Water Proximity and Its Effect on Consumption: In a Corporate Setting

by

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ABSTRACT

Water makes up about 45-70% of a human body's total weight. It is estimated that 80% of the human brain's tissue is composed of water. Cognitive productivity is altered when the body is in a mere 2% dehydrated state. Several cognitive functions impacted by dehydration include: visual motor tracing, short-term recall, attentiveness, and mathematic efficiency. It is estimated that 80% of the U.S. adult population endures the majority of their day in a mildly dehydrated state.

Participants were employees working full-time jobs with Arizona State University or Tri Star Motor Company. Employees had to be 18 or older were invited to join the study. Employees participating in the study lived within the the greater Phoenix area. Participants of all races, genders, activity statuses, and BMIs were encouraged to join.

A one-arm, pre-test, post-test study design was utilized. We examined whether the hydration status of participants in the intervention improved or worsened during the course of the intervention, and then attributed any such improvement or deterioration to the intervention. Urine collections from an afternoon sample were gathered before and after the one-week intervention. For the intervention, the participating offices received a water dispensing system in close proximity to employee desk spaces. A reusable water bottle was also given to each participant. Urine specific gravity (USG) was assessed in all urine samples to indicate hydration status, and all participants completed water intake surveys before and after the intervention.

From this study, the overall change in water intake over the course of the one-week intervention was 143 ounces/day. This is an average of adding two and a half 8 oz glasses of water each day of the week per participant. USG also decreased significantly at the end of the intervention in comparison to the baseline value. In the greater body of research, this study strengthens the viability of inputting a hydration station and offering reusable water bottles to employees. This cost-effective method is an easy way to incorporate employee wellness in the workplace. The benefit of employees to drink more water is numerous, including increased focus, mental reactivity, and overall mood and wellness.

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CHAPTER 1

INTRODUCTION

Water makes up about 70% of a human body's total weight. It is estimated that 80% of the human brain's tissue is composed of water. Cognitive productivity is altered when the body is in a mere 2% dehydrated state. Several cognitive functions impacted by dehydration include: visual motor tracing, short-term recall, attentiveness, and mathematic efficiency [1]. It is estimated that 80% of the U.S. adult population endures the majority of their day in a mildly dehydrated state [2]. Water is abundant in nature, yet many humans fail to get the amount they need in order to be optimally hydrated [1]. Headache, fatigue, irritability, and inability to focus are symptoms that nearly all people experience at some point in their life. How often are these symptoms associated to dehydration? Water is the body's most important nutrient, yet humans fail to prioritize drinking sufficient amounts of water throughout the day.

In a corporate setting, hydration should be of the utmost importance in order to keep employees working efficiently and in favorable moods. This study examined whether a fresh water fountain in close proximity to employee desks and access to a reusable water bottle would increase the likelihood of an employee to drink water throughout the day, thus, improving hydration. Many studies of this nature have been executed with food, concluding that proximity of a food item, such as a candy jar or fruits and vegetables, influences intake [2]. In one trial, apple slices were placed in front of a participant sitting and working on a given task at a desk. The research noted that the more convenient and proximate a food was, the more likely a subject was to intake that food, regardless of appetite [3]. However, there is a deficiency in the literature regarding proximity of water and hydration status. This research is very important to carry forward as corporate wellness grows and becomes more pertinent. It is among the highest interest to keep employees in good health to improve performance of workers, lower absenteeism in the workplace, and decrease health care costs spent by a company.

Purpose of study

This study examined the impact of a water dispensing system on hydration status in office-residing employees in the metropolitan Phoenix area. For this trial, participants were given reusable water bottles, an education session and handout on hydration and its effects on performance, and a water dispensing system placed conveniently in the middle of the desk area. Employees who participated in the study worked in the Computer Commons at Arizona State University or at a local business, Tri Star Motor Company. The relationship between participants' initial hydration status before the water station was put in and the hydration status after the water dispensing system was conveniently placed was measured.

Research Question and Hypotheses

- Q: Will implementing a hydration station improve hydration status and overall water consumption in employees in a corporate setting during work hours compared to baseline urine specific gravity hydration levels?
- H1: Implementing a conveniently located water dispensing system and promoting the use of reusable water bottles in the workplace will encourage employees to better hydrate during the intervention as indicated by USG scores, POMS, and urine color chart.
- H2: Implementing a conveniently located water dispensing system and promoting the use of reusable water bottles in the workplace will increase water consumption during the intervention as indicated by questionnaire.

Definition of terms

- Urine Specific Gravity: Urinary specific gravity (USG) is a gauge of the concentration of solutes in urine. It is a means to measure water density in ratio to urine density and this provides information on the kidney's capability to concentrate urine.

- Euhydration: Normal or optimal state of body water content.
- Dehydration: this is a condition that happens when the loss of body fluids, mostly water, surpasses the amount of water that is ingested.

Delimitations and limitations

- Limitations Include voluntary employee participation. This may suggest that employees more likely to volunteer were more open to change, thus these types of people were more inclined to change their ways and drink more water. The limitations that may alter USG results include: high amount of glucose in the urine (caused by a high carbohydrate diet) or high amounts of protein in the urine (caused by a high protein diet) may also increase specific gravity out of proportion to osmolality, as measured by hydrometer or refractometer.
- Delimitations: With a pre-post study design, the study lacks reference to a comparison group, it cannot answer whether participants' improvement or deterioration would have occurred anyway, even without the intervention. This may lead to erroneous conclusions about the effectiveness of the intervention. Such studies should therefore not be relied upon to inform policy decisions, but may still be useful in generating hypotheses about what works that merit confirmation in more rigorous studies (e.g., randomized controlled trials or well-matched comparison-group studies). Additionally, participants were employees in corporate setting that have offices in a contiguous set up. Thus, employees in a less proximal and more spread out venue location may be subject to diverse results than in comparison to this study. Finally, only one group at a time in a location was tested, which may not be conducive to separate population.

CHAPTER 2

LITERATURE REVIEW

I. Physiological Changes and Hydration

1. An Introduction to Hydration

In the average healthy adult, approximately 45-70% of total body weight is water [4], which acts as a solvent for many organic and inorganic materials, lubricates the joints, maintains internal body temperature, lessens the burden on the kidneys by helping to excrete waste, helps transport nutrients throughout the body, and aids in absorption of water-soluble vitamins. Water is needed in greater quantities than any other nutrient in the body. It is well known that people can exist up to 3 weeks without nourishment from food [5], however, water deficiency will lead to fatality within days, especially those living in warm climates [6]. Due to the fact that water is so imperative to the human body, the body has its own mechanisms to warn itself that it is dehydrated; this mechanism is known as the thirst reflex [7]. Among the central organs in the body, the kidney is one of the primary determinants in hydration status among humans. The kidneys regulate water excretion and reabsorption and influence other parts of the body to stimulate a response to drink water [8].

Presently, there are many ways to assess both the total volume of body fluid and its compartmental distribution within the body. Because of the various ways to assess fluid within the body, it is simpler to assess fluctuations in total body volume rather than the amount within each section of the body separately. Quick alterations in body mass seem to characterize equivalent deviations in hydration status. For example, a human cannot lose or gain three pounds of body fat or muscle in one day. These fluctuations are most likely due to variation in hydration status throughout the entire body. Approaches to determine hydration status not included in this study include, but are not limited to: an average of responses to orthostatic tolerance tests [9], bioelectrical impedance analysis (BIA) [10] and skinfold thickness [11]. These are acceptable measures of hydration status. Additionally, several blood analyses can indicate hydration status. Also, urinary indicators have enticed much interest over the past few years because of their easiness to obtain, the tests are inexpensive, and they are easy to analyze.

2. Body water

Water weight in an individual is dependent on the percentage of adiposity [12]. For example, as proportion of body fat rises, the amount of body water drops. Muscle tissue comprises of 75 percent water, this is almost identical to the amount that is present in your brain. Fat contains only roughly 10 percent water. This amount is less than bone, which contains 22 percent water. The alleged difference in muscle and fat tissue may be due to glycogen presence. Muscle contains glycogen, the storage form of glucose; glycogen is 75 percent water [12].

A study defining the difference in total body water in untrained males and trained males discovered that the more muscle mass one has, the higher the total body water percentage will be [13]. A body composition study with relation to total body water content describes that the average female has a lower body water percentage compared to males. Investigators have noted that the important factor in determining these differences is the relative content of overall body fat. On average, women have a higher body fat percentage than men for reproduction needs. This is why the relative water content depends upon the relative fat content. The percentage of body weight that is water therefore varies inversely with body fat [14]. From this study, the average lean adult male has approximately 70% of the body weight as water. In the female the percentage of body weight that is water is lower due to a relatively greater amount of subcutaneous fat and lower lean muscle mass.

Roughly 600 ml/kg of body weight represents total body water, and it is dispersed in intracellular and extracellular locations. The intracellular space accounts for two-thirds of the 600 ml/kg (400 ml/kg) and the extracellular space accounts for the final one-third of the 600 ml/kg (200 ml/kg). To delve deeper into what comprises water weight, three-fourths of the extracellular liquid is dispersed interstitially (150 ml/kg) and the remaining one-fourth remains intravascularly (50 ml/kg) [12].

An important concept is that regulation of osmolarity must be integrated with regulation of volume, because changes in water volume alone have diluting or concentrating effects on the bodily fluids. For example, when you become dehydrated you lose proportionately more water than solute (sodium), so the osmolarity of your bodily fluids increases. In this situation the body must conserve water but not sodium, thus stemming the rise in osmolality. If there is a large amount of blood loss from trauma or surgery, the loses of sodium and water are proportionate to the composition of bodily fluids. In this situation the body should conserve both water and sodium. Typically, when the temperature is mild and water and food are freely available, drinking water becomes a behavior of thirst. Thirst is an apparatus for preservation of fluid balance and it is administrated by blood volume and osmolality [15]. When blood volume decreases or blood osmolality increases, that is when the thirst reaction is initiated in the cerebrum to signal an action to drink water [8]. Plasma osmolality is the main signaler among the two mechanisms; this is because just a 2-3% upturn in plasma osmolality stimulates a resilient surge in discernment of thirstiness, while blood volume must drop by a 10% to encourage the thirst mechanism [15]. An example of this is when one eats salty foods, it increases blood osmolality and that individual is encouraged to drink water to balance osmolality. Blood osmolality is much more sensitive to water and solute ratio than blood volume. There are various ways that plasma osmolality can increase or blood volume to decrease. Water is lost in not only sweat, but also through renal excretion, gastrointestinal losses, and through respiration, discussed later in this review.

3. Water ‘s Role in Substance and Nutrient Transport

The lymphatic system is roughly 96% water. As discussed, water is an important component of any living animal. Nutrients pass out of water into cells and, conversely, waste products from cells are dumped back into the water and excreted by urine. Through osmosis, some water returns to blood capillaries from the lymphatic system. Lymph fluid (which is primarily water) is a clear and somewhat viscous liquid. Lymph vessels are a lot like veins in the cardiovascular system. The lymph vessels work to push the lymph fluid back towards the heart where it eventually enters the thoracic duct which is a large collecting tube located near the heart. From this duct, the lymph fluid empties into the blood circulatory system at the subclavian vein where it will be filtered within the body [16]. With proper hydration, the lymphatic system and cardiovascular system can function at an optimal level.

Cells within the body get what they need from the nutrients carried within the blood, which moves through the cardiovascular system. The fluid component of blood is water, which is needed for transport of vital nutrients. For example, the lungs bring in oxygen, which is then captured by hemoglobin within our red blood cells and transported to our cells. The hemoglobin containing red blood cells require water to float within the circulatory system to get the oxygen to all the cells which require it. With the same system, the gastrointestinal tract absorbs nutrients like glucose, salt, and other chemicals and sends them into the blood stream to deliver them to cells and tissues. However, many of the chemicals must first be dissolved in water from the blood before even being sent to the tissues. Therefore, it is important to understand that the body needs to make sure its cells have enough water so that it can properly dissolve specific nutrients and deliver them to organs, tissues, and cells. Without water, the body deteriorates.

Water within the body also acts as a necessary solvent for chemicals, the chemicals in electrolytes, proteins, and glucose which are vital for life [17]. The amount of water within the plasma, the interstitial fluid, or the cell is known as volume. Therefore, the total chemical concentration is known as the total number of chemical particles within the solvent and the presented volume. As water enters the cell, volume rises. When water leaves the cell, volume falls and total chemical concentration rises. This is an important concept to understand when thinking about dehydration or the loss of water. In order to be healthy, cells must keep the chemical concentration and the volume relatively constant within the body. This is beneficial for maintaining homeostasis. If there is too little water (hypohydration) or even too much water (hyperhydration) this disrupts the balance of all the cells, organs, tissues, cardiovascular and and lymphatic system posing threat to the homeostatic environment [18].

Water plays a critical role in digestion. Digestion begins in the mouth with saliva, the primary constituent of saliva is water. Digestion heavily relies on the enzymes within saliva that help break down food into other nutrients that are more available to the body [19]. Additionally, water helps to move food and fiber through the digestive tract to produce easier stool. It is mentioned from Goodman [20], that humans can survive without food for about 3 weeks, but without water humans will die within three to four days—this ultimately depending on the external environment and temperature.

The stomach requires water in two imperative purposes in stomach functioning. Water is required within the body in order to produce the proper pH of hydrochloric acid, or stomach acid. Proper pH of stomach acid is needed to maintain homeostasis and decrease the possibility of developing an ulcer [21]. Water is also needed in the production of the stomach's mucosal lining. The mucosal lining allows for protection of the stomach organ and tissue. Thus, dehydration can influence digestion and functioning of bodily organs and pose dangers to the digestive tract [20].

4. Hydration and Skin

There is a myth surrounding the argument that increasing water consumption can improve complexion and flush toxins from the skin, which has not been supported by research at this time. Another myth is that it can give the skin a glowing, more moisturized look. This, too, has not been supported by research at this time [22]. The skin, however, is an important aspect in maintaining body water levels and preventing water loss into the environment. The skin is a great tool for assessing hydration status.

The skin is comprised of approximately 30% water, which contributes to plumpness, elasticity, and resiliency of the skin. The lack of hydration will present itself by turning your skin dehydrated, tight, and flaky. Dehydrated skin has less pliability and is more prone to wrinkling. Skin is an organ just like the organs on the inside of your body that require water to function. The skin is made of of cells, which can be recalled from the section of Body Water, are primarily water. The dermis and epidermis are made up of cells that are sensitive to water fluctuations. Without water, the organs will undoubtedly not function appropriately [23]. When the body perspires, water and electrolytes escape through sweat glands which are distributed across the skin's surface [24]. Dryness of the skin can be caused by an inadequate amount of water intake or medical conditions or medications that dry the skin. The more serious levels of dehydration can be presented in reduced skin turgor with tenting of the skin taken as a sign for dehydration [25, 26]. Normal turgor in skin snaps back rapidly to normal. However, if skin has reduced turgor it is considered dehydrated skin [27].

5. Water Losses

Cutaneous losses Sweating is a thermoregulatory mechanism designed to control the internal temperature of the body. The human body's temperature is regulated within a very narrow range in order to maintain balance and keep the cells within the body alive. When exposed to very hot conditions, caused by environmental or increased metabolic factors, sweating becomes vital for survival. Sweating is a way to cool the body by releasing water and some electrolytes through the mechanism of heat dissipation. While the internal temperature and skin temperature is the primary controller of sweating, there are a number of non-thermal related aspects that modulate the sweat response [28].

One study in particular looked beyond the external environment to cue sweating and highlighted findings pertaining to metabolic increases in internal heat. Such as, exercise, body fluid status, or illness. The important finding from the study was that body fluid status has impact on sweat rate. Extended exposure to metabolic induced hyperthermic settings and/or lengthy exercise in the environmental heat can induce water deficits due to profuse sweating, resulting in hypohydration. This water insufficiency lowers both intracellular and extracellular volumes and results in blood hyperosmolality and hypovolemia; both of which have effect on sweat rate. In short, if the body has limited water, or is hypohydrated, sweat rates decrease posing potential threat to the individual causing heat exhaustion [29]. This research explains that if an individual is in a hot climate and in a dehydrated state, the body is more likely to preserve body water required by the cells than release water and electrolytes through sweating to cool the body off. This causes the individual to be at a high risk for heat exhaustion.

Its been noted that 580 kilocalories of heat are dispersed into the environment for every 1 L of sweat evaporated from a human [30]. Water losses from emission of regular perspiration, not related to physical activity, are generally about 500 ml/day. Conversely, these losses can increase tremendously with physical activity, illnesses, a fast metabolism, hyperthyroidism, or healing from an injury. Cutaneous sweat loss can upturn considerably throughout physical activity. Many trained individuals lose about 300 to 1,200 ml/hr if exercising in high temperatures and 1 to 2 L/hr if exercising in high temperatures with protective clothing [30]. Proper hydration throughout exercise or competition will improve performance, postpone fatigue, surpass thermal stress threshold, maintain plasma volume, and thwart injuries connected with sweat loss and dehydration.

In contrast, athletes who over consume water before, during, and/or after endurance exercise may cause reduction in serum sodium levels, which is just as harmful as under hydrating. This could potentially lead to hyponatremia. For athletes who compete in endurance events that last longer than one hour, it is important to replace sweat loss with fluid intake consisting of a hydrating water solution consisting of carbohydrate, sodium, and water to replenish lost fluid during training [31]. Glucose is necessary for the transport of sodium ions into the blood; one molecule of glucose co-transports one sodium ion into the blood, pulling water into the cell to rehydrate it [31-32]. The recommendation for athletes is to drink 0.5L of water within one to two hours before an endurance event and continually ingest water or cool beverages in 15-30 minute intervals during exercise to replenish fluid lost in sweat. For those activities lasting longer than one hour, it is recommended to drink 600-1200mL per hour in addition to consuming 30-60g carbohydrate and 0.5 to 0.7 g/L of fluid of sodium per hour [32]. Preserving fluid balance of sodium and water during exercise and competition is beneficial in improve performance, postponing fatigue, surpassing thermal stress threshold, maintaining plasma volume, and thwarting injuries connected with sweat loss and dehydration [33].

It is evident that physically active individuals require much more water than sedentary individuals [34]. It is extremely important to note that people for who are busy, utilizing their cerebrum's mental aptitude in work or physical activity, the thirst mechanism becomes less prevalent and can be ignored to a degree [34]. This phenomenon, explains that discernment of thirst is not an exact manifestation of hydration levels and water ingestion should be tracked throughout the day in order to know if one is optimally hydrated in the workplace [34].

Renal losses The kidneys are the primary sources of water balance and regulation, that is, under normal circumstances and standard health. Remarkably, the kidneys weigh less than 0.5% of complete body weight, but their blood circulation during rest is estimated to be a 25% yield of cardiac productivity. A high yield for a small organ. The kidneys can filter out 150 L of fluid per day, but only less than 1% of that liquid is actually dismissed via urine [15].

Arginine vasopressin (AVP), a diuretic hormone, and the renin-angiotensin system are the primary systems of renal excretion. However, there are supplementary hormones that have responsibility, these include atrial natriuretic peptide (atriopeptin) and urodilatin [35, 36]. AVP is controlled by signals in osmotic pressure [36, 37]. AVP levels, like thirst, grow quickly with minor rises in osmolality, and variations in blood volume develop to modify this osmotic stimulus [38].

High or low external temperatures, inadequate fluid consumption, physical activity, illness, and excessive sweating are common means to increase the chances of dehydration. The consequences of dehydration levels becoming inadequate create an intensification in osmolality and a diminution in plasma volume. Dehydration increases AVP levels and the thirst mechanism. When available, thirst is meant to increase fluid consumption. Thus, the raised AVP intensities counteract water losses through a reduction in urinary output due to augmented water reabsorption in the nephron. The nephrons are the functional unit of the kidneys designed to regulate water and ion concentration within the body. As a consequence of dehydration, perceived by the nephron, urine becomes more concentrated, thus generating a darker yellowish color. This increase in ion excretion and increase in water reabsorption within the nephron manifests as changes in not only urine color, but urine osmolality and urine specific gravity (USG), which is utilized to test and analyze degree of hydration of an individual [39].

Urine specific gravity is the density (mass per volume) of a example in relationship with distilled water [40]. The urinary concentration is determined by the number of particles per the unit of volume. The particles that cause a higher concentration are waste products in the urine such as phosphate, urea, electrolytes, glucose, uric acid, proteins, and other waste elements [41]. Urine specific gravity is altered with high carbohydrate diets consisting of >600g CHO/day and high protein diets >2g protein/lb per day. These cause the urine specific gravity to raise, regardless of an adequate water intake. Glucose and protein are heavy waste products with a much denser concentration than water [42-43]. Pure water has a USG density of 1.000, therefore, any fluid denser than water will have a higher urine specific gravity than 1.000. Using a refractometer is the only technique that has shown consistent accuracy with urine osmolality [43-44].

Gastrointestinal losses A small amount of water is lost from the digestive system, but it is still significant enough to note. Only about 100 ml is expelled daily through feces. A lot of the fluid that is ingested enters the small intestine, where it is reabsorbed, and the remaining water is absorbed in the colon. In instances of diarrhea, vomiting, or other gastrointestinal issues, water loss increases significantly and can further lead to dehydration. Some cases can increase losses up to ten-fold [34].

With severe dehydration, replacing only water is not a healthy way to rehydrate. When the body is dehydrated, from vomiting, diarrhea, or other illnesses, the body needs electrolytes and glucose added to improve hydration. The management of dehydration typically involves more than just water and should include other ingredients to improve hydration levels, similar to rehydration in an athlete. Plain water can offset the natural equilibrium of electrolytes and water within the body. Therefore, managing dehydration should be done slowly with the use of water, salt, and sugar. There World Health Organization describes the perfect solution to consist of one-liter of water with one teaspoon salt and six teaspoons sugar added to the water [45]. Including too much salt or sugar can make dehydration worse in ill patients. These numbers are different from the athlete rehydration recommendations. These recommendations are lower in carbohydrate and higher in salt. This is because athletes require more carbohydrates to restore glycogen for energy. This recommendation for ill individuals is the right proportion needed to get sodium into the cells without added carbohydrate and it is higher in salt because this population is losing more salt than athletes sodium loss in sweat. It is very important to drink the solution slowly and sip it in small intervals for effective rehydration to ensure cellular balance.

Respiratory Losses There are small amounts of fluid lost from respiration, yet the number is very dependent on levels of humidity in the environment [46]. The number, too, can increase immensely if an individual participates in exercise, has a condition with hyperventilation, fever, or low environmental comparative humidity. When it is humid, and the air has high moisture content, sweat cannot evaporate from the skin. This leaves the body hot and more likely to over heat. In order to cool off, the body must work harder to decrease internal body temperature. The result of this is an increased heart rate and an increase in breathing rate causing water loss. These factors create larger respiratory water losses. In a typical day, with small to modest levels of physical activity, respiratory water losses generally do not exceed 200 ml/day, but that has been quantified by an individual living in 40% humidity and simply completing day to day errands [39].

6. Plasma Volume Changes and Hydration Status

Blood is a mixture of numerous particles. It consists of proteins, water, electrolytes, hormones, waste products, clotting factors, and other molecules or nutrients that are moving between body cells and tissues. A reduction in plasma volume is most generally directly correlated to acute dehydration. The less water that is in blood, the lower the plasma volume. Water is essential to controlling blood volume. Blood volume, in turn, affects blood pressure and heart rate. During dehydration, blood volume and pressure falls causing an increase in heart rate. The result of this is generally headaches or migraines, caused by a lack of blood flow to the brain [47]. When cells are deprived of the water they need to work properly, all body systems are required to work harder. This is what usually causes lethargy or fatigue for the majority of the population. The body has to compensate for the low blood volume [47]. Research on this topic needs to be more refined, but the cause of many of these ailments has been linked to slight dehydration.

Water may freely cross the walls of some cell membranes from areas of low solute concentration to areas of high solute concentration. Osmolality tends to equalize across the body fluid spaces as result of the movement of water, not solutes. However, there are some solutes, like urea, which can freely cross cell membranes and they have little effect on the shift in water. Whereas some solutes, electrolytes like potassium and sodium, have great osmotic activity and cause shift in water moving in and out of cell membranes. As you become dehydrated, you lose more water than you do sodium. However, if you become dehydrated due to surgery or trauma with loss of blood, you lose water and sodium proportionately and your body tries to preserve both.

The main components a majority of workout recovery drinks include are carbohydrates, sodium, glucose, and water for rehydration. Pickle juice has been touted as a good workout recovery drink to avoid muscle cramps from electrolyte imbalance, one study discovered if this were true or not. The fact that pickle juice has glucose and high amounts of sodium, an electrolyte most quickly lost through sweat in an endurance workout, and appropriate amounts of potassium in ratio to sodium, make the drink key for preventing cramps [48]. One study designed research to determine if consumption of small amounts of sodium rich pickle juice, a carbohydrate-electrolyte (CHO-e) drink, will increase plasma electrolytes or other selected plasma variables. The study found that drinking an electrolyte rich fluid does have influence on blood concentration causing negative side effects, but there is a certain threshold at which it can change plasma concentration. In this study, ingestion of pickle juice and CHO-e drink did not cause considerable changes in plasma electrolyte osmolality, plasma concentrations, or plasma volume in rested, adequately hydrated men. Much concern was presented that consumption of higher volumes of pickle juice might enhance an athlete's risk of dehydration-induced hyper-tonicity, so participants drank 1 mL/kg pickle juice. At this given volume of pickle juice, there was no reported change in blood concentration of sodium [48]. The study found that drinking large amounts of sodium containing beverages after intense workout decreases plasma volume significantly causing worsening dehydration. Only small amounts of salt are needed to balance the water and sodium concentration in athletic populations.

7. Stages of Dehydration

When falling into the state of dehydration, it is easy to go from a mild health threat to extreme danger in a matter of days. The early signs of dehydration can comprise of dizziness, headache or migraine, decrease in appetite, reddened skin, fatigue, dry mouth, eye dryness, decrease in strength and muscle weakness, burning feeling in the abdominal region, and a concentrated, dark urine with pungent stench [49]. As dehydration progresses, additional symptoms arise such as difficulty swallowing, sunken eyes, loss in balance, blurred or darkened vision, muscle spasms, and loss of sensation in limbs and appendages. It has been found that electrolyte beverages may help to decrease the chances of symptoms worsening.

Dehydration causes an increase in internal body temperature resulting in heat cramps within the muscle, heat exhaustion, and finally, heat stroke [50]. Heat contractions are recognized as agonizing, short muscle cramps that can occur at any moment, even when a person is seated and resting. These heat cramps usually involve fatigue of muscles, generally in the legs, abdomen, or shoulders [49]. It is theorized that cramping is caused from a low intra and extracellular concentration of sodium and potassium, generally caused by sweating. It is important to note, however, it does not require a large amount of physical activity to induce muscle cramps; it can be caused by a decrease in fluid intake. This stage is when an electrolyte-containing drink will benefit the condition.

Heat exhaustion occurs when a person may go into hypovolemic tremor. This shock is described as a state of decreased blood plasma and volume within the arteries due to a decrease in blood volume. This stage is generally characterized by clammy, cool, and pale skin accompanied to a rapid heart rate and quick, shallow breathing [51]. Additional symptoms include: extremely low blood pressure, nausea or vomiting, increased sweat rate, a low-grade fever, headache, and falling in and out of consciousness. Urgent medical attention is required during this stage. Heat exhaustion can very rapidly lead to heatstroke, the final stage in dehydration [49,52].

Heat stroke is an escalated version of the past two stages in dehydration. This stage is tremendously life threatening and the condition happens when body temperature is 104 degrees (F) or greater. Sweating, during this stage, generally stops due to the increase in temperature and decrease in body fluids. Pulse rate generally begins to intensify to about 130 bpm or higher, also known as multifocal atrial tachycardia. Symptoms during this stage include seizures, lack of consciousness, muscle limpness and inability to respond to external cues, and even hallucination may begin to occur. If these symptoms last longer than an hour, permanent brain damage or organ failure may occur, commonly leading to loss of life [52].

8. Hyper-Hydration

Over hydration is possible. Generally, it is hard to get to this stage, but many athletes who fear dehydration are the population most known to over hydrate [53]. The result of over hydration is generally caused by a low concentration of salt in the body, disrupting homeostasis. Low sodium levels in the blood can be detrimental to a person's health. Extremely large amounts of water are needed to get to this point, and if pituitary glands, kidneys, and the liver are functioning normally it is difficult to become hyper-hydrated [30]. To put the concept into perspective, in order to exceed the body's ability to excrete water, a healthy adult with normal kidney functioning would have to drink 6 gallons of water a day on a daily basis in order to get to this point. However, if one is exercising vigorously, this 6 gallons of water isn't as seemingly impossible to achieve.

Salt is a combination of sodium and chloride, both of which are very important for proper physiologic functioning. High sweat rates, specifically in athletes or employees working laborious jobs in heat are at risk of losing fluid, sodium, and chloride. Drinking solely water as a fluid replacement may cause incomplete rehydration and possibly result in hyponatremia, decreased performance and reaction time, heat related illness, or possibly death [54]. Sodium and electrolyte loss varies from person to person. Some losses can be replaced with a normal diet and others can have large electrolyte losses and need to replace with electrolyte drinks, salty foods, or salt tablets. This understanding of fluid replacement and sweat loss is important in order to also avoid over hydrating. To avoid this, measuring weight before and after exercise or high sweat losses should be noted. For every pound of weight lost from sweat should be replaced with at least 20 ounces of water or electrolyte beverage [54].

Populations with a condition of the heart, kidneys, and/or liver, or premature infants, are at a higher risk for over hydration. This is due to reduced functioning of the kidneys. Over hydration can be caused if antidiuretic hormone excretion is slow [30]. Additionally, too much vasopressin secreted from the pituitary gland, stimulates the kidneys to conserve more water than is actually needed, resulting in over hydration.

The brain cells are the most susceptible to a decrease in sodium ions and an increase of water in the system [55]. Mild hyponatremia is defined as plasma sodium 130-135 mmol/l. This range generally presents itself as asymptomatic. Nausea and dizziness are common when blood sodium falls below 125-130 mmol/l. As blood concentration of sodium falls below 115-120 mmol/l headache, exhaustion, disorientation, and anxiety are typical [56]. If over hydration occurs gradually and remains minor or moderate, the brain cells in a healthy individual are good at adapting to the external conditions, so mild systems like decreased focus and reaction time may occur. When over hydration occurs swiftly, unconsciousness, confusion, or seizures may occur. When there is a substantial increase in blood volume, edema in the ankles, wrists, hands, and feet may occur. Additionally, fluid may begin accumulating in the lungs causing difficulty in breathing [30].

Populations that suffer from heart, liver, or kidney disease, are generally more susceptible to over hydration. In these populations, it is essential to restrict the intake of sodium in order to decrease the chances of edema. Sodium generally causes water retention resulting in an increased difficulty to drop the water within the system [30]. In some circumstances, doctors might recommend diuretics to upturn the emission of sodium and water in the urine. Over hydration is not only difficult to achieve, but tricky to mend. It is important to find a balance within an individual and discover individual needs based on body weight, physical activity levels, and external environment.

9. Thirst mechanism

Thirst, as previously discussed, is the innate instinct to drink water. Formerly, it was revealed that neurons classified in the part of the brain that makes up the hypothalamus were activated by thirst prompting circumstances [8]. More recently, it is understood that there are two distinct areas that create this thirst mechanism within the brain. The two, highly discrete neural populations, where one activates thirst and the other subdues the thirst response. Both neural populations are located within the tissue of the brain. The subfornical organ is an organ located within the brain operational in numerous biological progressions. Some areas include osmoregulation, heart and cardiovascular regulation [8, 52], and, of course, fluid homeostasis [52]. A vast majority of these areas of regulation include equilibrium of the release and control of hormones angiotensin or vasopressin. In a study done on animal drinking behavior, it was found that stimulation of subfornical tissue excitatory neurons, angiotensin, arouses extreme drinking behavior, and it will do so in even optimally hydrated animals. In contrast, stimulation of a subsequent populace of subfornical tissue neurons, vasopressin, considerably subdues water consumption, even in dehydrated and thirsty animals. The results of this study uncover the inborn circuit within the brain that can instigate an animal's water-drinking behavior off and on, and this area most likely serves as the center for thirst regulator in an animal's brain [57].

The homeostasis of body fluid regulates the internal salt and water balance within an organism. When the balance of this homeostasis shifts, the cerebrum senses the variations and prompts explicit goal-oriented fluid consumption actions [58]. For example, if an animal is presented as salt-deprived, in a hyper-hydrated state, the animal is prompted to consume salty solutions [59]. The inverse is true, as well; dehydrated animals, in a hypo-hydrated state, are motivated to drink water [60].

The thirst mechanism is highly sensitive to ingestion of salt. A plasma concentration increase of only a 2%–3% can induce feelings of thirst [61]. If plain water is ingested in attempt to replenish balance of water to solute concentration plasma volume is favorably reestablished over the intracellular and interstitial fluid space. The result is suppressing plasma sodium concentration and removing the thirst mechanism signaled to the brain. When sodium ingestion occurs during prolonged or dehydrating exercise, sodium ingestion helps to preserve and reestablish plasma volume and osmolality by continually signaling the thirst sensation (thus drinking) and also by accumulating body fluid retention. In a healthy individual, a high sodium meal may increase current blood pressure without issue to health long term. Particularly due in part to the acute increase in sodium intake will increase thirst mechanism. This will cause the blood concentration to return to a healthy equilibrium nearly instantly.

II. Dehydration and Cognition

1. Cognitive Performance and Assessment

Cognition is the psychological act of obtaining information and understanding concepts through reflective contemplation, life experiences, awareness of situations, perceiving judgment, and utilizing the senses. Cognitive functioning may comprise of a person's attentiveness or focus, perception of learning and comprehending, critical reasoning, and recollection [62]. Similarly, temper, motivation, stimulation, and physical wellbeing affect cognizance [62]. Cognitive performance, ability to focus, testing comprehension, and willingness to focus are all a means of cognitive functioning and allow for a person to be able to complete a task [62]. Many assessments are available in order to successfully test cognitive performance; however, there is much debate among researchers and practitioners on which assessments rank the best [63].

The degree of quickness to respond to a stimulus or ability to comprehend a situation is among two variations to test cognitive functioning [62]. For example, the amount of time it takes to respond to a queue would quantify speed/reaction time and memory recall and could test for a person's cognitive accuracy. Two practical tests that may test cognitive functioning would be the ruler drop test and the trail making test.

The ruler drop test is a measure to assess an individual's reaction time, hand-eye speediness, and ability to focus. The examinee is prompted to sit at a table and rest the elbow on the edge so that their wrist hangs over the side of the table. The assessor grips the ruler perpendicularly in midair amongst the examinee's index finger and thumb, without touching the examinee's hand. Next, the assessor aligns the zero spot with the examinee's fingers. It is up to the examinee to initiate when he is ready to perform the test. Without any forewarning, the assessor releases the ruler and it is up to the examinee to snag the ruler as quickly as possible and hold it with his/her fingers. Next, the assessor records the measurement the ruler dropped, in centimeters. This test must be repeated several times in order to get an accurate measurement and average the different scores [62].

One of the most meticulous, yet concise assessments for cognitive deficiency is the Trail Making Test. This test is neuropsychological assessment of pictorial attention and task exchanging. This time intensive test asks the subject to connect the dots in numerical order, of random placement on a paper. The second test is a numerical and alphabetical sequence (1, A, 2, B, 3, C, etc.). All of this is done with the pressure to complete the task as quickly as possible (and thus the observer is calculating efficacy of functioning per period of time). The test highlights elasticity in compartmentalizing stimulus material, keeping in mind two sequences at the same time, and trying to complete the task in a timely manner [62, 63].

2. Dehydration and Cognitive Performance

No matter how mild the dehydration, as a result, the brain is impacted by a water loss. A mere 2% decrease in hydration has been shown to impair mental and physical performance in tasks that require attention, reaction time, memory, and psychomotor skills [64].

With regard to mental performance, Gopinthan [65] calculated the outcomes of dehydration on decision-making and mental functioning, which may produce a decrease in efficiency and also an increase in job-related accidents. In this study, male and female participants were randomly selected into groups that were dehydrated to 1, 2, 3 and 4% of total body weight with careful observation throughout the decline in water weight. The study established that visual motor tracing, short-term recall, attentiveness, and mathematic efficiency were all weakened at dehydration intensities of 2% of total body weight or more [65-66]. In severe dehydration, the Gopinthan report also illustrated a 23% decrease in response time when participants were 4% dehydrated. The dehydration negatively impacted the cognitive tests that measure attentiveness, focus, reaction time, studying, recall, and analysis. Notably, both male and female participants were measured and claimed to have a noticeable irritability increase and decreased motivation to participate in workplace activities than those who were adequately hydrated [66].

Unfortunately, most people often use thirst as a gauge to drink water— a reaction that numerous specialists and research studies argue is too late to escape many of the detrimental effects of dehydration [67]. In two recent studies, researchers exposed the psychological, temper, and cognitive disadvantage of even slight dehydration. Researchers determined that a dehydrated group who exercised on the treadmill for 40 minutes versus a dehydrated group that sat behind a desk both had equal influence on the brain’s mental ability [68]. This deduction in reasoning proves that dehydration effects more than athletes, but also standard desk-working employees. Mild dehydration was distinctly marked at a 1.5 percent loss in normal water volume in the body [69]. The largest significance from the study is that individuals need to remain hydrated at all times, not just during a workout, tremendous heat, or physical exertion. The sensation of thirst doesn’t actually emerge until there is a 1-2% loss in body water [68]. By then, dehydration is now setting in and beginning to effect how the brain and body execute tasks. It is estimated that 75% of the U.S. adult population doesn’t meet their daily needs of hydration, meaning that three-fourths of the American population endures the majority of their day in a mildly dehydrated state [5]. Established in the same study, if one reports to work dehydrated, it is unlikely that the condition will improve during the day [70].

While an employee is doing physical exertion for their occupation, fluid output can quickly outpace water consumption, which inevitably leads to dehydration. The more severe the work, heat, or even stress level, the more accelerated dehydration ensues. Godek [71] detected that fully encapsulated protective uniform required for work amplified sweat amounts up to 2.25 liters per hour. In short, the amount of fluids that leave the body is the same amount that needs to be replaced. As for the office environment occupations, Kraft [72] founded that at a 3% dehydrated state from heat exposure participants had a substantial decline in cerebral blood flow velocity when merely standing up from their desks. This information is widely important for employers located in hot or dry cities. A decline in cerebral blood flow is noted to cause momentary dizziness, increase in the number of headaches an employee may endure, or if this decrease in blood flow happens often enough it may produce chronic neck pain [72].

It is important to note that most of the studies that have currently been done on hydration and cognitive performance are short term (i.e., hours or days long). This distinction is important to keep in mind when reviewing studies on this topic because it has not been tested to reveal if there are long-term cognitive decrements stemming from hypo-hydration. However, there have been studies that have made recent recommendations that even after replacing a fluid deficit, the adverse effect that dehydration has on cognition may persevere in some individuals [63]. This ultimately means that even after achieving optimal levels of hydration, cognitive performance may still be compromised. This is an area that is still in need of additional research.

3. POMS

POMS is a customary validated psychological assessment created by McNair in 1971 [73]. This standardized survey comprises of 65 words/statements, with no time limit, that designate feelings people may have or feel. The assessment involves an individual to indicate for each word or statement how he/she has been feeling in the past week, including the day of the assessment. POMS stands for Profile of Mood States. The test analyzes the responses and calculates the individual's Total Mood Disturbance (TMD) score. The test is scored utilizing a number scale 0-5 for each question. It is an analysis of the person's tension, anger, depression, vigor, confusion, and fatigue. The TMD is computed by adding the scores for Tension, Depression, Anger, Confusion, and Fatigue and then subtracting the Vigor score. There is a stable range, which is computed by the general average (50 with the standard deviation of 10) of moderate tempered populations to set the general consensus of each score [73-74]. This test was created to allow for a quick assessment of temporary, changeable feelings, and long-term affect conditions. This tool has been proven to be applicable in clinical, research, medical, and athletic settings. The sensitivities to change make the assessment ideal monitoring trials.

Limited information is presented regarding the consequences of mild dehydration on cognitive functioning. A 2009 study induced dehydration through exercise on 31 young athletes all under the age of twenty. In this study, athletes participated in one hour of intense rowing followed by a cognitive test and the Profile of Mood States. Dehydration was defined in this study as a 2.0% decrease in body mass in men and a 1.65% decrease in women. This resulted in an increase of POMS scores, calculating a significant change the individual’s Total Mood Disturbance (TMD) score [74]. Researchers used a validated test and the study was not blinded and no control of body temperature or sweat loss was recorded.

In more recent research in 2012, researchers studied exercise induced mild dehydration, cognitive performance, and POMS. In this study, body temperature was controlled and the studies were blinded with a diuretic condition. Exercise in this study was a forty-minute treadmill walk in a mild temperature controlled environment. From this research study, dehydration was marked at a 1.4% body mass loss in women and led to an increase in urine specific gravity. Findings from the females led to decline in vigor, to increased fatigue, to a larger total mood disturbance and increased difficulty to complete cognitive tasks and to concentrate. Women reported an increased amount of headaches during the study. In men, mild dehydration of 1.6% body mass loss with an increase in USG was noted. Findings from the males led to a diminished visual vigilance and working memory, and an increase in anxiety and fatigue. This study displayed differences between men and women regarding the impacts of mild dehydration [75]. In most dehydration and mood studies on adults, mood is affected by exercise induced dehydration, but limited studies present mood changes in non-exercise induced dehydration.

III. Assessments and Recommendations

1. Assessing Hydration Status Introduction

The conventional recommendation by medical providers of consuming eight glasses per day is not accurate. Water intake is dependent on variation in individual body dimensions and compositions, states of wellness, level of activity, environmental stimulus, sweat rate, and amount of stress in which every individual is exposed regularly.

2. Urine Specific Gravity (USG)

A urine specific gravity assessment associates the density of an individual's urine to the denseness of water. Urine becomes more concentrated as a person becomes more dehydrated [5]. This test can determine if a person is over hydrated or under hydrated based on their urine density, or urine specific gravity. A USG test requires a urine sample containing at minimum 1 to 2 ounces of urine [76]. A urine collection cup and a USG instrument is needed to perform a urine specific gravity test. A urine specific gravity instrument uses a refractometer to emit light into the urine sample and determine its density.

A urine specific gravity test is much more accurate than simply looking at the color of the urine. This is due to the fact that numerous color changes can occur from diet, medications, or certain foods. The steps to analyze the number given by the USG instrument are to measure the ratio of urine density to water. The specific density of pure water is 1.000. In ideal situations, urine specific gravity grades will fall between 1.002 and 1.030 if the kidneys are performing as they should [76]. Euhydration ranges are from 1.013–1.029; a USG of ≥1.030 suggests dehydration as indicated by low water to blood fractionation test and high serum electrolyte range; and 1.001–1.012 may indicate overhydration as measured by high water blood fractionation test and low serum electrolyte range [76]. The higher the number that the USG score is, the more dehydrated a person may be indicated by the denser urine score.

Logan-Sprenger discovered that sodium intake has effect on water retention, but results did not demonstrate a significant difference between trials in fluid retention measured by urine output [77]. Their findings demonstrate that if an individual is mildly hypohydrated (USG > 1.030-1.035) before consuming any liquid, consuming 600 ml of any fluid (water, salt water, carbohydrate containing water, or high sodium low carbohydrate containing water) will reverse the hypohydration and put an athlete in a hydrated state (USG > 1.029) within 45 minutes of ingesting fluids [77]. The difference in sodium intake, carbohydrate intake, and plain water intake did not have much effect on USG scoring, but any of the four fluids tested improved hydration levels measured by USG. This finding is significant in the fact that liquids may improve USG short term, so USG is not indicative of consistent hydration over a period of time.

A study determining proper USG collection time that is conducive to a 24-hour collection, eighty-two adults collected individual urine voids over a twenty-four-hour period. Urine osmolality and urine specific gravity were measured on each void and noted on the 24-hour sample. The results were used to determine the time of day when the spot sample was most equivalent to the entire 24-hour collection value. The results showed that in healthy adults, a twenty-four-hour urine collection concentration can be estimated from a mid- to late-afternoon spot urine sample [78]. The findings from this study suggest that a mid- to late-afternoon spot urine sample sample may be collected as an accurate and sensible tool for hydration monitoring for future research and healthcare practitioners.

3. Color Chart

Utilizing the color chart is the most affordable and easy urine analysis available to everyone. The urine color chart is a means of comparing the color of urine to a color chart to determine level of hydration. The color of urine lightens or darkens due to concentration levels. The more water input dilutes urine color and, generally, indicated a higher hydration status [5]. There is no precise relationship between color and urine due to the fact that medications, diet, and vitamins can change the color of urine significantly [5]. However, urine color can provide a decent education tool for people to measure their own hydration levels.

The color chart is a practical tool for hydration assessment. The technique has been validated in adults. A study explaining urine color in accordance with hydration levels validates the use of them with highly accurate results. The general accuracy of the urine color chart in the morning or the noon samples fluctuated from 67-78 % accurate. Additional threshold examination labelled that the optimum self-assessed urine color threshold for hypohydration was ≥4.

3. Water Intake Recommendation

Sources of water consumed to meet hydration needs include beverages, food, and drinking water. Even though water is the optimal means to sustain hydration, fluids in different beverages and foods can contribute significantly to a person’s daily fluid needs [34]. The most concise recommendation from the National Research Counsel to maintain euhydration consistently throughout the day, via blood panel and USG, was found at 0.5oz per pound of body weight for semi-active individuals living in a mild climate. For people living in more extreme climates (≥100F), or those who are highly physically active, the requirement was 1 oz. per pound of body weight [79]. The Institute of Medicine says that the average daily intake is reported at 3.9 cups of fresh water per individual in the United States [80]. Majority, 70%, of this water was consumed at home, the remaining 30% was consumed at work, on-the-go, or away from home [81]. The IOM makes water consumption intake recommendations based on sex, age, physical activity level, and current health status. The AI for adult men is 3.7L per day and for adult women the AI is 2.7L per day consumed by beverages [80-81].

A 2002 study questioned the 8 ounces of water 8 times per day rule and found it to be inconsistent with proper hydration [82]. After much review, researchers concluded that the average healthy adult, who doesn't participate in rigorous activities and living in temperate environments, need more water than the 8-ounces 8 times per day rule. Caffeinated drinks may amount toward fulfilling the fluid requirements [83].

It is often declared that caffeinated drinks, such as coffee, tea, and energy drinks, have adverse effects on hydration levels. While some research studying the effects of caffeine pills on hydration levels have shown inconsistent results, those research studies on caffeinated liquids (114-420mg caffeine), have found no significant impact on decreasing hydration levels [84, 85]. A 2010 randomized cross-over trial was performed to evaluate the impact of black tea on hydration levels in comparison to plain water in 21 healthy men. Participants were required to abstain from caffeine consumption and intense exercise during the trial. Black tea with skim milk was given to one group, the other group was given water at the same volume and temperature. Urine was then collected in a 24-hour period and tested for volume, USG, and electrolyte balances in urine and blood samples. There was no significant difference between the two groups in their urine or blood parameters. This research suggests that a caffeinated beverage is equally as hydrating as water at an intake of up to 420mg caffeine per day [86].

It has been determined that 80% of our daily water intake comes from plain water and other beverages while the remaining 20% comes from the food we eat [87]. Food can be equally as hydrating, if not more hydrating than plain water because water-rich fruits and vegetables provide the body with natural sugars, mineral salts, vitamins, and amino acids that may be lost during activity and sweating. Fruits and vegetables are a more natural source of rehydration than artificially created sports drinks. Additionally, fruits and vegetables with a high water content are generally lower in calories and provide a feeling of fullness in comparison to sports drinks. It is recommended to eat five or more servings of different fruits and vegetables per day to provide your body with fluids, vitamins, minerals, and important antioxidants [34].

4. **Encouraging Water Intake and Proper Hydration**

According to a meta-analysis on improving hydration, it is best implemented within the use of a three-pronged methodology incorporating instruction, calculation, and enactment of best practices of boosting fluid intake in individuals [88]. Within the realm of the research performed in this study, it will attempt to create input that proximity of water is also an important factor to improve hydration status within the work place.

5. **Education in the Workplace**

According to the meta analysis, the most pivotal component in boosting hydration among individuals is subject participation. The benefits of hydration span beyond performance at work, but take influence in personal life as well. Essentially, the cognitive and performance-based profits from good hydration at work will, evidently, be presented after work as well. From an employee's perception, adequate hydration encompasses a choice to improve and the determination to make their hydration a priority is up to that individual to form a habit. Corporations should implement hydration education continuously in their place of work. A way to better impact and remind individuals is allowing them to see signage or have electronic reminders. One study demonstrated the techniques to remind people of doing something [89]. The most evident concepts to remind people to do something was through visible and eye-level signage, email or messaging memorandum, and objects that help the individual remember—in the case of this study it would be a reusable water bottle. These and other relevant facts should be reinforced throughout the study in order to get people aware and reminded of their goal.

A 2013 study had participants determine the effect of an educational intervention on hydration practices in high school athletes. The purpose of this study was to determine the consequence of a hydration education session in male high school athletes' hydration status measured by urine specific gravity with an afternoon spot test. Education and handouts were presented regarding the significance of hydration and appropriate rehydration practices in a high school male athlete. The goal was to improve athletes' individual hydration understanding and practices and it will persuade them to integrate the hydration and rehydration practices into their everyday routines. The result was that hydration didn't improve based on USG, however, rehydration techniques (i.e. drinking before, during, and after practice and drinking water upon waking up) reported to have significantly improved among the athletes, though no improvement on USG was recorded [90].

6. **Implementation**

According to the meta analysis, the other critical point in a successful hydration plan is making drinking water accessible and taste fresh. Plumbing is generally the main concern in most building spaces to add a water fountain system. With a hydration station, it is much more easily accessible to fill up reusable water bottles, thus, saving the company money in the long run on plastic water bottle purchases.

According to recent survey, many companies and schools have converted to plastic water bottle usage to hydrate employees and students [91]. Although the approach is in the right direction to increase hydration, it is both costly and ecologically irresponsible to sustain this. In the United States alone, we use around 50 billion water bottles per year, thus placing around 30-40 billion plastic water bottles in landfills, since recycling is not always existent in some restaurants, heavy foot trafficked areas, and food courts [92]. Bottled water does improve the accessible water issue, but it is creating an adverse problem as time continues and landfills become increasingly full. This is why water fountains are to become increasingly emphasized and reusable water bottles should be pushed in society [93].

At St. Cloud State University in St. Cloud, Minnesota, the school implemented their version of a hydration station. The goal of this hydration station was more than just increasing water intake among students. The main reason it was implemented was because it looked appealing and fit the space nicely in the cafeteria. The idea came to the general manager of the cafeteria from spa water offerings in a hotel lobby. Another reason it was implemented was because it encouraged students to have an alternative decision than just carbonated soft drinks and sugar sweetened beverages. The manager argued that he had seen a pretty dramatic increase in the amount of water the students had been drinking, at least in the cafeteria [95]. The hydration station was made appealing by adding flavor infusions to the water done by fresh fruit, vegetables, and herbs. One of the reasons he believes the water is more popular is due to the fact that the containers that the water is put in are very attractive and eye pleasing. The containers are clear so that one can see the fruit floating in the water and composed of stainless steel and chrome, so it is a bit shiny and attracts the eye. In all, the cafeteria goes through roughly 150 gallons of filtered water each day for the hydration station equating to about 200 glasses of water per hour. It takes about thirty minutes in the morning to cut the fruit and prep the hydration station. Supplementary water is added throughout the day when needed. No sweetener is used in the beverages and no bottled water is available for purchase at the cafeteria. The waste is minimal and the hydration station is highly valued at the school. The school has made attempt to broaden this idea and implement on other campuses.

IV. Current Research On Proximity and Intake

There has been much research on accessibility and proximity of food and how it influences intake, but there are few to no research studies on if the same parameters are set on hydration. To highlight some examples of how proximity influences intake, the research had to be proven with studies done on proximity and food; this research will imply that the hypothesis is correct in that water proximity of water fountains, as opposed to snack options, also influences water intake.

The influence of environmental factors on consumer choices and ingestion amounts of food quantity particularly interesting to the field of nutrition and behavioral science because these factors have been shown to lead to overeating and increase possible chances of developing obesity [94, 96]. Sobal and Wansink (2007) introduced a name for this concept called the food environment. This food environment comprises of four small-scale environmental dynamics that can influence food intake. One example may be your surroundings and proximity of those food choices. Prominence and visibility of foods within a range of an individual's office or where one is seated has been shown to also influence food intake. The more visible a food is, the more desirable that food becomes to an individual. It was also shown from the research that when presented with a snack or candy bowl in front of a subject, that the subject was more likely to eat that item [95]. It is perceived and hypothesized that if a reusable water bottle was in front of a person on their desk, they would be more likely to consume it.

In other, similar findings it was hypothesized that applicants will consume more fruits (apple slices) and vegetables (carrot cuts) if the items are made more proximate to an individual. Proximity and visibility were the manipulated variables in the experiment; this was done so by placing fruits and vegetables in a dish at a table where subjects were seated near or far, 2 meters, from the table. Visibility was controlled by putting carrot sticks and apple slices in an opaque bowl that was covered, making it not visible, or in a clear bowl that was open, where the fruits and vegetables were visible. The outcomes showed that enlisting apple slices and carrot cuts in nearer propinquity to participants improved consumption of these beneficial foods [95]. Manufacturing these foods to make them more evident augmented consumption of apple slices. These data results were principal to establish experimentally that the immediacy and prominence of fruits and vegetables can encourage consumption of these foods [98].

There is a huge tendency to underestimate what an individual thinks he or she may consume. This is not only due to unawareness, but not having the awareness or understanding of how much/ how little a serving may be [99]. This phenomenon is a research topic that can influence people in thinking they ate less or more than what they actually ate. In context, this can be applied to hydration as well. This gap in approximation of what an individual may consume can lead to how education on portion control and consumer awareness is necessary for populaces to distinguish. According to this research, if you ask an individual to recall what they ate in the past 24 hours they will underestimate how much they really ate and overestimate what they consumed regarding water or juice [99]. Recall that 75% of the U.S. adult population is estimated to endure the majority of their day in a mildly dehydrated state. This isn't because Americans are deprived of water, it is because most individuals are most likely underestimating the amount of water they are drinking.

Building on that aspect of architecture affecting intake of individuals, Google tested that one consideration might sway snack ingestion exclusive of impacting fulfillment: the comparative remoteness amongst refreshments and beverages. A similar study was conducted to the Privatera study [96] in regards to a ratio of proximity and consumption. It was discovered that personnel who were planted in offices closer to the beverage and snack stations were more likely to have a snack than those who were in offices further away from the refreshment area. As a result, the probability of snacking amplified from 12-23 percent for males and from 13-17 percent for females when the employees were positioned closer to the snack station [98]. The results of this study suggest that companies and families could decrease snack ingestion effortlessly, economically, and without repercussions, merely by increasing the comparative remoteness between beverages and foods to snack on [100].

The connotation between closeness to healthy food sources and relative nutrition state was reduced in importance and not statistically momentous in the three-dimensional models. Conversely, the projected magnitude of the connotation between nearness to fast food and diet much more significant in spatial models. This may be due in part that it has been shown that people who eat healthy, generally prepare their own meals [100]. This study may be contributory to the recent study on hydration, that incorporating health habits may not be as easy as incorporating unhealthy habits [101].

There are few to no research topics done on proximity of water and hydration status. In offering proper education, convenience, and fresh water it is in high hopes that this will improve hydration in employees.

CHAPTER 3

METHODS

I. Participants and Study Design

Participant recruitment was based on the willingness of their business office supervisor to participate in the study. Participants were employees working full-time jobs with Arizona State University or Tri Star Motor Company. Employees 18 years or older were invited to join the study. Employees participating in the study live within the the greater Phoenix area. Participants of all races, genders, activity statuses, and BMIs were encouraged to join. The exclusion criteria during screening were employees on the following medications or diets that may alter USG results include a high carbohydrate diet (>600g/day) or a high protein diets (>2g protein/lb.). To screen for these diets, employees were asked what their typical diet consists of in the prescreening. These factors are known to increase urine specific gravity out of proportion to osmolality, as measured by hydrometer or refractometer.

In order to appeal to possible participants, a brief education session on the importance of hydration and how it affects cognitive performance was made available for all employees interested in participating. In addition, participants received a reusable water bottle.

Employees who decided to enroll, needed to pass dietary intake screening, read and sign a consent form, and agree to offer a before and after urine sample during the one-week intervention to be used only to measure urine specific gravity. Additionally, each participant needed to fill out a beverage questionnaire and complete a POMS questionnaire before and after the study.

A one-arm, pre-test, post-test study design was utilized. We examined whether the hydration status of participants in the intervention improved or worsened during the course of the intervention, and then attributed any such improvement or deterioration to the intervention. A reusable water bottle was given to each participant. The office received a water dispensing system in close proximity to their desk spaces after the initial USG was taken. After 1 week of implementing the water dispenser, a second USG was taken to look for improvement in hydration status. Urine collections from an afternoon sample, were gathered pre and post implementation of the water dispensing system. Urine samples were taken on Friday of the work week, but participants were not told which time in the afternoon the urine would be collected each week.

Recruitment began in January 2017. All human subjects who were included in the study after the initial survey, education, and screening provided written informed consent. At the consenting visit, subjects were given a description of the study including the length of the trial, possible harms and benefits, how data will be collected and protected, and contact information regarding the researchers. The study was approved by the Arizona State University Institutional Review Board and all participants consented to be in the study.

II. Independent Variable and Dependent Variable

The independent variables in this study include: proximity of the water dispensing system, the education, and the water bottle serving as a reminder. The dependent variables in this study include: POMS survey, beverage consumption questionnaire, USG, and color chart. For example, increased water consumption should result in a USG result score decrease. Mood was measured as a dependent variable due to its correlation to hydration status. According to a mood and hydration evaluation study done in 2015, results consistently showed that the less hydrated an individual was, the more irritable the individual [102]. This study validated the POMS survey and established a link between hydration and mood. The dependent variables in this study include: POMS, USG, and water consumption.

III. Protocol procedures

The study was conducted and completed in 1 week from start to finish for each group. The initial meeting with participants of the study was to introduce the researchers conducting the intervention and to educate both groups about the benefits of hydration, its effect on cognitive performance, and how optimal hydration has been shown to improve focus and fight fatigue within the workplace. At the end of the education, participants who wanted to join had to go through screening and were asked a series of questions regarding medication and diet, then completed a written questionnaire. Those who qualified for the study were handed a consent form and were verbally told exactly what was asked of them and their rights as a participant. On this same day, participants were asked to give a urine sample, recorded as the initial USG test (collection #1, week #0). Employees were required to urinate in a cup. Employees were given a specimen cup and told to take the cup into the restrooms and catch the stream of urine into the cup. Employees were told to take collect the urine from the initial release until the cup was half-full. It was important that the urine cup was half-full to make sure that there was sufficient volume to fill the tubes and/or perform the urine specific gravity tests. Employees were told not to touch the inside of the lid or cup. Once urine was collected, the cap was to be sealed securely and set into urine collection box. Each specimen cup had a label that was assigned by the research team to each employee.

Only ID # was used to identify samples and questionnaires for confidentiality purposes. It is imperative to make sure that the information on the container label and the appropriation match. Participants were asked to verbally verify what their ID# was when dropping their specimen off. Since the collection container was transported from the collection site to the lab, it was important to ensure that the label was be placed on the container outer part of the container and not on the lid, since the lid can be mistakenly placed on a different container during testing or transport. The date and time was written on the specimen label. This confirmed that the collection was done correctly and no collections were misplaced or are outdated. It was ensured that the labels used on the containers are adherent under temperature controlled conditions. Urine remained covered when being transported from collection area to the data collection area for further testing.

Finally, participants were given a POMS survey and a beverage questionnaire. The questionnaire included a series of questions regarding employee current fluid intake, drinking habits, consumption of fluids other beyond water, if employees feel optimally hydrated, and personal hydration goals. Once completed, the group was given a reusable water bottle and shown where the newly placed reusable water station was located and placed for one week.

Following the 1-week intervention, the research team collected a post urine sample (collection #2, week #1). Participants were only required to give two urine samples throughout the course of the intervention. USG analyses were performed and recorded onsite. A refractometer was used to measure USG. In order to measure USG, the half full urine cup was placed in a plastic bin in the restroom. Following urine collection, the cup was placed on white paper and, using top view, matched the color of the urine to the color chart. Data was recorded. To standardize the color chart and not oversaturate the color of the urine, partial urine was emptied from the cup to the 10ml line. The more urine that was in the container the darker the urine appeared, therefore, the standardization was necessary for consistency. Next, the probe was calibrated in distilled water by pressing “zero". It read ‘0’ before USG was sampled. The probe was placed in the urine and then the value was recorded. The probe was then rinsed with dH2O and gently blotted the USG with filter paper to avoid scratches or damage to the probe. After rinsing, the probe was put back into the dH20 water and reset back to 1.0000. If at any point the d20 did not read 1.0000, the water was considered contaminated and reset again with fresh dH20.

At the end of the one-week intervention, participants were asked to again fill out the POMS survey to examine if there were any significant changes in mood. USG samples and POMS survey answers were then performed and further analyzed in the lab. Employees who completed study and they were able to keep the water bottles as a reminder to stay hydrated in the future. Once completed, all results were calculated and assessed.

IV. Laboratory analyses

The research team collected afternoon specimen urine samples from employees who participated in this study. An afternoon sample is taken for the analysis because it is the time of day that is most accurate for spot urine samples [103]. An afternoon sample by definition is collected in the afternoon. Urination from employees into the specimen cup requires explicit instructions relayed to participants so that they do not touch the inside of the cup or cup lid and understand the specific instructions.

Internal consistency for the POMS questionnaire is numbered and scored utilizing basic addition. The questionnaire contains 65 words/statements that describe common feelings felt by people on a day to day basis. The test will be graded utilizing a number scale 0-5 for each question answered by the employee and the total score is calculated, also known as the total mood disturbance (TMD = (Tension + Depression + Anger + Fatigue + Confusion) – Vigor)). Once graded, POMS will be saved to compare scores with final POMS post-intervention [104].

V. Statistical analyses

Analyses were executed using IBM SPSS Statistics 24. The non-parametric Wilcoxon test was conducted for the study to compare the pre- and post-values for urine specific gravity, beverage consumption, POMS, and urine color. Additionally, the non-parametric Wilcoxon test analyzed the one-week change in outcome measures by gender. Data was first examined for outliers and confounders. All data are reported as mean ± SD. Data was considered significant at $p \leq 0.05$.

CHAPTER 4

DATA AND RESULTS

Descriptives of participants who completed the study (n=20) are shown in Table 1. Of the participants, 9 were women and 11 were men, with the mean age of 41.2± 7.9 years. The body mass index (BMI) of the participants averaged 26.3± 4.0 kg/m2, range, 19.6 to 34.3 kg/m2. For mention, a healthy BMI is considered to be within the range of 18.5-25 kg/m2, with obesity status at a BMI of 30 kg/m2 or more [105]. Two participants were considered obese from the sample.

Table 1 Descriptive statistics of desk working participants who completed intervention successfully from start to finish (n=20)

	Mean ± SD	*Minimum*	*Maximum*
Age, y	41.9 ±7.9	27	53
Height, inches	68.0 ±4.1	60	75
Weight, pounds	174.5 ±38.4	118	275
BMI, kg/m2	26.3 ±4.0	19.6	34.3
METS *kcal·kg−1·week−1*	36.2 ±22.5	6	69

Table 2 displays the outcome variables at the start and end of the one-week intervention. Weekly water intake increased from an average of 127.9± 122.5 ounces to 270.6± 136.7 ounces with having the water station in close proximity to the employees' desks and having a reusable water bottle placed on their desks. Water intake was self reported. The change in mean USG from week 1 (1.022± 0.001) to week 2 (1.018±0 .001) was decreased as was the mean color chart values (4.6 ± 0.461 to 3.0 ± 0.453). The urine color was analyzed utilizing a validated color chart. Over the course of the week, the POMS scoring decreased showing a mood improvement in mean scores from 52.1 ± 7.6 to 50.1 ± 7.3. Some of the data were not normally distributed; therefore, the p-values represent the non-parametric Wilcoxon test. Significance was calculated using $p<0.05$.

Table 2 Outcome variables prior to and following the one-week intervention*				
	pre	*post*	*change*	*P*
H2O, oz/wk	127.9±122.5	270.6±136.7	+142.7±102.5	0.000
POMS score	52.1±34.1	50.1±32.8	-2.0±2.3	0.003
USG	1.022±0.006	1.018±0.006	-0.005±0.008	0.017
Color score	4.600±2.062	3.000±2.026	-1.600±2.062	0.003

*Data are mean ± SD; P value represents the non-parametric Wilcoxon test

Overall, change in water intake increased by a mean average of 142.7 ±102.5 ounces (see Table 2). Overall change in POMS decreased units 2.0 ±2.3 units. USG decreased 0.005 ±.008 units. And finally, color of urine decreased 1.600 ±2.062 units.

There were no correlations between subject characteristics and outcome measures at baseline except for a positive association between BMI and POMS: as BMI increased moodiness also increased (p=0.020). As expected, the color chart correlated with USG (p<0 .001) indicating that as USG score decreased, urine color became more pale.

Table 3 shows there was significant change in outcome measures by gender. The change in H2O consumption was higher in men as compared to women (+186.4 ± 34.0 and +89.3 ± 19.0 ounces respectively, p=0.016). Changes in USG, POMS, and urine color are reported in Table 3 although no significant difference by gender was noted.

Table 3 The one-week change in outcome measures by gender*					
	N	*Change H20*	*Change POMS*	*Change USG*	*Change Color*
Male	11	+186.4 ±112.7	-1.5±2.1	-0.003 ±0.008	-1.273±2.284
Female	9	+89.3±57.2	-2.4±2.6	-0.008±0.007	-2.000 ±1.803
P		0.016	0.412	0.131	0.201

*Data are mean ± SD; P value represents the non-parametric Wilcoxon test

Table 4 displays the change in total fluid intake from the start to the end of the one-week intervention. The overall mean change in fluid intake increased +142.4±13.7 oz/week. There was significant improvement in overall fluid intake, (p<0 .001), but insignificant changes in soda or sweetened beverages and coffee or energy drinks. Therefore, it is not likely that weekly soda or sweetened beverages and coffee or energy drinks were exchanged with water. Looking back at Table 2, change in water intake increased by a mean average of 142.7 ±102.5; hence, water intake was the likely cause of increases in total fluid intake.

Table 4 Beverage outcome variables prior to and following the one-week intervention*				
	pre	*post*	*change*	*P*
Total fluid intake, oz/wk	318.6±166.8	461.0±153.1	+142.4±13.7	0.000
Soda or sweetened beverages, oz/wk	77±86.4	73±86.1	-4.0±0.3	0.066
Coffee or energy beverages, oz/wk	61.2±58.8	65.3±58.3	+4.1±0.5	0.593

CHAPTER 5

DISCUSSION

The present study was designed to evaluate the significance of the presence and close proximity of a water dispensing system on water intake in a corporate setting. The goal was to encourage hydration in a corporate work setting. This study's primary hypothesis was that adding a hydration station or water fountain in conjunction with providing reusable water bottles would relate to an increase in hydration of employees and encourage them to drink more water throughout the course of the day, as measured by reported water intake and USG. Secondary to this hypothesis was the possible correlation of a decreased mood affect to an increase in hydration.

This study was presumably the first of its kind since no studies were identified in the scientific literature that correlated water proximity to intake or studied water intake and hydration status in a corporate setting. The results of this study demonstrated that inputting a water station and providing reusable water bottles to employees increased their water intake and overall hydration status. Educational interventions focused on rehydration strategies have had little achievement decreasing dehydration rates; hence, alternative interventions endorsing adequate hydration status in participants should be explored. Zemek tested whether or not app technology would increase hydration status as compared to conventional education messaging. No significant alterations in hydration status were found between intervention groups. Additionally, no significant improvements were seen for either group [106]. Another randomized intervention trial evaluated whether an educational program emphasizing increased fluid intake could improve the hydration status of physically active adults. Hydration status improved significantly in the intervention group [107]. This group was given education, unlimited free access to water, a urine color chart, and participants were weighed before and after training to assess fluid losses as an additional reminder of hydration. There is not enough evidence to conclude what caused the increase in overall water intake over the course of the intervention.

From this study, the overall change in water intake over the course of the one-week intervention was 143 ounces. This is an average of adding two and a half 8 oz glasses of water each day of the week and the p-value was significant across the paired samples t-test and the Wilcoxon test, since not all data was normally distributed. This increase as an average of 16oz per day helped nine of the twenty participants reach an average of 0.5oz/lb/day; however, only one of the employees averaged 1oz/lb/day which is the recommended amount for active adults living in hot, dry climates.

The USG was also measured in this study. A simple urine specific gravity test was conducted and the change over the course of the week was documented. This yielded a significant p value of 0.017. It is noted that USG samples were only taken twice throughout the course of the intervention, which is a limitation in the data collection. USG is more indicative of recent fluid consumption versus overall chronic hydration status [108, 109]. The overall change in USG was a decrease of -0.005±0.008, which though significant, does not represent overall water intake for the average USG over the course of the week.

Demographics were a useful method of stratifying data. There was significant finding that men increased their water consumption more than women during the intervention. In a 2005 hydration study between men and women, men had significantly higher beverage water input (and food intake) than women during the study [110]. The 2005 study assumed that men drank more water because they eat more food, which caused the higher intake from men than women. From this current study, men and women were taught that in order to properly hydrate they must drink their body weight in ounces. Each participant was prompted to write down their daily minimum intake of water on the questionnaire before beginning the study. The increase in water intake from men over women may be due to the fact that men are larger and require more water than women. Therefore, men may have felt more inclined to drink at least half their body weight in ounces. However, changes in USG and color chart scores did not vary significantly by gender over the intervention week.

Mood improved to a greater degree among women (POMS score change, - 2.44) in comparison to the men (POMS score change, -1.55; $p<0.05$). However, this change is not relevant in regards to change on a linear assessment over time [111]. Accumulating evidence and research supports the concept that hydration state affects cognitive ability and overall mood. Differing degrees of dehydration have been presented to cause cognitive deficits such as short-term memory, visual perceptual abilities, and even mood disturbances. One study in particular highlights that dehydrated adult participants showed improvement in cognitive performance and mood significantly when water consumption increased and USG reached a hydrated amount. [112].

A limitation of this study is the small sample size. The population was 20 individuals who work in small office spaces, which was beneficial in setting up a water dispensing system that was close in proximity to all the participants' cubicles. Another limitation of this study is the type of work that the participants complete on a day to day basis. The participants within Tri Star Motor Company sit at their desk for the majority of the day, whereas other occupations are more mobile. Outcomes may vary for employees who are away from their desks at meetings or other occurrences often during a typical work day. More mobile jobs and jobs that incur many meetings would require participants to carry the water bottle with them and remember to fill it up on the go. In the present study, the participants sit at their computers for the majority of their day other than to get up and go to the bathroom or have a lunch break of one hour per day. The water dispensing system and water bottles can act as a visual reminder for participants to drink more water. Participants reported that having the water bottle left on their desk was a large component of drinking more water. The convenience of having a water bottle always on their desk and the water dispensing system nearby produced positive results from the participants.

Depending on two USG samples to measure hydration status is another limitation. USG samples are more indicative of recent fluid consumption. It is possible that a participant could be dehydrated for several days during the study and rapidly ingest large amounts of pure water or isotonic fluids and within one hour and display a properly hydrated USG sample [65]. Urine color is an easy and affordable way to measure hydration status, however, exercise, medications, supplements, and some foods have been shown to change urine color [113]. Hence, USG might offer a more viable method for assessing hydration status. Previous studies [114-116] suggest that USG is highly sensitive to change in acute hydration status. However, because this study was done outside of a laboratory, it may have greater external validity. A laboratory study suggests sampling subjects under normal working conditions and including a history of activity and fluid consumption prior to taking urine samples might indicate a more accurate hydration status [117].

From these results, the most significant finding was the amount of water ingested over the course of the week, which was self reported. Participants reported that the intervention was beneficial in encouraging them to drink more water, though the USG and color chart reported a slight change. Additionally, participants who had their desk directly next to the water station had higher increases in water consumption than participants further away. It is unsure if this was a direct causality or by coincidence. Finally, a randomized controlled trial would provide a more definitive answer to the question of whether an office place hydration station and readily available refillable water bottle would improve hydration status of worksite employees. This trial was a single group study design and cannot test causality.

Yet, this research helps to fill the literature gap identified at the beginning of this thesis. As stated in the review of past literature, prominence and visibility of foods within a range of an individual's office or where one is seated has been shown to also influence food intake. It was also shown from the research from Sobal and Wansink (2007) that when presented with a snack or candy bowl in front of a subject, that the subject was more likely to eat that item [118]. Therefore, the results of this study on hydration show the same effects. The more visible a food or drink is, the more desirable that food or beverage becomes to an individual.

In the greater body of research, this study strengthens the viability of inputting a hydration station and offering reusable water bottles to employees. This cost-effective method is an easy way to incorporate employee wellness in the workplace. The benefit of employees to drink more water is numerous. From increased focus, mental reactivity, overall mood and wellness, and drinking more water will encourage them to get out of their seat more often during the day to go to the bathroom. Studies show getting up and walking around every few hours is critical for your health and wellbeing [119]. This study was effective in discovering the result of inputting a hydration station into a workplace. Future research utilizing this method can focus on several different settings, methods, and intakes.

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APPENDIX A

PROTOCOL FLOW CHART

Week 0: **GROUP 1**

- Announce research, hand out consent form, and educate employees about the benefits of hydration and its effect on cognitive performance.
- Collect urine sample and run USG (Initial (Collection #1))
- POMS & Questionnaires
- Hand out reusable water bottle
- Show group the new water dispensing system

Week 1:

- Collect urine sample and run USG (Collection #2) – FINAL
- POMS & Questionnaires

Lab work:

- Analyze data
- Test for significance
- Compare pre & post intervention: POMS, questionnaire, USG

APPENDIX B

CONSENT FORM

Water Consumption in Corporate Settings

I am a graduate student under the direction of Professor Carol Johnston in the College of Health Solutions at Arizona State University. I am conducting a research study to examine the effects of an education session on hydration status during a 3-week period in office-residing employees.

I am inviting your participation, which will involve a 3-week intervention in which I will measure hydration using a urine specific gravity test before, during (x2), and after the intervention. Participants will need to give a total of four urine samples during the course of the intervention. Additionally, participants will have to fill out two surveys before and after the intervention. You have the right not to answer any question, and to stop participation at any time.

Your participation in this study is voluntary. If you choose not to participate or to withdraw from the study at any time, there will be no penalty. You must be 18 or older to participate in the study.

Benefits of participation may include improved hydration status. There are no foreseeable risks or discomforts to your participation.

Throughout the study, your name, questionnaire responses, urine samples, and participation will remain confidential. The results of this study may be used in reports, presentations, or publications but your name will not be used.

If you have any questions concerning the research study, please contact the research team at: kelsiwildermuth@asu.edu or CAROL.JOHNSTON@asu.edu. If you have any questions about your rights as a subject/participant in this research, or if you feel you have been placed at risk, you can contact the Chair of the Human Subjects Institutional Review Board, through the ASU Office of Research Integrity and Assurance, at (480) 965-6788. Please let me know if you wish to be part of the study.

By signing below you are agreeing to be part of the study.

Name: ____

Signature: ___________________________________ Date: ____________________

APPENDIX C

POMS SURVEY

ID: Date:

Please think of how you felt over the **last week** when answering these questions.

The numbers refer to these phrases.

0 = Not at all
1 = A little
2 = Moderately
3 = Quite a bit
4 = Extremely

Col (C) O.P. (O)

T D A V F C

	Not at all	A little	Moderately	Quite a bit	Extremely
1. Friendly	0	1	2	3	4
2. Tense	0	1	2	3	4
3. Angry	0	1	2	3	4
4. Worn out	0	1	2	3	4
5. Unhappy	0	1	2	3	4
6. Clear-headed	0	1	2	3	4
7. Lively	0	1	2	3	4
8. Confused	0	1	2	3	4
9. Sorry for things done	0	1	2	3	4
10. Shaky	0	1	2	3	4
11. Listless	0	1	2	3	4
12. Peeved	0	1	2	3	4
13. Considerate	0	1	2	3	4
14. Sad	0	1	2	3	4
15. Active	0	1	2	3	4
16. On edge	0	1	2	3	4
17. Grouchy	0	1	2	3	4
18. Blue	0	1	2	3	4
19. Energetic	0	1	2	3	4
20. Panicky	0	1	2	3	4
21. Hopeless	0	1	2	3	4
22. Relaxed	0	1	2	3	4
23. Unworthy	0	1	2	3	4
24. Spiteful	0	1	2	3	4
25. Sympathetic	0	1	2	3	4
26. Uneasy	0	1	2	3	4
27. Restless	0	1	2	3	4
28. Unable to concentrate	0	1	2	3	4
29. Fatigued	0	1	2	3	4
30. Helpful	0	1	2	3	4
31. Annoyed	0	1	2	3	4
32. Discouraged	0	1	2	3	4
33. Resentful	0	1	2	3	4
34. Nervous	0	1	2	3	4
35. Lonely	0	1	2	3	4
36. Miserable	0	1	2	3	4
37. Muddled	0	1	2	3	4
38. Cheerful	0	1	2	3	4
39. Bitter	0	1	2	3	4
40. Exhausted	0	1	2	3	4
41. Anxious	0	1	2	3	4
42. Ready to fight	0	1	2	3	4
43. Good natured	0	1	2	3	4
44. Gloomy	0	1	2	3	4
45. Desperate	0	1	2	3	4
46. Sluggish	0	1	2	3	4
47. Rebellious	0	1	2	3	4
48. Helpless	0	1	2	3	4
49. Weary	0	1	2	3	4
50. Bewildered	0	1	2	3	4
51. Alert	0	1	2	3	4
52. Deceived	0	1	2	3	4
53. Furious	0	1	2	3	4
54. Efficient	0	1	2	3	4
55. Trusting	0	1	2	3	4
56. Full of pep	0	1	2	3	4
57. Bad-tempered	0	1	2	3	4
58. Worthless	0	1	2	3	4
59. Forgetful	0	1	2	3	4
60. Carefree	0	1	2	3	4
61. Terrified	0	1	2	3	4
62. Guilty	0	1	2	3	4
63. Vigorous	0	1	2	3	4
64. Uncertain about things	0	1	2	3	4
65. Bushed	0	1	2	3	4

MAKE SURE YOU HAVE ANSWERED EVERY ITEM.

POM 021

POMS Problems & Scoring: Total Mood Disturbance (TMD) based on a scale from (-32 to 200). Lower scores represent less mood disturbances and higher scores represent more mood disturbances:

- Factor analysis: 6 subscales
    - tension-anxiety (9 items, score range: 0-36)
    - depression (15 items, range 0-60)
    - anger-hostility (12 items, range 0-48)
    - vigor-activity (8 items, range 0-32)
    - fatigue (7 items, range 0-28)
- Example of average POMS survey scores in US population 2016

Group	Tension	Depression	Anger	Vigour	Fatigue	Confusion
International	5.66	4.38	6.24	18.51	5.37	4.00
Club	9.62	8.67	9.91	15.64	8.16	7.38
Recreational	6.00	3.11	3.60	17.78	6.37	4.84

    - Terry et al. [1] provides POMS norms for an athletic sample (n=2086) grouped by level of competition (International standard athletes, club level athletes and recreational athletes).

REFERENCE

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APPENDIX D

EDUCATION

CDC Department of Health and Human Services
Centers for Disease Control and Prevention

Water Basics

Getting enough water every day is important for your health. Healthy people meet their fluid needs by drinking when thirsty and drinking with meals. Most of your fluid needs are met through the water and beverages you drink. However, you can get some fluids through the foods that you eat. For example, broth soups and foods with high water content such as celery, tomatoes, or melons can contribute to fluid intake.

Water helps your body:

- Keep your temperature normal
- Lubricate and cushion joints
- Protect your spinal cord and other sensitive tissues
- Get rid of wastes through urination, perspiration, and bowel movements

Your body needs more water when you are:

- In hot climates
- More physically active
- Running a fever
- Having diarrhea or vomiting

If you think you are not getting enough water, these tips may help:

- Carry a water bottle for easy access when you are at work of running errands.
- Freeze some freezer safe water bottles. Take one with you for ice-cold water all day long.
- Choose water instead of sugar-sweetened beverages. This can also help with weight management. Substituting water for one 20-ounce sugar sweetened soda will save you about 240 calories. For example, during the school day students should have access to drinking water, giving them a healthy alternative to sugar-sweetened beverages.
- Choose water when eating out. Generally, you will save money and reduce calories.
- Add a wedge of lime or lemon to your water. This can help improve the taste and help you drink more water than you usually do.

APPENDIX E

HEALTH HISTORY QUESTIONNAIRE

ID#___________________

1. Gender: M F

2. Age: __________

3. Height _________ Weight __________

4. Ethnicity: (please circle) Native American African-American Caucasian Hispanic Asian Other

5. Do you smoke? No, never ________

   Yes _______ # Cigarettes per day = ________

   I used to, but I quit _______ months/years (circle) ago

6. Do you take any prescribed medications (including antibiotics)?

Yes _______ No ________

If yes, please list type and frequency:

Medication Dosage Frequency

____

____

____

____

____

7. Please ANSWER (YES/NO) if **you have ever been clinically diagnosed** with any of the following conditions or if **you have ever experienced** any of the following signs:

Conditions	YES	NO		YES	NO
Coronary Heart Disease			Food Allergies		
High Blood Pressure			Anemia		
Heart Murmur			Liver Disease		
Rheumatic Fever			Thyroid Disease		
Irregular Heart Beat			Kidney Disease		
Varicose Veins			Lung Disease		
Stroke			**Signs**		
Diabetes			Leg or Ankle Swelling		
Prediabetes			Coughing of Blood		
Bronchial Asthma			Feeling Faint or Dizzy		
Hay Fever			Hormone Imbalances		
Depression			Heart Palpitations		
Eating Disorder			Chest Pain		
Celiac Disease			Shortness of Breath		

Please state any concern you have regarding your health and participation in this study:

____

→ please turn

8. Do you have a urinary tract infection (UTI)? Yes ________ No _________

9. Are you willing to provide spot urine samples (~3/4 cup) on 4 occasions during this three-week trial?

Yes__________ No ________

10. Do you follow a special diet? (e.g., high protein or vegetarian)

Yes _________ No _________

If yes, please explain:

____

11. How would you rate your lifestyle?

Not active ___________ Active ___________

Somewhat active __________ Very Active ___________

12. Please circle the number of times you did the following kinds of exercises for **more than 15 minutes** last week.

Mild exercise (minimal effort):

Easy walking, golf, gardening, bowling, yoga, fishing, horseshoes, archery, etc.

Times per week: 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14+

Moderate exercise (not exhausting):

Fast walking, easy bicycling, tennis, easy swimming, badminton, dancing, volleyball, baseball, etc.

Times per week: 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14+

Strenuous exercise activities (heart beats rapidly):

Running, jogging, hockey, football, soccer, squash, basketball, cross country skiing, judo, roller skating, vigorous swimming, vigorous long distance bicycling, etc.

Times per week: 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14+

APPENDIX F

BEVERAGE CONSUMPTION QUESTIONNAIRE FOR ADULTS

Beverage Questionnaire (BEVQ-15)

Instructions:

In the past month, please indicate your response for each beverage type by marking an "X" in the bubble for "how often" and "how much each time".

Participant ID ______________________

Date ______________________

1. Indicate how often you drank the following beverages, for example, if you drank 5 glasses of water per week, mark 4-6 times per week.

2. Indicate the approximate amount of beverage you drank each time, for example, if you drank 1 cup of water each time, mark 1 cup under "how much each time".

3. Do not count beverages used in cooking or other preparations, such as milk in cereal.

4. Count milk added to tea and coffee in the *tea/coffee with cream beverage category* **NOT** in the milk categories.

	HOW OFTEN (MARK ONE)							HOW MUCH EACH TIME (MARK ONE)				
Type of Beverage	**Never or less than 1 time per week (go to next beverage)**	**1 time per week**	**2-3 times per week**	**4-6 times per week**	**1 time per day**	**2+ times per day**	**3+ times per day**	**Less than 6 fl oz (3/4 cup)**	**8 fl oz (1 cup)**	**12 fl oz (1 1/2 cups)**	**16 fl oz (2 cups)**	**More than 20 fl oz (2 1/2 cups)**
Water	o	o	o	o	o	o	o	o	o	o	o	o
100% Fruit Juice	o	o	o	o	o	o	o	o	o	o	o	o
Sweetened Juice Beverage/ Drink (fruit ades, lemonade, punch, Sunny Delight)	o	o	o	o	o	o	o	o	o	o	o	o
Whole Milk	o	o	o	o	o	o	o	o	o	o	o	o
Reduced Fat Milk (2%)	o	o	o	o	o	o	o	o	o	o	o	o
Low Fat/Fat Free Milk (Skim, 1%, Buttermilk, Soymilk)	o	o	o	o	o	o	o	o	o	o	o	o
Soft Drinks, Regular	o	o	o	o	o	o	o	o	o	o	o	o
Diet Soft Drinks/Artificially Sweetened Drinks (Crystal Light)	o	o	o	o	o	o	o	o	o	o	o	o
Sweetened Tea	o	o	o	o	o	o	o	o	o	o	o	o
Tea or Coffee, with cream and/or sugar (includes non-dairy creamer)	o	o	o	o	o	o	o	o	o	o	o	o
Tea or Coffee, black, with/ without artificial sweetener (no cream or sugar)	o	o	o	o	o	o	o	o	o	o	o	o
Beer, Ales, Wine Coolers, Non-alcoholic or Light Beer	o	o	o	o	o	o	o	o	o	o	o	o
Hard Liquor (shots, rum, tequila, etc.)	o	o	o	o	o	o	o	o	o	o	o	o
Wine (red or white)	o	o	o	o	o	o	o	o	o	o	o	o
Energy & Sports Drinks (Red Bull, Rockstar, Gatorade, Powerade, etc.)	o	o	o	o	o	o	o	o	o	o	o	o
Other (list):	o	o	o	o	o	o	o	o	o	o	o	o

APPENDIX G

IRB APPROVAL

APPROVAL: EXPEDITED REVIEW

Carol Johnston
SNHP: Nutrition
602/827-2265
CAROL.JOHNSTON@asu.edu

Dear Carol Johnston:

On 11/23/2016 the ASU IRB reviewed the following protocol:

Type of Review:	Initial Study
Title:	Water Proximity and Hydration Status in Corporate Settings
Investigator:	Carol Johnston
IRB ID:	STUDY00005324
Category of review:	(3) Noninvasive biological specimens, (7)(b) Social science methods, (7)(a) Behavioral research
Funding:	None
Grant Title:	None
Grant ID:	None
Documents Reviewed:	• beverage questionnaire, Category: Measures (Survey questions/Interview questions /interview guides/focus group questions); • Protocol, Category: IRB Protocol; • water handout, Category: Other (to reflect anything not captured above); • Mood questionnaire, Category: Measures (Survey questions/Interview questions /interview guides/focus group questions); • consent, Category: Consent Form; • health history questionnaire, Category: Screening forms; • food questionnaire, Category: Measures (Survey questions/Interview questions /interview guides/focus group questions);

The IRB approved the protocol from 11/23/2016 to 11/22/2017 inclusive. Three weeks before 11/22/2017 you are to submit a completed Continuing Review application and required attachments to request continuing approval or closure.

If continuing review approval is not granted before the expiration date of 11/22/2017 approval of this protocol expires on that date. When consent is appropriate, you must use final, watermarked versions available under the "Documents" tab in ERA-IRB.

In conducting this protocol you are required to follow the requirements listed in the INVESTIGATOR MANUAL (HRP-103).

Sincerely,

IRB Administrator

cc:

Kate Zemek