Godek & Bartolozzi, 2005; McDermott, Casa, Yeargin, Ganio, Lopez & Mooradian, 2009; Yeargin et al., 2010a; Yeargin et al., 2010b).

While the literature has made it clear that dehydration is prevalent in athletics, research focusing on improving hydration is still limited. It is possible that the high prevalence of dehydration in athletes is due to a lack of knowledge of the appropriate hydration practices. Education is essential and effective in promoting proper hydration (Casa et al., 2000). Therefore, educational interventions could have positive implications for the overall hydration status of athletes.

Statement of the Problem

As previously mentioned, dehydration continues to be a problem within athletics. Research on outdoor athletes, specifically football and soccer players, has proved this to be evident (Godek et al., 2005; Decher et al., 2008; McDermott et al., 2009; Volpe et al., 2009; Yeargin et al., 2010). Outdoor athletes tend to have a greater emphasis on hydration due to the environmental factors that can cause increased sweat rates and fluid losses. To date, much of the research has focused on the hydration of outdoor athletes. The few studies that have focused on indoor athletes have shown that sweat rates are high and dehydration is still prevalent (Garcia-Jimenez, Yuste & Garcia-Pellicer, 2014; Hamouti et al., 2010; Lott & Galloway, 2011; Osterberg, Horswill & Baker, 2009; Thigpen, Green & O'Neal, 2014; Vukasinovic-Vesic, Andjelkovic, Stojmenovic, Dikic, Kostic & Curcic, 2015). This has been found to be especially true in basketball players because of the intermittent nature of the sport (Osterberg et al., 2009; Vukasinovic-Vesic et al., 2015). Although there is limited research, it is likely that this is also true in volleyball athletes, as the sport is also filled with short periods of high intensity effort.

Therefore, evidence-based strategies must be implemented to reduce dehydration and promote proper fluid intake practices in these populations.

Previous research has claimed that hydration education is an optimal tool for improving the hydration status of athletes (Casa et al., 2000; Kavouras et al., 2012; Sobana & Many, 2014). This claim has not been tested in collegiate indoor athletes, specifically volleyball or basketball players, despite showing mild to significant levels of dehydration in the current research. Therefore, it is necessary to identify whether or not these interventions will positively affect the hydration status of collegiate indoor athletes.

Purpose

The primary purpose of this study is to determine if a one-time educational session on hydration improves the hydration status and fluid intake practices of collegiate indoor athletes. Furthermore, this study will provide additional information to the current inconclusive status in the literature of the overall hydration status of indoor athletes.

Hypotheses

There are three hypotheses for this research. These include:

1. A one-time educational intervention will improve the overall hydration status and fluid intake practices of collegiate indoor athletes.
2. During the control period, athletes will begin practices in a dehydrated state (Usg greater than or equal to 1.020 and/or Ucol greater than or equal to 4) and will not drink enough during practices to compensate for this.
3. During the control period, athletes will not drink enough fluids during practices to match their sweat losses.

Operational Definitions

Euhydration: The state of hydration when the body has a “normal” body water content (Sawka & Pandolf, 1990).

Hypohydration: The state of hydration when an individual experiences a loss in total body water that is greater than normal daily fluctuations (Sawka, Cheuvront & Kenefick, 2015).

Dehydration: The state of hydration when an individual loses more fluid than they replace (American Dietetic Association, Dietitians of Canada, and the American College of Sports Medicine, 2009).

Hydration status: The hydration level determined by urinary indices (Usg and Ucol) and body mass losses during exercise (Casa et al., 2005).

Fluid intake: The volume of fluid (water, sports drink, etc.) consumed during exercise.

Fluid replacement: The replacement of body water lost during exercise. This occurs during and after exercise (Casa et al., 2005).

Rehydration: The replacement of body water and extracellular sodium losses. This occurs during and after exercise (Casa et al., 2005).

Sweat rate: The change in body weight during exercise (pre-practice weight – post-practice weight) + fluid intake – urine volume/exercise time (Casa et al., 2000).

Sweat losses: The volume of sweat lost during exercise (Thigpen, Green & O’Neal, 2014).

Urine specific gravity: The measure of the density of urine compared to double distilled water. This is determined using a clinical refractometer, with values greater than or equal to 1.020 signifying dehydration (Fernandez-Elias et al., 2014).

Urine color: The measure of the amount of urochrome in a urine sample, which is determined using a standard urine color chart. This chart ranges from 1 (pale) to 8 (dark), indicating euhydration to dehydration respectively (Armstrong et al., 1994).

Assumptions

It is assumed that all participants will provide a midstream urine sample, as instructed. This assumption includes assuming that the participants will provide the investigator with a urine sample that is their own. It is assumed that the participants of this research study will be truthful with their responses to the hydration awareness questionnaire and the hydration habits questionnaire. It is also assumed that the participants will continue their usual fluid consumption habits and refrain from drinking from a bottle other than their own during practices. Additionally, it is assumed that the participants in this study will pay attention during the educational intervention and take the information seriously. Lastly, it is assumed that the instruments used in this study are both reliable and valid.

Limitations

One limitation of this study is that water breaks during practices are often up to the coach's discretion, rather than the athlete. Therefore, the athletes' fluid intake may be more or less than if they drank fluid when they chose to.

A second limitation is that external factors may influence the urine indices being measured, specifically Usg and Ucol. Beverage consumption, nutrition habits, medicine and vitamin intake can all affect the participants' overall hydration status (Shirreffs, 2000).

A third limitation is the intensity of each practice. Of course, the more work the participant is doing during practice, the higher their sweat rate will be. This will increase the need for fluids. Unfortunately, each practice may not have been the same intensity during each testing day, which may have affected the results of the study. Additionally, the time of testing was dependent upon practice times. Therefore, urine samples and body mass measurements may have not been taken at the same time each testing day.

Delimitations

All subjects that were recruited were NCAA Division II athletes from Barry University, which may not be representative of the indoor collegiate athlete population. Criteria for exclusion included individuals under the age of 18, current injury causing lack of full participation, or inability to perform any portion of the testing protocols. In addition, if participants could not provide a urine sample during multiple testing days, they were excluded from the rest of the study.

Additionally, only pre-practice and post-practice urine sample were collected. Some studies suggest that the first morning void should be collected in addition to these collections for a more accurate measure of hydration status. Due to lack of feasibility and practical implications, this was not incorporated in the present study.

Significance of the Study

The results of this study will aid in improving hydration practices for collegiate indoor athletes. These results will also enhance the current body of literature on the hydration status of indoor athletes, which still remains widely unknown. Reducing dehydration is of the utmost importance for collegiate athletes, coaches, and athletic trainers. This is due to the negative effects of dehydration on overall health, as well as athletic performance. Athletes and coaches aim for high performance at all times. Athletic trainers emphasize the health and safety of the athlete throughout athletic participation. Dehydration impedes those characteristics, thus strategies are needed to reduce dehydration. Determining effective ways to improve hydration status and habits will ultimately aid in reducing dehydration overall.

The information provided in this study will allow athletic trainers and coaches to implement educational techniques to improve their athletes hydration. The incorporation of a one-time education session has been shown to be effective in youth athletes and positively impact their hydration status (Casa et al., 2000; Kavouras et al., 2012). Yet, there are no studies that have tested this intervention in collegiate indoor athletes. This could be an easy, yet effective tool to combating dehydration in this population.

Chapter 2 – Literature Review

According to the National Academy of the Sciences Food and Nutrition Board (2005), water encompasses the largest part of the human body. Without water, it would be impossible for the body to maintain homeostasis and ultimately life. Water intake and hydration are vital parts of physical activity, as physical activity increases the need for heat dissipation. Heat dissipation occurs via the sweating mechanism, which results in fluid loss for the human body (Casa et al., 2000). There has been a significant amount of research on hydration in conjunction with physical activity, but there is a lack of research focusing solely on physical activity that occurs indoors. Therefore, the purpose of this investigation is to assess the hydration status of indoor athletes, specifically collegiate volleyball and basketball players. The present review of literature will encompass hydration, hydration and performance, knowledge, attitudes, and behaviors related to hydration, hydration education, current recommendations on hydration and fluid intake, methods for hydration assessment, and the prevalence of hypohydration.

Hydration

The human body is made up of about 73% water. This water is housed in different parts of the body, with the majority found in the intracellular fluid. The remaining body water is in the interstitial fluid and plasma (Sawka & Coyle, 1999). The term euhydrated has been used to explain an optimal level of hydration. A euhydrated state is when the body has a "normal" body water content (Sawka & Pandolf, 1990). This is usually when an individual has a stable body weight when measured daily, normal urinary volume and concentration, stable total body water (TBW), extracellular water (ECW) and intracellular water (ICW), and normal blood chemistry (Oppliger & Bartok, 2002).

Conversely, an individual is said to be in a hypohydrated state when they experience a loss in total body water that is greater than normal daily fluctuations (Sawka, Cheuvront & Kenefick, 2015). Dehydration occurs when an individual loses more fluid than they replace, which often occurs as a result of exercise (American Dietetic Association, Dietitians of Canada, and the American College of Sports Medicine, 2009). This is mainly due to the body dissipating heat through evaporation of sweat on an individual's skin. The body uses this to maintain core temperature during physical activity. This can affect hydration levels, as vital fluid is lost through sweat. Intense exercise can create increased sweat losses, ultimately causing a large deficit in body water. This deficit can lead to dehydration if the individual does not replace the fluids that are lost. Fluids can be replaced with water and other beverages, such as sports drinks. Fluid replacement should occur during and after all physical activity. It is also vital that athletes begin all physical activity in a euhydrated state to prevent further dehydration and performance deficits (Casa et al., 2000).

Hydration and Performance

Many studies have suggested that dehydration can negatively affect performance in athletics (Armstrong et al., 1985; D'anci et al., 2009; Derave et al., 1998; Dougherty et al., 2006; Ganio et al., 2011; Hayes & Morse, 2009; Jones et al., 2008; Maxwell et al., 1999; Patel et al., 2007; Walsh et al., 1994). Dehydration of just 1% to 2% of body weight can start to impact physiologic function and in turn cause a decline in performance. Dehydration of 3% or more causes an even larger impact on physiologic function and increases the risk of heat illnesses during athletic events. These are important statistics, as it is common for athletes to experience these levels of dehydration in normal practices and games (Casa et al., 2000). Although sweat losses vary from athlete to athlete, some athletes have a substantial sweat rate in just a short practice. According to Casa et al. (2000), there is varying data on the average sweat rates during athletic activity, ranging from 0.5 L per hour to 2.5 L per hour. Furthermore, the Joint Position Statement on Nutrition and Athletic Performance by the American Dietetic Association, Dietitians of Canada, and the American College of Sports Medicine (2009) found that sweat rates during activity can be higher than 1.8 L per hour, but this ultimately depends on body size, exercise intensity, ambient temperature, humidity, and acclimatization. It has been proposed that indoor athletes do not have sweat rates as high as outdoor athletes because they do not have the effects of heat and humidity and often have easier access to water. To determine the sweat rates of indoor athletes, Osterberg, Horswill & Baker (2009) measured the sweat losses of National Basketball Association (NBA) players during games. It was found that on average these athletes sweat more than 2 L in only 20 minutes of playing time. Some individuals sweat losses were found to be as high as 4.6 L. Additionally, Thigpen, Green & O'Neal (2014) found that sweat losses during a 170 minute collegiate basketball practice were approximately 2.4 L and 1.9 L for men and women, respectively. Conversely, Silva, Mundel, Altoe, Saldanha, Ferreira & Marins (2010) studied the fluid intake during one hour of running in a thermoneutral environment (23 ± 0.2°C, 63-65% relative humidity) and found that males only had an average sweat loss of 1.2 L. The females in the study had a much lower sweat loss of only 0.8 L. The significant differences in sweat rates between these studies are likely due to the nature of the exercise. Basketball involves intermittent bouts of high-intensity effort, whereas the run completed in the study by Silva et al. (2010) was set at a fixed intensity and a fixed pace. It is clear that even in indoor events, sweat rates can be high. It is important to recognize that all sweat losses must be replaced in order to prevent dehydration.

As previously mentioned, dehydration has been shown to have serious negative effects on athletic performance. As little as 2% dehydration was found to decrease shooting percentage, increase sprint times, and increase lateral movement times in 12 to 15-year-old basketball players (Dougherty, Baker, Chow & Kenney, 2006). Additionally, Maxwell, Gardner & Nimmo (1999) found that intermittent sprint performance was reduced when completed in a hypohydrated state. Research has also shown that run times and cycling times are negatively affected by only mild levels dehydration (Walsh, Noakes, Hawley & Dennis, 1994; Armstrong, Costill & Fink, 1985).

Other studies have suggested that dehydration can affect postural stability, coordination and strength, which are all important components of athletic maneuvers. Derave, Clercq, Bouckaert & Pannier (1998) studied the effects of exercise-induced dehydration on postural balance using a measure of the velocity of the center of pressure excursion. The mean velocity of those who were dehydrated was much higher, indicating poor postural stability compared to the individuals who were not dehydrated. Maintaining postural stability is essential to success in athletic maneuvers, as well as protect the body from injury during physical activity. Additional research has indicated that other vital components of athletic maneuvers, such as strength and power, can be affected by dehydration. Hayes and Morse (2009) studied the effects of exercise-induced dehydration on strength and power. Participants were required to complete 5 exercise sessions to further induce dehydration. Significant differences were found in isometric and isokinetic leg extensions. As the level of exercise-induced dehydration increased, performance decreased. Maximal isometric strength was reduced by approximately 28.4 Nm^{-1} within 5 exercise sessions and maximal isokinetic strength was reduced by approximately 31 Nm^{-1} in just 4 exercise sessions. No significant differences were found regarding power, measured using a counter-movement jump. Similarly, Abian-Vicen, Coso, Gonzalez-Millan, Salinero & Abian (2012) studied strength and power in badminton players. This study aimed to determine the relationship between dehydration and strength and power in a sport involving intermittent high-intensity bursts of effort. No relationship was found, as dehydration rates were found to be very low. Sweat rates were moderate, but the athletes in this study did an adequate job of rehydrating. No significant differences were found in power, measured using a counter-movement jump, or strength, measured using hand grip strength, pre and post exercise. These results do not agree with those of Jones, Cleary, R.M. Lopez, Zuri & R. Lopez (2008), who studied active dehydration and anaerobic muscular power. It was found that when the participants were dehydrated they had a mean power decrease of 7.17% in the upper body and 19.20% in the lower body compared to when they were euhydrated. Additionally, peak power was decreased by 14.48% in the upper body and 18.36% in the lower body during the dehydration condition. Although this conflicts with the findings of other research, these decreases in lower body power can significantly affect athletic performance and create a higher injury risk, creating a need for a better understanding of this topic (Jones et al., 2008).

Furthermore, research has also shown that dehydration impacts more than just physical performance, but can also negatively impact cognitive aspects. D'Anci, Vibhakar, Kanter, Mahoney & Taylor (2009) studied the effect of dehydration on mood and cognitive performance. In this study, collegiate athletes achieved dehydration by fluid restriction during their practices. When given a mood questionnaire, dehydrated athletes experienced higher levels of anger, fatigue, depression, tension and confusion, as well as lower levels of vigor. Additionally, differences were found in vigilance attention during a continuous performance task for the dehydrated condition compared to the euhydrated condition. In 2011, another study was conducted by Ganio et al. to evaluate the same variables. Participants were also given a mood questionnaire, in which results indicated that dehydration caused significantly increased tension/anxiety and fatigue/inertia. Additionally, cognitive performance was decreased in false alarms on the scanning visual vigilance task and response time on the matching-to-sample task due to dehydration. Overall, these studies are in agreement that dehydration negatively affects some aspects of mood and cognitive performance. Other aspects of cognitive function and dehydration have been explored by Patel, Mihalik, Notebaert, Guskiewicz & Prentice (2007). Specifically, participants were placed in a dehydrated and euhydrated condition to determine differences in mental status, neuropsychological performance, postural stability, and concussion-like symptoms. All of these assessments were gathered based on a concussion assessment, as it has been suggested that dehydration can portray signs and symptoms similar to that of a concussion. No significant differences between conditions were found for mental status and postural stability. Conversely, significant differences were found for visual memory and fatigue measures in the dehydrated condition. Subjects in the dehydrated condition experienced more concussion-like symptoms and they were higher in severity, as graded by the Graded Symptom Checklist (Patel et al., 2007).

Overall, it is clear that there is no positive side to dehydration in relation to athletic performance. The previous studies have found a combination of decreases in sprint and cycle times, strength, power, postural stability, mood, and cognitive performance. All of which can easily negatively affect athletic performance. Additionally, the majority of these studies found that these results can occur with only mild to moderate levels of dehydration. Despite this knowledge, dehydration is still a common concern among athletics today.

Knowledge, Attitudes, and Behaviors of Hydration

There are a variety of reasons as to why athletes are dehydrated, despite the compelling information that the current research provides. These include lack of athlete knowledge, negative attitudes, and ultimately poor rehydration behaviors. Various studies have assessed these aspects in athletics of different age groups and competition levels (Decher et al., 2008; Esa, Saad, Phing & Karppaya, 2015; Geijer, Pitney & Brandenburg, 2009; Nichols, Jonnalagadda, Rosenbloon &Trinkaus, 2005; Sobana & Many, 2014; Torres-McGehee, Pritchett, Zippel, Minton, Cellamare & Sibilia, 2012). According to the National Athletic Trainers' Association (NATA) Position Statement on Fluid Replacement for Athletes, coaches, athletic trainers, and team physicians play a large role in successful rehydration (Casa et al., 2000). These individuals, along with strength and conditioning coaches and the athletes themselves can aid in the reduction of dehydration within athletics. Coaches, athletic trainers, and strength and conditioning specialists have been determined to be a major resource for nutrition and hydration information for athletes. Therefore, research has been conducted to identify how much knowledge these individuals actually have on these topics. Torres-McGehee et al. (2012) found that athletic trainers and strength and conditioning specialists have adequate knowledge (an overall score of 75% or above on the survey) about sports nutrition, whereas athletes and coaches have limited knowledge. In terms of hydration specifically, athletic trainers and strength and conditioning coaches also had the most knowledge, with a score of 79.4% each. Athletes scored 54.7% on hydration knowledge. Conversely, athletes scored 66.3% on the supplements and performance domain. From this, it can be inferred that athletes focus more on supplements because they have the ability to increase their performance. It is plausible that athletes may decide to pay more attention to hydration if they are aware that dehydration can negatively affect their performance. The coaches in this study scored 61.9% in the hydration domain, also indicating a large gap of knowledge for these individuals (Torres-McGehee et al., 2012). Geijer et al. (2009) studied the hydration knowledge of high school athletic coaches and found that 45.5% of the coaches in the study did not have adequate hydration knowledge, indicated by their lack of correct responses on the knowledge assessment. This provides limited evidence, as this study only had a response rate of 4.4% and only 22 coaches responded. Nonetheless, these results agree with that of the previous study by Torres-McGehee et al., further suggesting that athletic coaches have limited knowledge about hydration.

Nichols et al. (2005) assessed the knowledge, attitudes and behaviors regarding hydration and fluid replacement in collegiate athletes. Their results indicate that collegiate athletes should be educated further about hydration. In agreement, Sobana and Many (2014) found that many collegiate athletes lack hydration knowledge and attitudes, and demonstrated poor practices. In their study, not a single athlete scored an excellent score, above 75%, on the questionnaire. Gender differences were also observed within the study. It was found that female athletes had better knowledge scores, but worse hydration practices. Similarly, Esa et al. (2015) demonstrated that even when athletes have adequate hydration knowledge, they do not always have adequate hydration behaviors. Contrarily, a significant positive correlation was found between the knowledge, attitude and behavior scores by Nichols et al. (2005). This suggests that the more knowledge an athlete has, the better their hydration practices and status will be. To investigate this further, Decher et al. (2008) incorporated hydration status assessment to study the relationship between hydration knowledge and behaviors during a youth summer sports camp. Significant correlations were found for the participant's hydration measure and their perceived hydration status. The participants in this study were found to be mildly to severely dehydrated, even though they demonstrated a good knowledge of hydration. This explains that there were other factors playing a role in their hydration behaviors, and that individual hydration knowledge may not be enough to prevent dehydration.

Hydration Education

To take hydration knowledge a step further, many researchers have assessed the effect of education on hydration practices. Casa et al. (2000) explains that, "appropriate education of athletes is essential." Although, some research has found that education is not effective. Cleary, Hetzler, Wasson, Wages, Stickley & Kimura (2012) studied the hydration behaviors of adolescent volleyball athletes. After a control period, each participant was given a one-time educational intervention. No significant differences were found in hydration behaviors following this intervention. The following week, participants were prescribed an individualized hydration amount based on sweat rates.

This created a significant difference in hydration behaviors and status, reducing the amount of dehydration. Ultimately, this study determined that a one-time education session was not enough to improve hydration behaviors. On the contrary, Kavouras et al. (2012) found that youth athletes had significant changes in their hydration behaviors after receiving a one-time lecture on hydration. In addition, performance increases were shown during an endurance run following the lecture and the improvement of hydration behaviors. Additionally, Sobana and Many (2014) investigated the effects of education on collegiate athletes and found that hydration education improved fluid intake behaviors, as well as knowledge and attitudes on hydration. This study differed from the previous studies on education sessions, as they included seven consecutive education sessions rather than just a one-time session.

Some studies have found more success with prescribed hydration interventions, rather than just education. This has been found with adolescent athletes (Clearly et al., 2012) and collegiate athletes (Magal, Cain, Long & Thomas, 2015). Magal et al. (2015) implemented a prescribed hydration intervention, but solely focused on pre-practice hydration status. They determined that prescribing the athletes a specific amount of additional water to drink per day in addition to their usual habits was successful in improving their pre-practice hydration status. Overall, research has shown that education programs, in addition to individualized hydration protocols, have the ability to improve hydration status in athletes.

Current Recommendations on Hydration and Fluid Intake

As previously described, there are many negative effects of dehydration, ranging from cognitive deficits to power and performance deficits. Therefore, steps should be taken to ensure proper fluid intake and rehydration practices. The American Dietetic Association, Dietitians of Canada, and the American College of Sports Medicine (2009) have explained a set of recommendations to ensure adequate athlete hydration. It is recommended that 4 hours prior to practice or competition athletes drink 5-7 mL of water or sports drink per kg of body weight. For example, if an individual weighs 70 kg, they should drink at least 350 mL prior to exercise. This recommendation is quite conservative compared to that of the NATA (2009), who recommends that athletes drink 500-600 mL of water or sports drink 2-3 hours prior to exercise and 200-300 mL of water 10-20 minutes prior to exercise. The NATA also recommends that athletes drink 200-300 mL of water every 10-20 minutes during activity (Casa et al., 2000). After exercise athletes should attempt to replenish at least all of their sweat losses, if not more. Specifically, athletes should drink 25-50% more than their losses (Casa et al., 2000). On average, athletes should drink about 450-675 mL of fluid for every pound of body weight lost during activity (American Dietetic Association, Dietitians of Canada, and the American College of Sports Medicine, 2009). Although, each individual will have different sweat losses, indicating that rehydration practices need to be individualized in order to ensure proper rehydration (Casa et al., 2000).

Methods for Hydration Assessment

To date, there are a variety of methods to assess the hydration status of athletes. According to the ACSM and the NATA, body weight measurements, urine-specific gravity (Usg), urine color (Ucol), and urine osmolality (Uosm) are all useful tools for hydration assessment (Casa et al., 2000; Casa et al., 2005). Certain tools have been shown to be more accurate than others, but some tools are less invasive and more practical in the field than others. Plasma osmolality is typically considered the best technique for measuring hydration status, but this tool is more invasive. Also, it must be completed in a laboratory, requiring more time and more money (Popowski, Oppliger, Lambert, R. Johnson, A. Johnson & Gisolfi, 2001; Sommerfield et al., 2016). Therefore, for the purpose of this review, the main focus will be on non-invasive measures of hydration status. Urine osmolality, which measures the total urine solute content, has been shown to be the most accurate of the above hydration measures. Unfortunately, this measurement tool requires more expensive equipment and more time (Fernandez-Elias et al., 2014; Shirreffs, 2000). Often, other measures are compared to plasma and urine osmolality to determine their reliability. Shirreffs (2000) explained that urine osmolality may be a better measure than urine specific gravity and urine color, but urine specific gravity and urine color are easier in the field measurements. Fernandez-Elias et al (2014) found that urine specific gravity is highly associated with urine osmolality, along with it being more affordable and user-friendly. Popowski et al. (2001) also determined that urine specific gravity was able to successfully detect changes in the hydration status of athletes. Urine specific gravity measures the density of urine compared to double distilled water (Fernandez-Elias et al., 2014). This is a tool that can be used by athletic trainers, coaches, and even athletes themselves, whereas urine osmolality is less accessible for those individuals. Urine specific gravity is typically measured with a refractometer, which is a relatively low cost tool. Optical refractometry should be the measure of choice when looking for the most accurate results of urine specific gravity (Popowski et al., 2001). Conversely, urine specific gravity has been shown to miss a large number of dehydrated subjects (Popowski et al., 2001) and produce a high rate of false positives

(Sommerfield et al., 2016). Regardless, many researchers agree that it is one of the most practical methods to assessing hydration status with accuracy (Casa et al., 2000; Casa et al., 2005; Fernandez-Elias et al., 2014; Popowski et al., 2001; Shirreffs, 2000). Urine color, which is measured by determining the amount of urochrome in a urine sample, is another non-invasive tool that is commonly used (Fernandez-Elias et al., 2014). When urine volume is high, the urine is usually more diluted, producing a more pale color. When urine volume is low, the urine is more concentrated, creating a darker color (Shirreffs, 2000). These colors are correlated to a chart ranging from 1 to 8, indicating extremely poor hydration to very good hydration (Fernandez-Elias et al., 2014). Urine color is a very practical measure that athletes can pay attention to on a daily basis. Color charts can easily be placed in locker rooms and bathrooms to promote the athlete's assessment of their own urine color. Unfortunately, some research has shown that urine color does not correlate to urine output post-exercise, indicating that it is not a good measure of hydration status up to 6 hours after activity (Kovacs, Senden & Brouns, 1999). Additionally, it has been demonstrated that various other factors, ranging from nutrition to medications, can affect urine color. This may affect hydration status, but urine color still remains a useful tool when looking for an easy and affordable way to measure hydration. It also has the quality of being able to provide immediate feedback to an athlete about their hydration level (Shirreffs, 2000).

Body weight measurements are often used as a tool for approximating post-exercise hydration status. This is performed by taking the difference in weight measurements before and after exercise (Casa et al., 2000). As previously explained, several decrements begin to occur after about 2% of body weight is lost, therefore it is vital to ensure that this does not occur. Unfavorably, this measure is most accurate when the athlete begins in a euhyrated state, which is not always the case (Casa et al., 2000). Maughan, Shirreffs & Leiper (2007) explain that despite having multiple sources of error, body weight measurements may be the most practical for athletes, coaches, and athletic trainers.

Overall, there are a variety of options that can be explored to assess hydration status. Although, some tools sacrifice accuracy for field practicality, they are all useful in different settings. The Gatorade Sports Science Institute recommends the following combination of techniques for practical assessment of hydration status: morning body weight, urine specific gravity, and urine color measurements, in addition to pre-practice and post-practice weight measurements to determine sweat losses during activity ("Gatorade Sports Science Institute," 2013).

Prevalence of Hypohydration in Athletics

Extensive research has been conducted to assess the hydration status of a variety of athletes. Much of the research has determined that many athletes do not maintain a proper hydration level. Pre-practice hydration status is a vital component of an athlete's hydration status. Beginning practice or exercise in an already hypohydrated state can predispose the athlete to further dehydration. This can not only negatively affect their performance, as previously discussed, but can also negatively affect their physiologic function and overall health (Volpe, Poule & Bland, 2009). Magal et al. (2015) and Volpe et al. (2009) researched pre-practice hydration statuses. Volpe et al. (2009) found that 66% of collegiate Division I athletes were hypohydrated prior to practice. This involved a wide variety of sports, including baseball, football, lacrosse, tennis, crew, gymnastics, field hockey, lacrosse, soccer, swimming, tennis, water polo, and volleyball. Magal et al. (2015) found that 75% of collegiate Division III athletes in their study began practices in a less than euhydrated state. Osterberg et al (2009) focused mainly on pregame hydration levels. Their results matched with previous studies, as approximately half of the athletes began games hypohydrated. Additional studies focused on overall hydration status. Within these studies, they found that the majority of athletes were hypohydrated at baseline, or during pre-practice hydration measures (Arnaoutis et al., 2015; Cleary et al., 2012; Finn & Wood, 2004; Hamouti, Del Coso, Estevez & Mora-Rodriguez, 2010; Rivera-Brown & Felix-Davila, 2012; Silva et al., 2010). Thigpen et al. (2014) was one of the few studies to find that most athletes showed up to practice in a euhydrated state. Based on the research, it is clear that pre-practice hydration status is a concern.

There is a large body of research assessing the overall hydration status and fluid replacement behaviors of athletes during practices and competitions. Researchers have studied a variety of sports in a variety of settings, but sports occurring outdoors seem to be a more common area of interest. This is likely due to the fact that hydration is closely related to heat stresses (Casa et al., 2000).

Research on outdoor youth athletes has indicated that they have a high prevalence of dehydration. In a study on youth football, campers came to camp dehydrated and remained that way throughout the camp. Although they drank enough fluids during activity to match their sweat losses, they did not remain hydrated, indicating that they were not rehydrating properly after exercise (McDermott, Casa, Yeargin, Ganio, Lopez & Mooradian, 2009). Likewise, high school football players in a study by Yeargin et al. (2010a) were dehydrated throughout the length of their preseason training camp. In research focusing on athletes participating in youth football, adolescent football, and soccer, participants were also found to have high rates of dehydration during 4 days of sports camp (Decher et al., 2008). Overall, youth outdoor athletes have a high prevalence of dehydration.

Studies on collegiate outdoor athletes have found similar results. After only 2 days of pre-season football training, athletes were already dehydrated (S. Godek, J. Godek & Bartolozzi, 2005). In a study on Division I collegiate athletes, 47% of outdoor male athletes were hypohydrated (Volpe et al., 2009). In addition, another study found that out of 403 collegiate athletes, 53% were hypohydrated (Yeargin et al., 2010b). On the other hand, female rugby league players were investigated and it was found that their hydration habits were enough to limit dehydration. The participants in the study consumed 78.5% and 85.6% of fluid losses, during competitions and practices respectively. This was enough to limit body mass losses to 1% or less and prevent dehydration for the majority of the participants (Jones, Till, King, Gray & O'Hara, 2016).

Recent research has shown that sweat losses are just as great in indoor athletes, creating a high potential for dehydration as well. Multiple studies have shown a high prevalence of dehydration amongst indoor athletes of all ages. Arnaoutis et al. (2015) observed fluid balance in elite youth athletes during training. Sports consisted of basketball, gymnastics, swimming, running, and canoeing. 89% of the athletes in this study reported to practice dehydrated and 74.5% of the athletes remained dehydrated or experienced further dehydration during practices. Out of all of the athletes, gymnasts lost the most body mass during practices and gymnasts and basketball athletes were the most dehydrated via urine indices. Conversely, research on indoor tennis, futsal, indoor soccer, basketball, volleyball, and handball has found that on average athletes replace enough fluids to prevent significant dehydration (Garcia-Jimenez, Yuste & Garcia-Pellicer, 2014; Hamouti et al., 2010; Lott & Galloway, 2011) although, mild dehydration was seen in the majority of these sports.

Furthermore, research has been conducted at different levels of competition on basketball solely. In a study on sweat rate and fluid intake in young elite basketball players, participants were dehydrated at the start of competition and did not drink enough to prevent further dehydration during competition (Vukasinovic-Vesic, Andjelkovic, Stojmenovic, Dikic, Kostic & Curcic, 2015). At the college level, Thigpen et al. (2014) found that the majority of basketball players arrived to practice dehydrated, but drank enough fluids throughout practices to limit a body mass loss of greater than 1-2%. At the professional level, Osterberg et al. (2009) studied the hydration practices of the National Basketball Association (NBA) players during competition. They too, found that fluid intake was not adequate enough to compensate for the lack of proper hydration prior to practices. Athletes in this study lost 1.4% body mass on average. All of these studies agree that basketball athletes lacked proper pre-exercise hydration and progressed their dehydration level further during activity. Overall, there is a consensus that dehydration occurs in the indoor sport of basketball, but data varies at to what extent it actually occurs.

Summary

In summary, it is known that hydration is essential for athlete health and performance. Based on the current body of literature on hydration in sport, it is clear that dehydration continues to be a concern. Proper hydration allows the body to function at an optimal level. When the body reaches as little as 2% body mass loss due to dehydration, significant deficits are seen, ranging from decreases in cognitive function to decreases in sport-specific skills (Armstrong et al., 1985; D'Anci et al., 2009; Derave et al., 1998; Dougherty et al., 2006; Ganio et el., 2011; Hayes & Morse, 2009; Jones et al., 2008; Maxwell et al., 1999; Patel et al., 2007; Walsh et al., 1994). There is a limited consensus on the prevalence of dehydration in volleyball and basketball athletes, but the research that has been done has determined that pre-exercise and during exercise hydration strategies are poor in basketball players (Osterberg et al., 2009). Today, there are tools to assess hydration status, including urine specific gravity, urine color, and body weight measures, that can be used not only by clinicians, but athletes as well (Casa et al., 2000; Casa et al., 2005). In addition, position statements from the NATA, ASCM, American Dietetics Association, and Dietitians of Canada provide specific recommendations for fluid intake before, during, and after activity in hopes to limit dehydration. Despite this information, dehydration is still prevalent. Previous research has claimed that hydration education is essential and effective in improving hydration status in athletes (Casa et al., 2000; Kavouras et al., 2012; Sobana & Many, 2014). This has not been tested in collegiate volleyball and basketball athletes, despite showing mild to significant levels of dehydration in the current research. Therefore, it is warranted to identify if these interventions will positively affect the hydration status of indoor collegiate athletes.

Chapter 3 – Methods

The purpose of this study is to determine the effect of a one-time educational intervention on the hydration status and fluid intake practices of indoor collegiate athletes, specifically volleyball and basketball players. As previously discussed, dehydration is prevalent in indoor athletes, despite the lack of heat stresses. Research has shown that education is an appropriate tool for limiting dehydration in athletics (Casa et al., 2000; Casa et al., 2005; Kavouras et al., 2012; Sobana & Many, 2014). The effects of hydration education on collegiate athletes is limited and still not well understood. Therefore, research should be conducted to determine if education can improve hydration practices in this population, as much of this research has been centered on youth athletes. The investigation of the effectiveness of a one-time educational intervention on hydration status and fluid intake practices will not only assess the educational intervention, but enhance the literature on the hydration status of indoor collegiate athletes.

Participants

Fifty collegiate, male and female indoor athletes at Barry University, an NCAA Division II institution were recruited for participation in this study. The participants were recruited from the following teams: women's volleyball, women's basketball, and men's basketball. All participants completed a pre-participation physical exam and were medically cleared by the Barry University Athletic Training staff prior to recruitment. Criteria for exclusion included individuals under the age of 18, current injury causing lack of full participation, or an inability to perform any portion of the testing protocols.

All participants were required to read and sign written informed consent forms approved by Barry University prior to involvement in this study. Approval for this study was granted from the Barry University Institutional Review Board (pending approval).

Instrumentation

Body Mass.

Body mass (BM) was measured before and after practice to the nearest 0.1 kg using a digital scale (model BWB-800S; Tanita, Brooklyn, NY, USA). Dehydration was indicated by a decrease in BM greater than 2% (Casa et al., 2000).

Urinalysis.

Urine samples were used solely to measure the participant's urine specific gravity (Usg) and urine color (Ucol). Usg measurements were determined using a clinical refractometer (model REF312ATC; General Tools & Instruments, Secaucus, NJ, USA). Prior to testing, the refractometer was calibrated using distilled water. To determine the Usg value, a small amount of urine was taken from the participant's urine sample cup via a disposable transfer pipette and was placed on the glass plate of the refractometer. Values greater than or equal to 1.020 indicated hypohydration (Casa et al., 2000). Ucol was determined by comparing the participant's urine color to the standard urine color chart provided by the NCAA Fact Sheet for Student-Athletes on assessing hydration status. This chart ranges from color 1 (lightest) to color 8 (darkest), indicating very well hydration to extremely poor hydration respectively (Armstrong et al., 1994; Fernandez-Elias et al., 2014).

Fluid Intake.

The volume of fluid drank by each participant was obtained by measuring the amount of water consumed out of the participant's water bottle during each practice. This was determined using a digital scale (model KD-320; Tanita, Tokyo, Japan). The investigator weighed each of the participants' filled water bottles and subtracted the weight of the bottle itself. At the end of the practice, the volume of fluid remaining in the bottle was recorded and subtracted from the initial amount in the bottle. This gave the investigator the total volume of fluid consumed.

Questionnaires.

Questionnaires on hydration awareness (HAQ) and hydration habits (HHQ) were used to determine hydration knowledge and habits (Decher et al., 2008) (see Appendix C). The HAQ is likert-type scale ranging from 0 (strongly disagree) to 10 (strongly agree). The HHQ incorporates a likert-type scale, ranging from 0 (never) to 10 (always), but also has a qualitative component to some of the questions. The questionnaires were designed using a multidisciplinary approach and were found to be understandable and reliable (HAQ: 70% reliability).

Procedure

All data was collected in the Health and Sports Center at Barry University's Miami Shores, Florida campus. Pre-practice and post-practice data collection occurred in the athletic training facility. During-practice data collection occurred in the gymnasium. All data was collected in the middle of each team's season to limit any physiologic changes or adaptations that could occur at the beginning of the season. Data was collected on days that teams had sport-specific practices. Pre-game practices and strength and conditioning sessions were excluded from the study.

A pre-intervention control period was used to establish the hydration status and fluid intake practices of the participants prior to the educational intervention. At the beginning of the control period, all participants filled out the HAQ and HHQ (Decher et al., 2008). Each questionnaire was labeled with the individual's participant number, rather than their name, to protect their confidentiality.

After the control period, a one-time educational intervention was provided to the participants. This occurred after practice, in a group setting, and lasted approximately twenty minutes. The educational intervention was a verbal presentation including the importance of hydration, the negative effects of dehydration, and how to prevent dehydration. Specific information was explained from the recommendations of the NATA, ACSM, and ADA. Participants were also given handouts (NCAA Performance Hydration handout) and urine color chart (NCAA Fact Sheet for Student-Athletes) to take home with them (see Appendix D). Additionally, each participant was provided with a written summary of his or her hydration status from the control period (see Appendix E). To ensure privacy, the investigator brought the summaries in sealed envelopes labeled with the participant numbers. Each participant was instructed to take the envelope with his or her assigned number. Instructions regarding how to use the information given in the summaries were included during the education session.

During the following collection days (post-intervention period), data was collected to determine if the educational intervention positively affected the participants' hydration status and fluid intake practices. At the beginning of the post-intervention period, participants filled out the same HAQ and HHQ (Decher et al., 2008). Again, each questionnaire was labeled with the individual's participant number.

The control period and the post-intervention period were each comprised of three testing days, all of which included pre-practice, during-practice, and post-practice data collection. This came to a total of six testing days per athletic team involved. Each sport (volleyball, women's basketball) had six designated testing days in the middle of their competition season. Therefore, data collection was comprised of twelve testing days, but each participant only participated in a total of six. The same pre-practice, during-practice, and post-practice data collection procedures were followed during each period. Pre-practice data collection consisted of urinalysis and BM measurements. Participants were asked to arrive to the athletic training facility approximately thirty minutes prior to practice (one hour on the first day of testing). Upon arrival, participants were required to turn in a signed informed consent form that was given to them when they expressed interest in the study. Each participant was then given a participant number to protect their privacy and de-identify them for the remainder of the study. They were asked to remember this number for all of data collection. They were then provided with a urine sample cup that was numbered with their participant number (i.e. participant 1). They were instructed to fully empty their bladders and provide a midstream urine sample. This was completed in a private restroom of their choice, without the investigator present. Upon completion, participants were asked to bring their sample to their locker room and place the sample in a large box labeled "urine samples". This was done to ensure privacy and de-identify the participant from their sample.

Once the participant provided their urine sample, their body mass was measured the athletic training facility. Each individual was weighed barefoot, in only athletic shorts (male) or athletic shorts and a sports bra (female). If the participant preferred more privacy, they were able to stand behind a curtain while the investigator recorded their body mass from the remote display that was placed outside of the curtain. In between participants, the scale was disinfected.

After all participants provided urine samples and BM measurements, the box of urine samples was retrieved by the investigator so Usg and Ucol measurements could be measured and recorded. During all handling of the urine samples, the investigator wore medical gloves. After the Usg and Ucol measurements were recorded, the urine sample was discarded in the toilet and the urine sample cup was disposed of in a garbage bag. As per the Occupational Safety and Health Administration (OSHA), urine with the absence of blood is not considered biohazardous material; therefore urine sample cups do not need to be disposed of in a biohazard bag.

During-practice, data collection included fluid intake measurements. Each player had their own water bottle, previously provided to them by the Barry University athletic training staff. Each participant was given a sticker with their participant number and instructed to place it on their bottle prior to the start of practice on the first testing day. The bottles of the team members who did not consent to participation were not labeled or measured at any point during the study. At the beginning of practices, bottles were filled with water by the athletic training staff, as usual. Throughout practice, the investigator kept track of the volume of fluid consumed by each participant, as explained in the instrumentation section. Participants drank fluids ad-libitum during all practices. All participants were encouraged to continue to their normal hydration habits and instructed not to share their water bottles with other teammates during data collection. Each participant was instructed to inform the investigator if they needed to urinate during practices, so the urine volume could be collected in a urine jug and recorded. This was to be used for sweat rate and sweat loss measurements. Additionally, the number of water breaks provided by the coaches was documented. Each practice during data collection lasted approximately three hours.

At the end of each practice, participants were asked for another urine sample and BM measurement. Participants were specifically instructed to complete their BM measurement and then provide a urine sample, in that order. With the exception of the order of the measurements, all procedures were done exactly the same as during the pre-practice data collection.

Statistical Analysis

A one-way within subjects analysis of variance (ANOVA) with repeated measures was used to determine the differences between the control and post-intervention period for each of the indicators of hydration status (% BM lost, Usg, Ucol), sweat rate, fluid intake practices (fluid intake, fluid replacement %), and HAQ scores. A one-way within subjects analysis of variance (ANOVA) with repeated measures was used to determine the differences between each sport for each of the same variables. Pearson correlations were used to determine the relationship between hydration knowledge (HAQ) and actual hydration status (mean Usg, Ucol, %BM loss). The data was analyzed using SPSS (ver. 21, IBM corp., Chicago, IL, US) statistical software.

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Manuscript

The effect of an educational intervention on the hydration status and fluid intake of collegiate indoor athletes

Abstract

Purpose: To assess the hydration status and fluid intake of collegiate indoor athletes before and after a one-time educational intervention. ***Methods:*** Twenty-five female collegiate volleyball (n= 15) and basketball (n=10) athletes (mean age: 21 ± 1 years, mean height: 173.53 ± 8.67 cm, mean weight: 72.08 ± 9.98 kg) were assessed during six days of sport specific practices. Hydration status (pre- and post-practice) and fluid intake were assessed during a control period consisting of three practice days. The intervention was then provided, and hydration status and fluid intake were assessed again during the post-intervention period consisting of another three practice days. Participants completed surveys before and after the intervention to assess hydration knowledge (HAQ) and hydration habits to determine if it was successful in improving their knowledge. ***Results:*** 3-day mean urine specific gravity (Usg) and urine color (Ucol) were considered euhydrated pre-practice (Usg 1.015 ± 0.006, Ucol 4 ± 1) and remained euhydrated post-practice (Usg 1.019 ± 0.005, Ucol 5 ± 2) during the pre-intervention period. Significant decreases (p = .027) in pre-practice urine color and increases (p =.001) hydration knowledge (via HAQ score) were found following the educational intervention. Basketball athletes had significantly higher (p = .000) changes in body mass after practices compared to volleyball athletes. Significant increases were found for pre- and post-practice measures of Usg and Ucol in the pre-intervention period (p = .000, p = .001) and the post-intervention period (p = .001, p = .000). No correlation was found between hydration knowledge (HAQ scores) and indices of hydration status and fluid intake. ***Conclusion:*** Overall, female collegiate indoor athletes are well hydrated and

have a good sense of hydration knowledge. Variability is present within athletic teams, indicating that attention should be given to personalizing the needs of each athlete to incorporate education for those who lack proper hydration.

Keywords: dehydration, hydration assessment, hydration knowledge, urine specific gravity, urine color

Introduction

Proper hydration allows the body to function at an optimal level.[1] When the body reaches a 2% body mass loss due to fluid losses, significant deficits are seen, ranging from decreases in cognitive function to decreases in sport-specific skills.[2-11] Although recommendations for proper hydration practices have been created for athletes, [1,12,13] it is clear that athletes may not be following these recommendations appropriately based on the high rates of dehydration found in the current research. Research shows that pre-practice dehydration is very common in athletes of all competition levels.[14-21] The current literature shows that exercise-induced dehydration is common in athletes due to increased sweat losses and a lack of proper fluid intake during and after experiencing sweat losses.[14,22-26] Research on outdoor athletes, specifically football and soccer players, has proved this to be evident.[21-25] Outdoor athletes tend to have a greater emphasis on hydration due to the environmental factors that can cause increased sweat rates and fluid losses. To date, much of the research has focused on the hydration of outdoor athletes. The few studies that have assessed indoor athletes have shown that sweat rates are high and dehydration is still prevalent.[17,27-31] This has been found to be especially true in basketball players because of the intermittent nature of the sport.[29,31] Although there is limited research, it is likely that this is also true in volleyball athletes, as the sport is also filled with short periods of high intensity effort. Therefore, evidence-based strategies must be implemented to reduce dehydration and promote proper fluid intake practices in these populations.

While the literature has made it clear that dehydration is prevalent in athletics, research focusing on improving hydration is still limited. It is possible that the high prevalence of dehydration in athletes is due to a lack of knowledge of the appropriate hydration practices because it is thought that education is essential and effective in promoting proper hydration.[1] Previous research has claimed that hydration education is an optimal tool for improving the hydration status of athletes.[1,32,33] Therefore, educational interventions could have positive implications for the overall hydration status of athletes. The purpose of this study was to determine if a one-time educational session on hydration improves the hydration status and fluid intake practices of collegiate indoor athletes. Furthermore, this study will provide additional information to the current inconclusive status in the literature of the overall hydration status of indoor athletes.

Methods

Subjects

Twenty-five female collegiate indoor athletes from an NCAA Division II institution were recruited for participation in this study (mean age: 21 ± 1 years, mean height: 173.53 ± 8.67 cm, mean weight: 72.08 ± 9.98 kg). The participants were recruited from the women's volleyball and women's basketball teams. Criteria for exclusion included individuals under the age of 18, current injury or illness causing lack of full sport participation, or an inability to perform any portion of the testing protocols. All participants were required to read and sign written informed consent forms approved by

Barry University prior to involvement in this study. Approval for this study was granted from the Barry University Institutional Review Board.

Procedure

All data was collected over a period of six days, involving a pre-practice and post-practice testing session. All data was collected in the middle of each team's season to limit any physiologic changes or adaptations that could occur at the beginning of the season. Data was collected on days that teams had sport-specific practices. Each practice ranged from one and a half hours to two hours. Practices were similar in structure and intensity during the pre- and post-intervention periods. Pre-game practices and strength and conditioning sessions were excluded from the study.

A pre-intervention control period was used to establish the hydration status and fluid intake practices of the participants prior to the educational intervention. At the beginning of the control period, all participants filled out informed consent forms and questionnaires. After the control period, a one-time educational intervention was provided to the participants. This occurred after post-practice collection on day three, in a group setting, and lasted approximately twenty minutes. The educational intervention was a PowerPoint presentation including the importance of hydration, the negative effects of dehydration, and how to prevent dehydration. Specific information was explained based on recommendations of the NATA, ACSM, and ADA.[1,12,13] Each participant was also provided with a written summary of her hydration status from the control period, a urine color chart, and an NCAA flyer on performance hydration. The following collection days were considered the post-intervention period and the same protocol was followed to determine if the educational intervention positively affected the participants' hydration status and fluid intake practices. At the beginning of the post-intervention period, participants filled out the same questionnaires to determine if their knowledge increased.

Pre-practice data collection consisted of urinalysis and body mass (BM) measurements. Upon arrival, participants were instructed to fully empty their bladders and provide a midstream urine sample. Once the participant provided their urine sample, their body mass was measured. Each individual was weighed barefoot, in only athletic shorts and a sports bra. During-practice, data collection consisted of fluid intake measurements. Throughout practice, the investigator kept track of the volume of fluid consumed by each participant. Participants drank fluids ad-libitum during all practices and were encouraged to continue to their normal hydration habits. They were also instructed not to share their water bottles with other teammates during data collection. Each participant was instructed to inform the investigator if they needed to urinate during practices, so the urine volume could be collected and recorded. At the end of each practice, participants were asked for another urine sample and BM measurement. Participants were specifically instructed to complete their BM measurement and then provide a urine sample, in that order. With the exception of the order of the measurements, all procedures were done exactly the same as during the pre-practice data collection.

Instrumentation

Body Mass.

BM was measured before and after practice to the nearest 0.1 kg using a digital scale (model BWB-800S; Tanita, Brooklyn, NY, USA). Exercise induced hypohydration was indicated by a decrease in BM greater than 2%.[1]

Urinalysis.

Urine samples were used solely to measure the participant's urine specific gravity (Usg) and urine color (Ucol). Usg measurements were determined using a clinical refractometer (model REF312ATC; General Tools & Instruments, Secaucus, NJ, USA). Prior to testing, the refractometer was calibrated using distilled water. To determine the Usg value, a small amount of urine was taken from the participant's urine sample cup via a disposable transfer pipette and was placed on the glass plate of the refractometer. Values greater than or equal to 1.020 indicated hypohydration.[1] Ucol was determined by comparing the participant's urine color to the standard urine color chart created by Armstrong.[34] This chart ranges from color 1 (lightest) to color 8 (darkest), indicating very well hydrated to extremely poorly hydrated, respectively.[1,34]

Fluid Intake.

The volume of fluid drank by each participant was obtained by measuring the amount of water consumed out of the participant's water bottle during each practice. This was determined using a digital scale (model KD-320; Tanita, Tokyo, Japan). The investigator weighed each of the participants' filled water bottles and subtracted the weight of the bottle itself. At the end of the practice, the volume of fluid remaining in the bottle was recorded and subtracted from the initial amount in the bottle.

Questionnaires.

Questionnaires on hydration awareness (HAQ) and hydration habits (HHQ) were used to determine hydration knowledge and habits[22]. The HAQ is likert-type scale ranging from 0 (strongly disagree) to 10 (strongly agree). The HHQ incorporates a likert-type scale, ranging from 0 (never) to 10 (always), but also has a qualitative component to some of the questions. The questionnaires were designed using a multidisciplinary approach and were found to be understandable and reliable (HAQ: 70% reliability).[22]

Statistical Analysis

A one-way within subjects analysis of variance (ANOVA) with repeated measures was used to determine differences between the control and post-intervention period for indicators of hydration status (3-day mean of % BM lost, Usg, Ucol), fluid intake practices (3-day mean of fluid intake volume), and hydration knowledge (HAQ score). A one-way ANOVA with repeated measures was used to determine differences between pre-practice and post-practice Usg and Ucol. A one-way mixed model ANOVA with repeated measures was used to determine differences of indicators of hydration status (3-day mean of % BM lost, Usg, Ucol), fluid intake practices (3-day mean of fluid intake volume), and hydration knowledge (HAQ score) between sports. Pearson correlations were used to determine the relationship between hydration knowledge (HAQ) and actual hydration status (mean Usg, Ucol, %BM loss). The data was analyzed using SPSS (ver. 21, IBM corp., Chicago, IL, US) statistical software.

Results

The following analyses involved all 25 subjects. Means and standard deviations for all dependent variables during the control and intervention periods are provided in Table 1. It was identified that there were significant decreases in pre-practice urine color ($p = .027$) and significant increases in hydration awareness questionnaire scores ($p = .001$) following a one-time educational intervention. No significant differences were found for pre-practice urine specific gravity ($p = .979$), post-practice urine specific gravity (p = .980), post-practice urine color (p = .095), body mass change (p = .068), fluid intake (p = .665), sweat rate (p =.894), or fluid replacement percentage (p = .180).

Significant increases were found for pre- and post-practice measures of urine specific gravity (p = .000) and urine color (p = .001) in the pre-intervention period. Significant increases were also found for pre and post practice measures of urine specific gravity (p = .001) and urine color (lp = .000) in the post-intervention period.

Means and standard deviations for all dependent variables divided by sport are provided in Table 2. No significant interaction was found between time period (pre-intervention and post-intervention) and sport. Significant differences were found between sports for body mass change (p = .000), where basketball experienced greater body mass losses compared to volleyball. Basketball displayed significantly higher sweat rates (p = .001) and significantly lower fluid replacement percentages (p = .008) compared to volleyball. No significant differences were found between sports for pre-practice urine specific gravity (p =.353), post-practice urine specific gravity (p = .063), pre-practice urine color (p = .871), post-practice urine color (p = .761) fluid intake (p = .719), or HAQ scores (p = .134).

No correlation was found between HAQ scores and any indices of hydration status (Usg, Ucol, % BM change) or fluid intake. Strong positive correlations were found between pre-practice Usg and pre-practice Ucol during the pre-intervention period (r = .844, p = .000) and the post-intervention period (r = .930, p = .000). Strong positive correlations were found also between post-practice Usg and post-practice Ucol during the pre-intervention period (r = .719, p = .000) and the post-intervention period (r = .791, p =

.000). A weak positive correlation (r = .410, p = .042) was found between % BM change and fluid intake during the control period.

Discussion

The purpose of this study was to determine if a one-time educational intervention on hydration improved the hydration status and fluid intake practices of female collegiate indoor athletes. This would also provide additional information on the overall hydration status and hydration knowledge of this population. Based on the results of this study, female collegiate indoor athletes have proper hydration knowledge and exhibit hydration habits that are adequate enough to keep them euhydrated before, during, and after practices. Much of the previous research has focused on pre-practice and/or pre-game hydration levels, as pre-practice euhydration is a vital component of an athlete's overall hydration status. Beginning practice or exercise in a hypohydrated state can predispose athletes to further dehydration.[35] This can not only negatively affect their performance, but can also negatively affect their physiologic function and overall health.[21] Magal et al[18] and Thigpen et al[30] found that at least half of collegiate basketball athletes began practices or games in a less than euhydrated state. Additional studies have found this to be true with varying sports and levels of athletes.[14-20] The present results disagree, indicating that on average indoor athletes began practices in a euhydrated state (Usg < 1.020 and Ucol ≤ 3) and ended practice in a euhydrated state. Though not significant, it is important to note that during the control period 28% of participants in this study were hypohydrated (Usg ≥ 1.020 and Ucol ≥ 4) prior to practice and 44% ended practice in a hypohydrated state. Forty percent of the basketball participants were hypohydrated before practice, while only 20% volleyball participants were. After practices, 60% basketball athletes were hypohydrated, while only 33.33% volleyball athletes were. This shows that hypohydration is still prevalent among certain athletes, specifically within the sport of basketball. Despite the group means displaying overall euhydration, there was clearly variability within the participants, which can be seen specifically in measures of pre-practice Usg (Figure 1) and Ucol (Figure 2), as well as body mass change % (Figure 3). As expected, the few individuals who showed up to practice in a hypohydrated state were unable to drink enough fluids during practice to compensate for this, and ended practice in a further hypohydrated state. This was explained by the significant increases in urine specific gravity and urine color measurements when comparing pre-practice to post-practice.

The hypothesis that a one-time educational intervention will improve the overall hydration status and fluid intake practices was partially supported because a significant decrease was shown in pre-practice urine color for these participants. This could indicate that the athletes were able to judge their hydration level based on being able to visually see their urine color on a daily basis, allowing them to adjust their hydration practices to improve their urine color. In addition, significantly higher scores on the HAQ were found after the educational intervention, which is indicative of an increase in the participants' hydration knowledge. Despite this, there was no improvement in post-practice urine color, pre-practice urine specific gravity, post-practice urine specific gravity, % body mass change, or fluid intake. This explains that although there was an increase in hydration knowledge, the participants did not change their hydration habits. This is likely due to the fact that participants of this study initially had good knowledge of hydration, indicated by a 90% score on the HAQ during the pre-intervention period, which was also reflected in their overall euhydrated status. Conversely, previous studies have found that collegiate athletes lack proper hydration knowledge. On various assessments, Nichols et al[36] found an average of 81.7% on a questionnaire, while Sobana and Many[33] and Torres-McGehee et al[37] found scores of under 55%. A significant positive correlation was found between knowledge, attitude and behavior scores by Nichols et al,[36] which could suggest that the more knowledge an athlete has, the better their hydration practices and status will be. To investigate this further, Decher et al[22] incorporated hydration status assessment to study the relationship between hydration knowledge and behaviors in youth athletes. The participants in this study were found to be mildly to severely dehydrated, even though they demonstrated a good knowledge of hydration. In agreement, the present study found no correlation between hydration knowledge and indices of hydration (Usg, Ucol, %BM loss) and fluid intake, in addition to findings of good hydration knowledge in an indoor collegiate population. No previous studies have assessed hydration knowledge in combination with specific measures of hydration status in indoor collegiate athletes. Previous research on outdoor collegiate athletes agrees with findings of inconsistencies between hydration knowledge and hydration behaviors.[36,37]

A notable unexpected finding in this study was that multiple individuals were actually drinking more fluids than necessary and gaining weight during practices. These cases of hyperhydration can lead to exercise-associated hyponatremia (EAH), which is defined as an abnormally low serum or plasma sodium concentration (typically less than 135 mmol/L). This condition is often caused by excessive fluid intake compared to sweat losses and can lead to serious signs and symptoms, and even death.[39] Athletes who drink excessively and gain weight during exercise are among the risk factors for EAH[40].

Additionally, female athletes have a higher likelihood of developing EAH.[12,39] These characteristics were found within some of the participants in this study, indicating a risk of hyponatremia in this population, specifically volleyball athletes. More than two volleyball players gained weight during each practice. During the educational intervention, each athlete was given feedback on their level of hydration via urine color and urine specific gravity measurements; along with information on their average body mass changes and sweat rates. Individuals who lost a significant amount of weight were to be instructed to drink more fluids, but this was not necessary, as not a single athlete had a 3-day mean body mass loss of greater than 2%. Individuals who gained weight were advised that they were hyperhydrating, which could be dangerous; therefore, it was recommended that they lessen their fluid intake during practice. Despite this, their behaviors did not change significantly and weight gain was still seen. These trends were not as prevalent in basketball, as the majority of basketball athletes lost weight during each practice. In agreement with previous research, athletes were able to replace enough fluids to prevent significant dehydration[17,27,28] although; mild dehydration was still seen on occasion. The lack of improvement in body mass changes after the intervention was likely due to the fact that athletes were aware their hydration status was adequate prior to the intervention. For individuals who were nearing 2% BM loss, this may indicate that athletes are not being given enough opportunities to drink water during their practices or they are choosing not to drink enough when they are given these opportunities. Additionally, significant differences in body mass changes were seen between sports throughout the entirety of the study (see Table 2). This is likely due to the increased sweat rates and decreased fluid replacement % in basketball athletes compared to volleyball athletes. On average, basketball athletes lost 0.7% of their body mass during all practices (pre- and post-intervention), while volleyball athletes only lost 0.2%. In agreement, research on collegiate and professional basketball athletes has also found that the majority of basketball athletes do not experience a body mass loss of greater than 1-2% during practices and games.[29,30] The limited research that has been done on volleyball athletes was conducted on youth athletes and found a BM loss of 0.4% during control and 0.5% after educational intervention[15], which is slightly higher than the present study, which found 0.2% pre- and post-intervention.

Overall, it was clear that in the present study that not all participants needed to improve their hydration status. Figure 1 and 2 display that participants who experienced pre-practice hypohydration seemed to benefit from the educational intervention by decreasing their Usg and Ucol. This indicates that a one-time educational intervention may be a useful tool for individuals who really need to improve their hydration status. Previous studies on hydration education have found conflicting results on this topic. Kavouras et al[32] found that youth athletes had significant changes in their hydration behaviors after receiving a one-time lecture on hydration. Additionally, Sobana and Many[33] investigated the effects of education on collegiate athletes and found that hydration education improved fluid intake behaviors, as well as knowledge and attitudes on hydration. The present study agrees with Cleary et al[15] in that education alone is not completely successful in improving all indices of hydration status and fluid intake. Instead, they found success with prescribing athletes with the adequate amount of fluid specific to their sweat losses.[15] Although, unlike the present study, the participants of these studies[15,32,33] were found to be hypohydrated prior to the intervention, indicating a need for improvement.

Practical Applications

It was determined that the incorporation of a one-time educational intervention was not extremely effective in improving the hydration status and fluid intake practices of female collegiate indoor athletes. More importantly, it determined that athletes in this study had a very high knowledge of hydration and hydration behaviors that kept them euhydrated, making this intervention unnecessary for the majority of participants. Variability was seen in this population indicating that some individuals were hypohydrated before, during and after practices. Futhermore, there were participants who were displaying improper hydration habits by hyperhydrating during practices. Reducing improper hydration behaviors is of the utmost importance for collegiate athletes, coaches, and athletic trainers. This is due to the negative effects of hypohydration on overall health, as well as athletic performance, and the dangerous effects of hyperhydration and hyponatremia. Athletes and coaches aim for high performance at all times. Athletic trainers emphasize the health and safety of the athlete throughout athletic participation. Improper hydration impedes those characteristics, thus strategies are needed to reduce this in these populations. Athletic trainers and coaches can use hydration measures and information from this study to identify individuals who exhibit hypohydration or hyperhydration and will likely benefit from an educational intervention. As seen in the present study, individuals who needed the intervention benefitted from it and improved their hydration status.

Several limitations were present in this study. External factors may influence the urine indices being measured and in turn could have affected the results. Beverage consumption, nutrition habits, medicine and vitamin intake can all affect the participants' overall hydration status.[38] Other limitations of this study include variations in practice intensity and practice structure. Additionally, water breaks during practices are often up to the coach's discretion, rather than the athlete. Therefore, the athletes' fluid intake may be more or less than if they drank fluid when they chose to dependent upon their coaches.

Future research should consider similar variables with other indoor sports, along with involving male participants. Additional educational interventions (i.e. multiple sessions) or prescribed hydration protocols should also be studied to determine their effectiveness in combating improper hydration behaviors in the indoor athlete population. Barriers to changes in hydration behaviors should also be assessed. In addition, a focus on hyperhydration and hyponatremia may be warranted.

Conclusions

It was observed that female collegiate indoor athletes were generally well hydrated before, during and after practices. These individuals began the study with a good knowledge of hydration, which improved following a one-time educational intervention. However, all variables of actual hydration status did not significantly improve because they did not need to due to their euhydrated status prior to the intervention. However, some individuals did experience hypohydration and benefitted from hydration education to better their hydration status and fluid intake practices. Other individuals also needed hydration education to ensure that they were not continuing to overhydrate and put themselves at risk for hyponatremia. Overall, athletic trainers and coaches should pay particular attention to personalizing the needs of their athletes to improve hydration in those who are hypohydrated and decrease hyperhydration in those whose fluid intake during activity is too high.

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APPENDIX A
INSTITUTIONAL REVIEW BOARD PROTOCOL FORM

Barry University

Research with Human Participants
Protocol Form

PROJECT INFORMATION

1. **Title of Project** The Effect of an Educational Intervention of the Hydration Status and Fluid Intake of Collegiate Indoor Athletes

2. **Principal Investigator** (please type or print)
Student Number or Faculty Number: 2311213
Name: Isabella Abbasi
School – Department: Barry University School of Human Performance and Leisure Sciences – Athletic Training
Mailing Address: 3741 State Road 84 #201, Davie, FL, 33312
Telephone Number: (561) 213-9981
E-Mail Address: **Isabella.abbasi@mymail.barry.edu**; **Isabella.abbasi@gmail.com**

NOTE: You ***WILL NOT*** *receive any notification regarding the status of your proposal unless accurate and complete contact information is provided at the time the proposal is submitted.*

3. **Faculty Sponsor** (If Applicable)
Name: Dr. Sue Shapiro
School – Department: Barry University School of Human Performance and Leisure Sciences – Athletic Training
Mailing Address: 11300 NE 2nd Ave, Miami Shores, FL, 33161
Telephone Number: (305) 899-3574
E-Mail Address: **sshapiro@barry.edu**

Faculty Sponsor Signature:________________________________ Date: _____________

4. **Is an IRB Member on your Dissertation Committee? Yes _____ No: ___X___**

5. **Funding Agency or Research Sponsor**
Not Applicable

6. **Proposed Project Dates**
Start ___11/01/16_______
End ___11/01/17_______

Note: It is appropriate to begin your research project (i.e., the data collection process) only *after* you have been granted approval by this board. Proposals that list starting dates occurring before the date of submission will be returned without review. Please allow time for approval when determining your start date. It is best if the end date you choose is one year after the start date.

Please Provide the Information Requested Below

A. Project activity STATUS is: (Check one of the following three as appropriate.)

_X_ NEW PROJECT
___ PERIODIC REVIEW ON CONTINUING PROJECT
___ PROCEDURAL REVISION TO PREVIOUSLY APPROVED PROJECT
(Please indicate in the **PROTOCOL** section the way in which the project has been revised.

B. This project involves the use of an **INVESTIGATIONAL NEW DRUG (IND) OR AN APPROVED DRUG FOR AN UNAPPROVED USE** in or on human participants.
___ YES **_X_** NO
Drug name, IND number and company:
____

C. This project involves the use of an **INVESTIGATIONAL MEDICAL DEVICE (IMD)** or an **APPROVED MEDICAL DEVICE FOR AN UNAPPROVED USE.**
___ YES **_X_** NO

D. This project involves the use of **RADIATION** or **RADIOISOTOPES** in or on human participants.
___ YES **_X_** NO

E. This project involves the use of Barry University students as participants. (If any students are minors, please indicate this as well.)
_X_ YES Barry Students will be participants (Will minors be included? ___ YES **_X_** NO)
___ NO Barry Students will participate

F. **HUMAN PARTICIPANTS** from the following population(s) would be involved in this study:

___ Minors (under age 18)
___ Fetuses
___ Abortuses
___ Pregnant Women
___ Prisoners
___ Mentally Retarded
___ Mentally Disabled
___ Other institutionalized persons (specify)
_X_ Other (specify) ______Barry University Student-Athletes____________

G. Total Number of Participants to be Studied: ___50___

Description of Project

1. **Abstract** (200 words or less)

Proper hydration allows the body to function at an optimal level. It is widely understood that dehydration causes significant deficits to athletic performance, ranging from decreases in cognitive function to decreases in sport-specific skills. Despite this knowledge, dehydration is a popular concern among athletes of varying competition levels. Hydration education has been said to be an important component to limit the prevalence of dehydration. However, the effectiveness of education within indoor collegiate athletes is unknown. Therefore, the purpose of this study is to determine if a one-time education session on the importance of hydration, the negative effects associated with hydration, and ways to determine hydration status, is effective in improving the hydration status and fluid intake practices in indoor collegiate athletes. This investigation will also provide additional information to the current body of literature on the hydration status and fluid intake practices of indoor collegiate athletes. Fifty participants will be recruited for this study and will partake in a total of eight testing days. Each testing day will be comprised of pre-practice, during-practice and post-practice data collection. It is intended that the results of this study will assist in providing an effective evidence-based tool to improving hydration.

2. **Recruitment Procedures**

   Describe the selection of participants and methods of recruitment, including recruitment letter if applicable. (**NOTE**: If the investigator has access to participants by virtue of his or her position within the study setting, please provide a brief description of such access.)

This study will involve Barry University NCAA Division II student-athletes. Both male and female indoor athletes, specifically volleyball and basketball athletes will be attempted to be recruited. Research on the hydration status of indoor athletes is limited, as the majority of research has focused on outdoor athletes (e.g. football, baseball, soccer). The current research shows that athletes who participate indoors still have high sweat rates and an increased risk of dehydration; therefore, further research on this population is warranted. Additional inclusion criteria that will be used during the recruitment procedures of this study include being over the age of 18, being in their athletic competition season, and being free from any injuries or conditions that will limit their full participation in sport practices.

Once the Barry University Institutional Review Board has approved the use of human participants, flyers (see Appendix A) will be placed in the athletic training facility, male and female athlete locker rooms, and bulletin boards around the Sport and Exercise Science department. Potential participants will be asked to contact the primary investigator (PI) through contact details listed on the flyer. Once the potential participants contact the PI, the PI will explain the study in detail and determine if the potential participant meets the inclusion criteria. If the potential participant meets the inclusion criteria and agrees to participate, times and dates for data collection will be arranged. However, participants can choose not to report and withdraw from the study at any time.

3. **Methods**

Describe procedures to which humans will be subjected. Include a description of deceptive techniques, if used, and debriefing procedures to be used on completion of the study. Use additional pages, if necessary.

This study will include a total of eight testing days per participant. Each sport (volleyball, women's basketball, men's basketball) will have eight designated testing days in their competitive season. Therefore, data collection will be comprised of twenty-four testing days, but each participant will only be asked participate in a total of eight testing days. These testing days will correspond with their team practices. Data collection will include body mass measurements, urine sample collection, and fluid intake measurements. These measures will occur before, during, and after team practices. The first four testing days will be considered the pre-intervention (control) period, while the last four testing days will be considered the post-intervention period. Participants will partake in both testing periods for this study. Each participant will be asked to contribute approximately nine hours of his or her time throughout his or her competition season. This will include 30 minutes of testing before and after eight practices, with the exception of an hour on the initial testing day, and a twenty-minute hydration education session.

The pre-intervention (control) period will be used to establish the hydration status and fluid intake practices of participants prior to an educational intervention. After the data collection for the control period is completed, a one-time educational intervention will be provided to the participants (see appendix E). The intervention will be a twenty-minute presentation to the group of participants and will include the importance of hydration, the negative effects of dehydration, and ways to assess and prevent dehydration. Specific information will be explained from recommendations from the National Athletic Trainers' Association, the American College of Sports Medicine, and the American Dietetics Association. Each participant will receive a hand out (NCAA Performance Hydration) and a urine color chart (NCAA Fact Sheet for Student-Athletes) to take home (see Appendix D). Additionally, each participant will be provided a written summary of his or her hydration status from the control period. To ensure privacy, the investigator will bring the summaries to the education session in sealed envelopes labeled with the participant's study number, which will be provided at the start of the study. Participants will be instructed to take the envelope with his or her assigned number.

On the first day of testing, each participant will be asked to arrive to the athletic training facility approximately one hour before his or her scheduled practice. This is to allow additional time for informed consent collection (see Appendix B) and questionnaire completion (see Appendix C). Upon arrival, consent will be collected. Each participant will then be given a participant number to protect their privacy and de-identify them for the remainder of the study. They will be asked to remember this number for all of data collection. The PI will keep a list of names and their corresponding numbers. This information will be kept on the PI's password protected computer and will be kept confidential. Participants will be asked to complete a hydration awareness questionnaire and a hydration habits questionnaire and return them to the investigator. Each questionnaire will be labeled with the participant number. Upon completion, participants will be given a urine sample cup, labeled with their participant number (e.g. participant

#1). Participants will be told to take the urine sample cup to a private restroom of their choice. They will be instructed to fully empty their bladders and provide a midstream urine sample. The investigator will not be present for this portion of the study to ensure participant privacy. Participants will also be instructed to return their urine sample to a box in their locker room labeled "urine samples." This will be done to ensure privacy and de-identify the participant from their urine sample.

Upon completion, participants will be asked to come back to the athletic training facility to provide a body mass measurement. This will be completed using a Tanita BWB-800s digital scale. Each participant will be asked to remove his or her shoes and socks and remain in athletic shorts (males) or athletic shorts and a sports bra (females) only. If the participant prefers more privacy, they will be able to stand behind a barrier, while the investigator records their body mass from the remote display of the scale. In between participants, the scale will be disinfected.

After all body mass measurements are taken, the investigator will retrieve the urine samples from the locker room to measure each sample's urine specific gravity and urine color. Urine specific gravity will be measured using a clinical refractometer (model REF312ATC; General Tools & Instruments) with a range of 1.000 to 1.060 μg/L. Prior to testing, the refractometer will be calibrated using distilled water. To determine the urine specific gravity value, a small amount of urine will be taken from the participant's urine sample cup via a disposable transfer pipette and placed on the glass plate of the refractometer. The investigator will then hold the refractometer toward an area of natural light and will look through the eyepiece to read the value. Values greater than or equal to 1.020 will indicate hypohydration. Urine color will be determined using a standard urine color chart provided by the NCAA Fact Sheet for Student-Athletes on assessing hydration status. The chart ranges from color 1 (lightest) to color 8 (darkest), indicating well hydrated to very dehydrated, respectively. During the handling of all urine samples, the investigator will wear medical gloves. Additionally, all urine samples will be discarded immediately following data collection. Urine will be discarded in the toilet and urine sample cups will be disposed of in the garbage. As per the Occupational Safety and Health Administration (OSHA), urine with the absence of blood is not considered biohazardous material; therefore, urine sample cups do not need to be disposed of in a biohazard bag. This will conclude pre-practice data collection. For the remainder of the study, participants will be asked to arrive for pre-practice data collection approximately thirty minutes prior to practice to provide his or her urine sample and body mass measurement. The same procedures as explained above will be followed during every pre-practice data collection session, a total of 8 times. The same hydration awareness and hydration habits questionnaires that were given on the first testing day will be given to the participants again on the fifth testing day to aid in determining the effect of the educational intervention on hydration knowledge and awareness.

During-practice data collection will be comprised of fluid intake measurements. Each player will have their own water bottle, provided to them by the Barry University athletic training staff. On the first day of testing, each participant will be given a sticker with their participant number and will be instructed to place it on their bottle prior to the start of practice on that day. The bottles of the team members who do not volunteer and consent for participation will not be labeled or measured at any point during the study. At the beginning of practices, bottles will be filled with water by the athletic training staff.

Throughout practice, the investigator will keep track of the volume of fluid consumed by each participant. This will be done using a Tanita KD-320 digital scale. The investigator will weigh the bottle at the start of practice and subtract the weight of the bottle itself. At the end of practice, the investigator will measure the weight of the fluid remaining inside the bottle and will subtract this from the initial weight of the water in the bottle. This will provide the investigator with the total volume of fluid consumed during practice. All participants will be encouraged to continue to their normal hydration habits and instructed not to share their water bottles with other teammates during data collection. Each participant will be asked to inform the investigator if they need to urinate during practices, so the urine volume can be collected in a urine jug and recorded. This will solely be used for sweat rate and sweat loss calculations. All urine will be disposed of in the toilet immediately after the volume is recorded. Additionally, the number of water breaks provided by the coaches will be documented throughout the duration of each practice.

At the conclusion of practice, participants will be asked to return to the athletic training facility for a post-practice body mass measurement and urine sample. They will be instructed to ensure that their body mass measurement is recorded prior to providing their urine sample. Other than the order in which the participants provide body mass measurements and urine samples, post-practice procedures will remain exactly the same as the pre-practice procedures.

Completion of eight total testing days, including pre-practice, during-practice, and post-practice data collection, as well as a one-time educational intervention on day five, will conclude the participant's involvement in the study.

4. Alternative Procedures

Describe alternatives available to participants. One alternative may be for the individual to withhold participation.

Participation will be strictly voluntary and they may decline to participate at any stage of the protocol. Participants are free to stop and/or withdraw from the testing at any time. Participants may also choose not to answer any question on any of the questionnaires. Should they choose to not participate or withdraw completely from the study, there will be no adverse effects on them.

5. Benefits

Describe benefits to the individual and/or society.

There are no direct benefits to the individual participating in the study. An indirect benefit may be that the individual gains a better understanding of his or her own hydration status and the importance of hydration.

6. Risks

Describe risks to the participant and precautions that will be taken to minimize them. Include physical, psychological, and social risks.

There is minimal risk to the individual participating in this study. A body mass measurement is something an athlete is used to, as it is typically conducted each year within an athlete's pre-participation physical. Also, the athletic training staff and coaching staff often utilize pre-practice and post-practice weight measurements throughout the athletic season. Additionally, the NCAA has mandated drug-testing policies, which include providing a urine sample. All athletes are aware that they may be subject to this at some point in their athletic career; therefore, providing a urine sample is something they are familiar with.

7. Anonymity/Confidentiality

Describe methods to be used to ensure the confidentiality of data obtained.

The informed consent forms will be stored in a locked filing cabinet in the Faculty Advisor's (Dr. Sue Shapiro) office. The data collected will be inputted in an excel document on the primary investigator's password protected computer.

Each participant will be assigned a number (i.e. participant #1), which will correspond to their consent form and all data collection. Only the primary investigator will have access to the assigned numbers linking participants consent forms and their data. This information will also be kept on the primary investigator's password protected computer. If any published results occur from this study, no identifiable information will be disclosed and data will be discussed in terms of group averages. All data will be maintained for a minimum of five years upon completion of the study and will be kept indefinitely.

8. Consent

Attach a copy of the consent form(s) to be signed by the participant and/or any statements to be read to the participant or informational letter to be directed to the participant. **(A copy of the consent form should be offered to each participant.)** If this is an anonymous study, attach a cover letter in place of a consent form.

See Appendix B.

9. Certification

I certify that the protocol and method of obtaining informed consent as approved by the Institutional Review Board (IRB) will be followed during the period covered by this research project. Any future changes will be submitted to IRB review and approval prior to implementation. I will prepare a summary of the project results annually, to include identification of adverse effects occurring to human participants in this study. I have consulted with faculty/administrators of any department or program which is to be the subject of research.

_______________________________ ____________________

Principal Investigator *Date*

***Reminder*: Be sure to submit sixteen (16) individually collated and bound (i.e. stapled or paper clipped) copies of this form with your application.**

*NOTE: Your proposal **WILL NOT** be reviewed until the completed packet is received in its entirety.*

APPENDIX B
INSTITUTIONAL REVIEW BOARD INFORMED CONSENT FORM

Barry University
Informed Consent Form

Your participation in a research project is requested. The title of the study is The Effect of an Educational Intervention on the Hydration Status and Fluid Intake of Collegiate Indoor Athletes. The research is being conducted by Isabella Abbasi, ATC, LAT, a student in the Sport and Exercise Science department at Barry University, and is seeking information that will be useful in the field of Athletic Training. The aim of the research is to determine if a one-time education session on hydration is effective in improving the hydration status of collegiate indoor athletes. In accordance with these aims, the following procedures will be used: hydration awareness and habits assessment via questionnaire, measurement of body mass, measurement of urine density, urine color, and urine volume, and measurement of fluid intake during team practices. In order to participate in this research study, inclusion criteria involve being over the age of 18, being a NCAA student-athlete who participates in an indoor-sport (e.g. volleyball, basketball) and being free of injury that limits full participation during practices. We anticipate the number of participants to be fifty.

If you decide to participate in this research, you will be asked to contribute approximately nine hours of your time throughout your competition season. This will include thirty minutes (an hour on day one) of your time before and after team practices for a total of eight testing days. In addition, you will be asked for twenty minutes of your time for a one-time hydration education session. During each testing day, you will be asked to provide pre-practice and post-practice body mass measurements and urine samples. During body mass measurements, you will be asked to wear only shorts (males) or shorts and a sports bra (females). Each urine sample cup will be labeled with a participant number to de-identify you from your urine sample and all urine samples will be discarded immediately after data is recorded. Throughout the duration of the study, you will be asked to fill out a total of four questionnaires, two hydration awareness questionnaires and two hydration habits questionnaires. You will also be asked to listen to a twenty-minute educational session on the importance of hydration, the negative effects of dehydration, and ways to assess your hydration level.

Your consent to be a research participant is strictly voluntary and should you decline to participate or should you choose to drop out at any time during the study, there will be no adverse effects on your status as a student-athlete. You may also choose not to answer any of the questions on any of the questionnaires provided.

There is minimal risk to the individual participating in the study. A body mass measurement and urine sample collection are typical activities for a student-athlete. Body mass measurements occur every year during pre-participation physicals, as well as during pre-season training. Urine sample collection in this study would be no different than completing a urine sample for NCAA mandated drug testing. In fact, the policies in this study are much more private for the student-athlete. Both of these measures are common to athletes and pose minimal risk. There are no direct benefits to you for participating in this study, although, your participation in this study may help our understanding of how to improve the hydration of indoor athletes.

To maintain confidentiality during this study, you will be assigned a number (i.e., participant #1), which will correspond to your consent forms and all data. Only the principle investigator will have access to the assigned numbers. This information will be kept on the primary investigator's password protected computer. As a research participant, information you provide will be held in confidence to the extent permitted by law. Any published results of the research will refer to group averages only and no names will be used in the study. All data will also be kept on the investigator's password protected computer. Your signed consent form will be kept separate from the data, in the Faculty Advisor's (Dr. Sue Shapiro) office. All data will be maintained for a minimum of five years upon completion of the study and will be kept indefinitely.

If you have any questions or concerns regarding the study or your participation in the study, you may contact me, Isabella Abbasi, ATC, LAT, at (561) 213-9981, or **Isabella.abbasi@mymail.barry.edu**, my supervisor, Dr. Sue Shapiro, at (305) 899-3574, or **sshapiro@barry.edu**, or the Institutional Review Board point of contact, Barbara Cook, at (305) 899-3020 or **bcook@barry.edu**. If you are satisfied with the information provided and are willing to participate in this research, please signify your consent by signing this consent form.

Voluntary Consent

I acknowledge that I have been informed of the nature and purposes of this experiment by Isabella Abbasi, ATC, LAT and that I have read and understand the information presented above, and that I have received a copy of this form for my records. I give my voluntary consent to participate in this experiment.

________________________ ___________

Signature of Participant *Date*

______________________ __________ __________________ __________

Researcher *Date* *Witness* *Date*

(Witness signature is required only if research involves pregnant women, children, other vulnerable populations, or if more than minimal risk is present.)

APPENDIX C
RECRUITMENT FLYER

ARE YOU DEHYDRATED?

Are you interested in learning about how hydration can affect your athletic performance?

You may be eligible to participate in a research study if you:

- Are currently a Barry University student-athlete of an in-season indoor sport
- Are free of injury restricting your full participation in team practices
- Can meet for at least 30 minutes before and after eight team practices

If you are interested and/or have any questions regarding the study please contact, Isabella Abbasi, at (561) 213-9981 or Isabella.abbasi@mymail.barry.edu, Dr. Sue Shapiro, at sshapiro@barry.edu, or the Institutional Review Board point of contact, Barbara Cook, at (305) 899-3020, or bcook@barry.edu.

Barry University

APPENDIX D
HYDRATION AWARENESS AND HABITS QUESTIONNAIRES

HYDRATION AWARENESS QUESTIONNAIRE

Please circle a number.

1. To be hydrated means to have the proper amount of fluids in your body.

   0 1 2 3 4 5 6 7 8 9 10

   |____|____|____|____|____|____|____|____|____|____|

   strongly disagree strongly agree

2. Feeling thirsty while I am playing sports is one way I know my body is losing water and I need to drink.

   0 1 2 3 4 5 6 7 8 9 10

   |____|____|____|____|____|____|____|____|____|____|

   strongly disagree strongly agree

3. It is important to drink **before** practices and games.

   0 1 2 3 4 5 6 7 8 9 10

   |____|____|____|____|____|____|____|____|____|____|

   strongly disagree strongly agree

4. It is important to drink fluids **during** practices and games.

   0 1 2 3 4 5 6 7 8 9 10

   |____|____|____|____|____|____|____|____|____|____|

   strongly disagree strongly agree

5. It is important to drink fluids **after** practices and games.

   0 1 2 3 4 5 6 7 8 9 10

   |____|____|____|____|____|____|____|____|____|____|

   strongly disagree strongly agree

6. Drinking fluids helps keep my body temperature from getting too high while exercising.

   0 1 2 3 4 5 6 7 8 9 10

   |____|____|____|____|____|____|____|____|____|____|

   strongly disagree strongly agree

7. I do not need to drink fluids to perform at my best in sports.

   0 1 2 3 4 5 6 7 8 9 10

   |____|____|____|____|____|____|____|____|____|____|

strongly disagree strongly agree

8. I need to drink fluids to replace the sweat I lose during exercise.

0 1 2 3 4 5 6 7 8 9 10

|____|____|____|____|____|____|____|____|____|____|

strongly disagree strongly agree

9. My urine should appear dark yellow in color if I am drinking enough fluids.

0 1 2 3 4 5 6 7 8 9 10

|____|____|____|____|____|____|____|____|____|____|

strongly disagree strongly agree

10. I may need to drink more fluid and more often if I am practicing harder (more intensely) than usual.

0 1 2 3 4 5 6 7 8 9 10

|____|____|____|____|____|____|____|____|____|____|

strongly disagree strongly agree

11. I may need to drink more fluid if practice is longer than usual.

0 1 2 3 4 5 6 7 8 9 10

|____|____|____|____|____|____|____|____|____|____|

strongly disagree strongly agree

12. If I weigh less after a practice or game than I did at the beginning, then the weight I lost was probably due to sweat.

0 1 2 3 4 5 6 7 8 9 10

|____|____|____|____|____|____|____|____|____|____|

strongly disagree strongly agree

13. Drinking soda or any other caffeinated beverage does not hydrate me as well as water.

0 1 2 3 4 5 6 7 8 9 10

|____|____|____|____|____|____|____|____|____|____|

strongly disagree strongly agree

HYDRATION HABITS QUESTIONNAIRE

1. How important do you feel that drinking fluids is while you play sports or exercise?

   0 1 2 3 4 5 6 7 8 9 10

   |____|____|____|____|____|____|____|____|____|____|

   Not Important Very Important

   Why or why not?

2. How often do you drink fluids when you play sports or exercise?

   0 1 2 3 4 5 6 7 8 9 10

   |____|____|____|____|____|____|____|____|____|____|

   never always

3. What kind of fluids do you drink during sports or exercise?

   Why do you choose these drinks?

4. Where do you get the fluids you drink during sports/exercise? (you may circle more than one)
   a. Team cooler b. Water fountain
   c. Water bottle d. Other (please list)__________________

5. In a normal game or practice, how frequently do you drink? (you may circle more than one)

a. Whenever I want (I will stop playing to go drink)
b. Only during breaks
c. When not playing
d. When coach tells us
d. I don't drink during practice
e. Other (please explain)________________

6. Do you wish you could drink more fluids during practices and games?

0 1 2 3 4 5 6 7 8 9 10

|_____|_____|_____|_____|_____|_____|_____|_____|_____|_____|

Not at all A lot more

Explain why:

7. Name two ways you know you are dehydrated

APPENDIX E
HYDRATION EDUCATION HANDOUTS

HOW TO MAXIMIZE

PERFORMANCE HYDRATION

I am a freshman student-athlete on the football team. I am used to training hard, but now that I am in college I train twice a day on some days. I always make sure to drink some sports drink during practice and strength training, but I find that I am really tired and have headaches during and after practice, which is affecting my performance. I have also noticed that I am cramping more often.

I thought that what I already drink during practice would be enough, but should I be drinking more?

(For the consequences of dehydration and tips to avoid it, turn the page.)

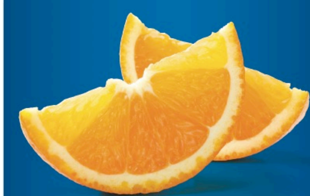
Information presented by NCAA SPORT SCIENCE INSTITUTE

Sports, Cardiovascular, and Wellness Nutrition
a dietetic practice group of the
eat right. Academy of Nutrition and Dietetics

www.NCAA.org
www.scandpg.org | 800/249-2875

TIPS TO TAKE WITH YOU

- Monitor your urine color. Clear to pale yellow (lemonade color) is indicative of optimal hydration status.
- Fruits and vegetables are made mostly of water and are a great way to add fluids to help meet your hydration needs. Plus, they have lots of vitamins and minerals!
- Weigh in before practice and after to determine your amount of water loss.



- If you are a salty sweater, eat salty foods before activity and don't be afraid to use the salt shaker. Replace losses post-workout with watery foods that contain salt, such as broth-based soups or vegetable juice.
- Other sources of water include smoothies, juice, sports drinks and tea. However, be wary of the extra calories these liquids may contain.
- Carry a water bottle with you so you can drink water throughout the day.

Written by SCAN Registered Dietitians (RDs). For more information on performance hydration or a customized nutrition plan, consult a RD who specializes in sports, particularly a Board-Certified Specialist in Sports Dietetics (CSSD). Find a SCAN RD at www.scandpg.org.

GOALS OF PERFORMANCE HYDRATION

- Begin workouts in a well-hydrated state
- Maintain hydration throughout practice
- Maximize performance
- Improve ability to recover quickly from training and competition
- Minimize injury and muscle cramps

CONSEQUENCES OF DEHYDRATION

- Performance declines with as little as 2 to 3 percent decrease in body weight from water (sweat) loss
- Increased core temperature and heart rate
- Decreased blood pressure
- Nausea and vomiting
- General feeling of fatigue
- Headaches
- Muscle cramps

HYDRATION TIMING

The chart below shows fluid intake recommendations before, during and after practice.*

When	How much
Before exertion	2 to 3 hours before: 16 ounces (about 1 water bottle) 15 minutes before: 8 ounces
During exertion	4 ounces of fluid every 15 to 20 minutes (2 to 3 large gulps)
After exertion	16 to 20 ounces of fluid for every pound lost (1 to 1½ water bottles per pound lost)

* You should still drink water and other fluids throughout the day to stay hydrated.

WHAT ABOUT SPORTS DRINKS?

Sports drinks are designed to rehydrate, provide energy and replenish the body's electrolytes, especially sodium, which is lost through sweating. Sports drinks also contain carbohydrates – the body's main source of energy. During prolonged, intense exercise, it is important to replace the fluid and minerals lost in sweat. The appropriate amount for rehydration will depend on factors such as the level and duration of exertion. Reduce the risk of fluid-electrolyte imbalances such as hyponatremia (dangerously low blood sodium level), which can occur after long and intense exercise when a high level of sweating has also occurred and large volumes of plain water are consumed. Athletes that will benefit most from a sports drink are those intensely exercising for longer than 60 minutes and salty sweaters. Sports drinks are designed to help replenish sodium lost from sweat. If exercising longer than 60 minutes, consuming a few gulps of a sports drink every 15 to 20 minutes can help to maintain energy and electrolyte levels, and sustain performance. (For more information, refer to the Fueling During Exercise fact sheet.)

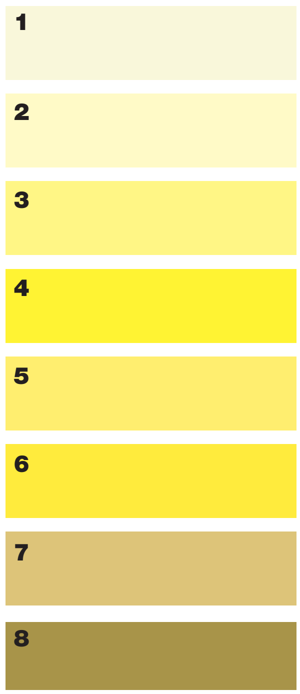
A FACT SHEET FOR STUDENT-ATHLETES

ASSESS YOUR HYDRATION STATUS

Step 1: Match the color of your urine to a color on the chart.

Step 2: Determine your level of hydration to dehydration. The lower the number, the better the result.

Step 3: If your urine color matches:



- Nos. 1, 2 or 3, you are hydrated.
- Nos. 4, 5 or 6, you are mildly to moderately dehydrated.
- No. 7 or darker, you are dehydrated.
- Athletes should consume water throughout the day. Do not wait until you are thirsty.
- To avoid dehydration, consume water and/or sports drinks before, during and after workouts or exercise. Be cautious of “energy drinks.”
- In general, 20 ounces of fluid should be replaced for every pound lost during that exercise session.
- Certain foods, medicines and vitamins may cause the color of urine to change. If these have been consumed in large amounts, this chart may be unreliable. Report all medicines, vitamins and supplements to your sports medicine staff.
- Report any symptoms of heat illness or general medical illness to your sports medicine staff as soon as possible.

Reprinted with permission. Armstrong, L.E. (2000). Performing in Extreme Environments, Human Kinetics, Champaign, IL.

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- Armstrong, L.E., Maresh, C.M., Castellani, J.W., Bergeron, M.F., Kenefick, R.W., LaGasse, K.E., and Riebe, D. (1994). “Urinary Indices of Hydration Status.”, Int. J. Sport Nutr., 4, 265-279.
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APPENDIX F
SAMPLE OF HYDRATION EDUCATION SESSION
(INTERVENTION)

Sample Outline of Hydration Education Session (Intervention)
The Importance of Hydration for Athletes
By: Isabella Abbasi, ATC, LAT

Why is Hydration Important?

- Water makes up the majority of the human body (Casa et al., 2000)
- Proper hydration is essential to homeostasis and every day life (Centers for Disease Control & Prevention; National Academy of the Sciences Food & Nutrition Board, 2005)
- Exercise increases the need for heat dissipation (Casa et al., 2000)
    - The more sweat you lose, the more fluid you must replace

What is Dehydration?

- Dehydration occurs when an individual loses more fluid than they replace, which often is a result of exercise (American Dietetic Association, Dietitians of Canada, and the American College of Sports Medicine, 2009)
- Intense exercise can create a large deficit in body water
    - This must be replaced during and after all activity
- Athletes should begin exercise properly hydrated

Dehydration in Indoor Athletes

- Pre-practice dehydration is very common in athletes of all competition levels
- Exercise-induced dehydration is common in athletes
- Dehydration is not only possible, but common in indoor athletes
    - High sweat rates
    - Less emphasis on hydration

Negative Effects of Dehydration

- Dehydration of just 1% to 2% can start to impact physiologic function (Casa et al., 2000)
- Significant deficits are seen after 2% body mass loss due to fluid losses
- Signs & Symptoms (Casa et al., 2000)
    - Thirst, irritability, general discomfort, headache, weakness, dizziness, cramps, chills, vomiting, nausea, decreased performance
- Decreases in physical performance (Casa et al., 2000)
    - Decreased postural stability and coordination
    - Decreased sprint, run, and cycling times
    - Decreased strength and power
    - Decreased shooting %, sprint times and lateral movement times
- Decreases in cognitive performance
    - Mood changes
        - Anger, fatigue, depression, tension, confusion
    - Concussion-like symptoms
        - Headache, dizziness, feeling slowed down/in a fog, fatigue, drowsiness, difficulty concentrating/remembering, balance problems

  - Decreased attention and memory

How to Determine your Hydration Level

- Urine color (can be used throughout the day, before & after practices)
  - Urine color chart
    - The lighter the color, the better hydrated you are
- Body weight change (before & after practices)
  - (Pre-exercise body weight - post-exercise body weight)/ pre-exercise body weight x 100 = % body weight change
  - Strive for anything less than 1%

How to Prevent Dehydration

- Proper hydration practices before, during, and after all exercise!!
- Drink beyond thirst sensation

Individualized Hydration Summaries

- Any value indicating dehydration is highlighted
- Urine measures
  - USG greater than or equal to 1.020, urine color greater than or equal to 4 = dehydrated
- Body weight changes & sweat losses
  - You each have a calculated sweat loss per day
    - You should replace 25-50% more than this number after each practice
    - Your average sweat loss will give you an idea of how much you should be replacing daily
    - If you are gaining weight, this indicates you are taking in too much fluid during practice!

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APPENDIX G
MANUSCRIPT TABLES AND FIGURES

Table 1. Variables of hydration status, fluid intake, and hydration knowledge pre and post educational intervention

	Pre-Practice Usg	Post-Practice Usg	Pre-Practice Ucol	Post-Practice Ucol	Δ BM (%)	Fluid Intake (mL)	Sweat Rate (L/hr)	Fluid Replacement %	HAQ
Pre	1.015 ± 0.006	1.019 ± 0.005	4 ± 1*	5 ± 2	-0.3 ± 0.4	575.14 ± 146.14	0.5 ± 0.2	82.8 ± 47.9	117 ± 11*
Post	1.015 ± 0.007	1.019 ± 0.006	3 ± 1*	4 ± 1	-0.5 ± 0.5	591.51 ± 239.34	0.5 ± 0.2	72.9 ± 33.8	125 ± 7*

Note. Values are mean ± standard deviation. *Indicates a significant difference between groups (p < .05)

Table 2. Variables of hydration status, fluid intake, and hydration knowledge pre and post educational intervention separated by sport

		Pre-Practice Usg	Post-Practice Usg	Pre-Practice Ucol	Post-Practice Ucol	Δ BM (%)	Fluid Intake (mL)	Sweat Rate (L/hr)	Fluid Replacement %	HAQ
VB (n=15)	Pre	1.013 ± 0.006	1.018 ± 0.005	4 ± 1	5 ± 1	-0.2 ± 0.4	589.66 ± 162.28	0.4 ± 0.1	98.5 ± 55.8	114 ± 11
	Post	1.015 ± 0.008	1.017 ± 0.006	3 ± 1	4 ± 1	-0.2 ± 0.4	555.79 ± 267.09	0.4 ± 0.1	88.4 ± 35.6	123 ± 8
	Total	1.014 ± 0.007	1.017 ± 0.006	4 ± 1	5 ± 1	-0.2 ± 0.4 *	572.73 ± 217.83	0.4 ± 0.1*	94.0 ± 68.7*	119 ± 11
BB (n=10)	Pre	1.017 ± 0.006	1.021 ± 0.005	4 ± 1	5 ± 2	-0.6 ± 0.3	553.35 ± 122.91	0.6 ± 0.1	59.4 ± 27.3	121 ± 8
	Post	1.015 ± 0.006	1.022 ± 0.004	3 ± 1	5 ± 1	-0.9 ± 0.3	645.08 ± 190.96	0.6 ± 0.1	52.3 ± 24.7	126 ± 7
	Total	1.016 ± 0.006	1.021 ± 0.005	4 ± 1	5 ± 1	-0.7 ± 0.3 *	599.22 ± 163.22	0.6 ± 0.1*	55.8 ± 26.0*	124 ± 8

Note. VB = volleyball, BB = basketball. Values are mean ± standard deviation. *Indicates a significant difference between groups (p < .05)

Figure 1. Pre-practice Urine Specific Gravity before and after educational intervention for each participant

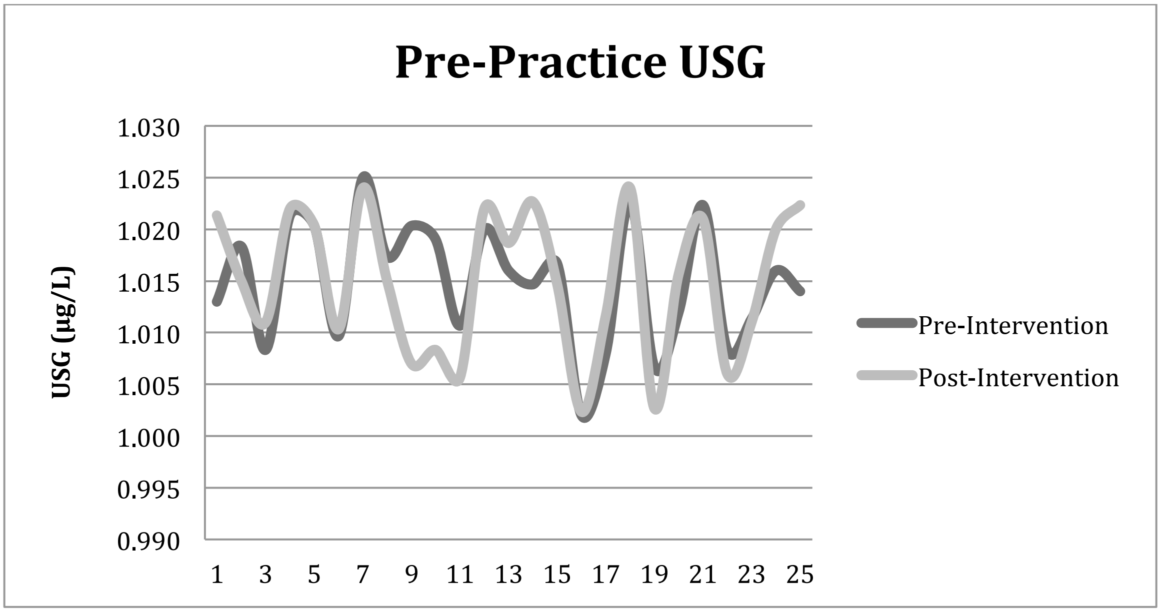

Figure 2. Pre-practice Urine Color before and after educational intervention for each participant

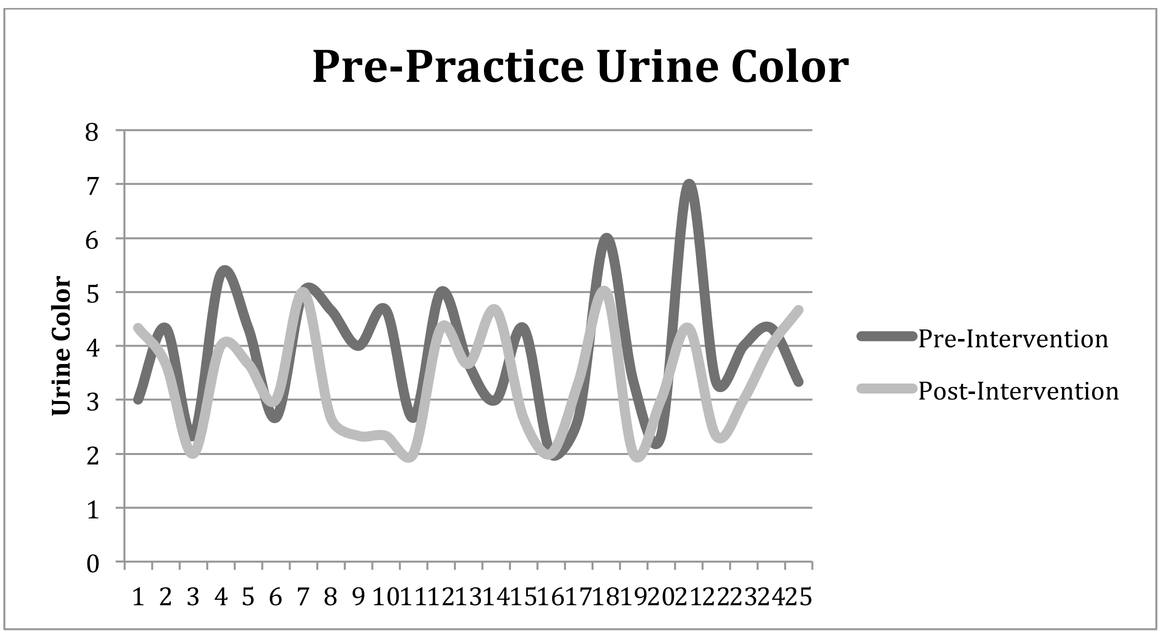

Figure 3. Body mass changes (%) before and after educational intervention for each participant