An Assessment of Daily Plain Water Intake Level and Its Association with Total Energy Intake Among College Students

Maria Alanazi
Montclair State University

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Abstract

Water is an essential nutrient for humans with several vital roles including maintaining body functions, temperature and preventing dehydration. Nevertheless, many population groups in the United States do not drink the recommended amount of water on a daily basis. The literature notes that drinking water is associated with better dietary practices including reduced sugar-sweetened beverages consumption, but few studies investigated the impact of drinking water on the total energy (calories) intake. In this study, an assessment of the intake of both plain water (pure water) and total water (water from pure water, beverages, and foods) is performed, and the intake is tested for its relationship with the daily calories consumed. A total of 81 college students between 18-32 years of age, completed the study by submitting two 24-hr dietary recalls for a weekday and a weekend. The 24-hr dietary recall was collected using the Automated Self-Administered 24-hr (ASA24®), and analyzed by IBM SPSS Statistics 22.0 using Pearson’s correlation, Eta squared, ANOVA and t-tests. Results indicated that in this age subgroup, plain water intake was 1577 ± 1150 mL/ day and total water intake was 2582 ± 1300 mL/ day, of which both were positively correlated with the daily energy intake (r= 0.3, P ≤ 0.005, and r=0.50, p< 0.001, respectively). In reference to Adequate Intakes (AIs), total water intake was closer to the recommended levels compared to plain water. The two demographic variables; gender and physical activity, were found to be associated with drinking water. Males showed better compliance with the recommended levels of AIs than females, while extremely active participants drank more water than sedentary participants (ηp² = 0.28, p= 0.01). All other demographics including, age, Body Mass Index (BMI), race/ethnicity, annual income and employment status did not have any association with drinking plain water or the total water consumed. Additionally, other college information did not show
any relationship with total and plain water, including major, year of education, part-time/full-time, participation in the meal plan and living on campus/off campus. These findings suggest that more educational campaigns targeting college students, or young adults in general, need to be conducted. Furthermore, it is necessary to update the dietary guidelines to acknowledge the importance of water, and to review the intake recommended levels to reflect the needs of different age groups. Finally, more studies need be conducted using various assessment tools with larger sample sizes and varying demographics, while taking seasons and location into consideration.
MONTCLAIR STATE UNIVERSITY

An Assessment of Daily Plain Water Intake Level and Its Association
with Total Energy Intake Among College Students

by

Maria Alanazi

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Faculty of Montclair State
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A THESIS

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Montclair State University Montclair, NJ

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Introduction

Water is considered an essential element in the human body, serving as the primary component in the body's cells, organs, and tissues (Jéquier & Constant, 2010). It is also needed for survival by preventing dehydration. Still, there exists a controversy with regards to the appropriate amounts of water required to achieve optimal hydration in the body. The tools that have been devised to measure the level of hydration in the human body are still controversial. Marcos et al. (2014) observed several variables including water balance, total body weight, and hydration biomarkers in their study that can be considered when measuring hydration level.

Despite the fact that most people understand the importance of drinking water every day, many groups in the population still do not consume sufficient water to meet their bodies’ needs (Sawka, Cheuvront & Carter, 2005). In order to understand the importance of proper water intake for maintaining health and healthy functioning of the body, many factors need to be examined in this context. These factors include identifying the importance of water as an essential daily beverage, as well as considering the needs of a particular subset of the population; in this study, college students, to assess interventions and other resources aimed at increasing the amount of water they drink on a daily basis. It is argued that making water more readily available and promoting education to help the general population understand the benefits of drinking water will result in increased overall water intake by all population sectors in general, and by targeted subset of the population, i.e., young college students, in the United States.
Water in the Human Body

According to Jéquier and Constant (2010), it is proven that regular and sufficient water intake is essential for the proper functioning of the human body. Water (fluid) is the primary component in the human body, serving as the foundation for human cells, as well as the body's vital tissues and organs. It is also noted that water has a number of different functions including helping to facilitate the transfer of nutrients, as well as the removal of waste by-products. In addition, water is used as a reactant, or lubricant, means to diffuse shocks to the body, and in the body's natural process of thermoregulation (Jéquier and Constant, 2010). Furthermore, water volume in the human body is considerably higher than other chemical compounds. On average, water composes 73% of the brain and heart, 83% of the lungs, 64% of the skin, 79% of the muscles and kidneys and 31% in the bones (Perlman, 2016). Infants have the highest water content of as it composes 78% of their body weight, which decreases to 65% by the first year of their lives to finally about 55% in the elderly. Considering the fact that fat in the adipose tissue does not have as much fluid as lean tissue of muscles, the male body is composed of 60% water (more muscular) compared to only 55% in the female body (Perlman, 2016). For an average young person, water makes up approximately between 50% and 70% of the individual's overall body weight. The entirety of the water in the human body is divided between the intracellular, inside the living cells, and the extracellular space. Given that the average male has roughly 42 liters of water in his body; 28 liters is typically located in the body's intracellular fluid, while 14 liters is typically found in the extracellular fluids (Sawka et al., 2005). This information clearly demonstrates the vital role of water in the body's normal functioning, metabolism and repair. Thus, there is a high health necessity for people of all ages to ensure
that their daily water intake levels are sufficient to support their health and the proper functioning of their body by maintain hydration and avoid dehydration.

_Hydration and Water Balance_

In their review titled “Water, Hydration and Health”, Popkin, D’anci and Rosenberg (2010) looked at consumer knowledge of water, consumption patterns, factors associated with consumption, and the mechanism controlling fluid homeostasis. They investigated the effects of different water consumption levels with regards to human wellbeing, weight and general performance. The researchers noted the significance of water for hydration as an inhibitor of caloric beverages; in other words, the increase in drinking water was associated with a decrease in drinking caloric beverages. Popkin et al. (2010) explained that most animals have evolved to possess a physiological control mechanism to preserve body water when it is needed and also by increasing fluid intake by feeling thirsty. This mechanism is mostly regulated by the kidneys which can quickly get rid of excess water or reduce the urine excretion to decrease water loss, in order to maintain fluid homeostasis.

Maintaining constant fluid and mineral balance in the body demands coordination of unique sensors at different locations that are connected by “neural pathways with integrative brain centers that analyze and send the information via neurotransmitters” (p6). The sensors also respond to hormones made by the adjustments of diuresis, blood pressure and natriuretic (Nicolaidis, 1988).

Physiological thirst occurs due to two mechanisms: the fluid control of intracellular and extracellular fluids (Popkin et al., 2010). The authors further noted that when water is lost, the concentration of ions rises. This causes the intracellular spaces to yield a portion
of its water onto the compartments of the extracellular space. Reduction in size of the cell then triggers the brain to send hormonal signals to provoke drinking. The link with receptors is accompanied by a heightened salt appetite. Individuals who sweat prefer drinks with a lot of fluid that includes sodium ions salts compared to plain water. It is therefore necessary, in some cases such as after excessive sweating, to supplement drinks with salt and/or other key minerals.

Individuals also consume water via other regulatory mechanisms. Although people experience thirst, it does not play any significant role especially in individuals living in temperate climates. People drink many different kinds of fluids including water to quench their thirst; fluid in foods, and beverages such as tea, coffee, juice and soft drinks, are additional examples of sources of water. In other cases, drinks are consumed due to their nutrient content in milk or certain soft drinks. This kind of intake is mediated via taste buds which convey information to the brain. Normally, individuals consume water or other fluid to rehydrate themselves and this is beneficial because it allows individuals to replace water that has been lost via sweat and urine and therefore stay rehydrated (Marcos et al. (2014)).
Dehydration

Dehydration refers to the process of water loss from the body. The importance of water during physical activity has been considered critical in research studies. Athletes lose a significant amount of body weight in sweat and therefore become dehydrated if the fluids lost are not replenished. Nonetheless, the decrease in physical activity of athletes has been noted when there is less hydration. Under mild levels of dehydration, persons involved in sport and those people under serious physical activity will experience reduced performance, increased fatigue, reduced motivations and even increased effort. Rehydration, on the other hand, helps reverse the aforementioned deficits and limit the oxidative stress brought about by dehydration and physical activity (Popkin et al., 2010).

Mild dehydration, or failure to replace lost fluids after physical activity or exposure to heat, can bring about changes in cognitive functioning and mood. This may be profound in young individuals, old people and those doing undertaking heavy exercises. D’Anci, Vibhakar, Kanter, Mahoney and Taylor (2009) explains that mild dehydration causes alterations in various crucial aspects of cognitive functioning including alertness, concentrations and memory in younger people between the ages of 10 and 12 and young adults between the ages of 18 and 25. Older adults aged 50 to 82 years also experience these alterations (D’Anci et al., 2009). Nonetheless, it is important to note the dehydration does not interfere with cognitive performance in a consistent manner, but was consistently associated with mood score, including fatigue, confusion, anger, and vigor (Popkin et al., 2010).

In a research study performed by Cian et al. (2000), participants were systematically dehydrated by approximately 2.8% by exposing them to heat and exercise.
In the study, performance was impaired on tasks assessing memory and visual awareness. While, another study by D’Anci et al. (2009) water restriction in conjunction with exercise was used to produce dehydration; they reported a small reduction in visual awareness in young individuals. In a similar study by Szinnai, Schachinger, Arnaud, Linder and Keller (2005), withdrawal of water alone over 24 hours showed no significant reduction in cognitive performance with a 2.6% dehydration. This indicates that heat stress is critical outcome of dehydration.

Intake of water following dehydration is said to reverse cognitive impairments arising from dehydration. Neave et al. (2001) analyzed how the intake of water influenced cognitive performance and arousal in younger individuals after a 12-hour period of water intake restriction. While cognitive performance was not influenced by the reduction of intake of water, drinking water impacted arousal. Subjects showed an increase in alertness after water intake. This study relates to a study conducted by Rogers, Kainth and Smit (2001), that reported a related rise in attentiveness after the intake of water both in high and low thirst levels in the studied subjects, which were divided based on their reported nine-point scale of thirst level. Rogers et al. (2001) concluded that not only dehydration status but thirst level was also associated with the mental performance of the subjects.

Lack of water has been associated with various other conditions such as headaches. Despite this observation being unexplored, some studies have reported that the deprivation of water can be a trigger for migraines. Blau, Kell and Sperling (2004) stated that when headaches arise as a result of water deprivation, intake of water is often able to successfully reduce headache between 30 mins to 3 hours. Although the intake of water has been reported to reduce headache, its intake has not been well documented to prevent headache.
Mineral Elements in Water

Surface water and ground water often contain inorganic mineral elements. These nutrients are essential and they are readily present in the earth’s crust. They are also highly soluble in water. Accordingly, the minerals are widely distributed in the aquatic environment based on geologic and hydrologic conditions. Treatment of drinking water which includes corrosion control and pH adjustment, also results in dissolution of certain mineral nutrients (Donohue, Abernathy, Lassovszky & Hallberg, 2005). The minerals include zinc, calcium, magnesium, phosphorous and sodium compounds. Copper and zinc can also leach from plumbing materials. Impurities such as paints and sand add chromium and selenium in the water. According to World Health Organization (WHO) website, water contributes to 1% to 20% of consumed trace elements and electrolytes which can be divided into three subgroups. First subgroup is essential elements which includes Calcium, Sodium, Potassium, Chlorine, Magnesium, Iron, Zinc, Copper, Chromium, Iodine, Cobalt, Molybdenum and Selenium. Second is beneficial elements such as, Fluorine, Boron, Manganese, Nickel, Samarium and Vanadium. Finally, the toxic group which consists of Lead, Cadmium, Mercury, Tin, Aluminum, Lithium and Arsenic (Olivares, n.d.).

In 2003, the U.S. Environmental Protection Agency (EPA) reviewed drinking water regulations in the country. The agency analyzed the concentrations of contaminants in the public water systems where researchers at the agency assessed minerals such as selenium, chromium, fluoride, manganese and sodium (Donohue al., 2005). The assessment results were then used to provide additional evidence on the extent of mineral exposure over potable water in the United States. In areas where freshwater resources are scarce, desalination and demineralization of drinking water is heavily practiced.
Unfortunately, desalination which includes flash evaporation or reverse osmosis, depletes the mineral content in the treated water.

Potassium and sodium are the principal electrolytes in controlling intracellular and extracellular mechanisms, respectively, during sweating (Donohue et al. 2005). The balance between the two minerals is crucial in the diffusion of impulses across the cell membrane. Sodium levels in the serum also help in maintaining the osmotic pressure within mammalian cells. Sodium is widely distributed in all sources of water, in surface and ground water. However, the concentration in the water is less than that required in the diet. Surface water contains a smaller amount of sodium compared to ground water. Donohue et al. (2005) study which assessed drinking water in five states namely: Alabama, California, Oregon, New Jersey and Illinois by the EPA, concluded that other than California, 90% of the population in the other states had drinking water with sodium less than 60mg/L. In California, only 23% of the samples recorded the same results.

**Sources of Water in Human Diet**

According to Popkin et al. (2006) about 20% of water comes from food, so Adequate Intakes (AIs) for fluids including plain water and other beverages should be in the range of 3 liters per day for men and 2.2 liters per day for women. It is important to note that these levels are subject to change due to several factors including engaging in intense physical activity or exposure to significant levels of heat stress and sweating. Without these conditions, the majority of adults can meet their daily water intake needs by adhering to the quantities outlined above. Despite the fact that the majority of adults need a substantial amount of water every day in order to support their overall body functioning, many demographics in the North American population are not consuming enough water
based on the appropriate guidelines (Sawka Cheuvront and Carter, 2005). Moreover, the problem appears to be particularly pronounced in North America. On the contrary, research from France has shown that plain water tends to be the primary fluid taken by all groups in the population, regardless of their age (Bellisle, Thornton, Hébel, Denizeau & Tahiri, 2010). Such findings suggest that different population groups in North America may need to be targeted for intervention that is designed to improve education and emphasize the need for greater daily water intake especially among young individuals and older adults. It is important to note that patients with kidney or heart failure are an exception, due to their bodies inability of getting rid of excess water.

**Fluids, Beverages and Water**

Fluid in the human body comes from all the beverages that we drink and the food that we eat. In the present study of this thesis, fluids are referred to as “Total Water” that is obtained from all sources. Age, gender, activity level, weather temperature or pregnancy determine the needs of fluids by each individual. Examples of fluids are water, fruit and vegetable juices, milk, soft drinks, tea and coffee, broth and soups and sports drinks. On the other hand, beverages are all potable liquids including water. Specifically, sugar-sweetened beverages (SSB) are caloric drinks with added sugar such as fruit drinks, soft drinks, energy drinks and vitamin water. While, water is a clear colorless, tasteless, odorless liquid that may appear in different states such as solid ice or gas vapor. Chemically, water is compound that consists of two hydrogen atoms and one oxygen atom H\(_2\)O. As mentioned by Milly, Dunne and Vecchia (2005), availability of water on earth is essential for several reasons such as “economic, geophysical processes, ecosystem function and for human health” (p134), which is the focus of this paper.
The required amount of water by the body can be supplied by various beverages such as fruit juice, tea, milk and soft drinks. However, observing their nutritional values and their effect on general wellbeing and health status is critical and therefore, one must practice a healthy pattern of drinking water (Ryan, 2012). In fact, teenagers and young adults tend to be vulnerable to develop unhealthy conditions that predispose them to health risks based on the type of beverages consumed. A study by Gibson (2008) that tracked the intake of soft drinks found that young people tend to get used to consume one drink and continue to consume it into adulthood. This shows that the habits and the type of beverage consumption acquired during early years can have strong impact on the choice of beverage consumed later in life.

Popkin, Armstrong, Bray, Caballero & Willett (2006) findings suggested a beverages guidance panel, called six levels pitcher (Figure 1), which demonstrates how beverages are divided into six different levels based on their nutritional benefits. Level 1 is water, which is the preferred beverage that should be consumed most frequently by humans to fulfill their body fluids' needs. Popkin et al. (2006) agreed that because water requirements differ between individuals, Estimated Average Requirement (EAR) is not available for water. Instead, Adequate Intakes (AIs) for water was established based on usual intake of females and males assuming that 80% of the fluids or total water intake comes from beverages and 20% of the intake comes from foods. They also recalled that fluids had minimally contributed to the Recommended Dietary Allowance (Institute of Medicine, 2007) of the essential nutrients in with an exception to milk and fruit juices.
Level 2 is tea and coffee, which are very popular beverages providing flavonoids, antioxidants and other nutrients and can be calorie-free drinks, if consumed plain. Level 3 is low fat 1%-1.5% or nonfat skim milk and soy beverages, because of their contribution to bone health such as calcium and vitamin D when the milk is fortified. Level 4 is non-calorically sweetened beverages which are calorie free because they are sweetened with artificial sweeteners such as aspartame, saccharin, sucralose or stevia (Healthy Beverage Guidelines, 2015). Level 5 is caloric beverages with some nutrients, including 100% fruit juices, vegetable juices, whole milk, sports drinks and alcoholic beverages. Finally, Level 6, which is calorically sweetened beverages are the least recommended beverages due to their increased caloric value and decreased the nutritional value. This level includes carbonated and noncarbonated beverages that are sweetened with sucrose or high fructose corn syrup (e.g. soft drinks and juice drinks) (Popkin et al., 2006). This beverage guideline clarifies that water is the preferred and, recommended beverage over all other different types of beverages.
Fluids (Total Water) Balance

For a healthy population, the balance of fluid in the body is sustained through many physiological mechanisms; thirst is largely feedback regulated and controlled by the peripheral and central nervous system. Nevertheless, voluntary water consumption is a behavior arising due to various social, psychological and environmental influences (Balaghi, Faramarzi, Mahdavi & Ghaemmaghami, 2011). Conditions such as temperature and medical situations that also influence levels of thirst should be considered, taking into account that individuals consume water and beverages for other reasons, especially hedonic ones.

As established by Balaghi, et al. (2011), the water balance in the human body can be estimated by examining both input or water intake and output or water loss during a given period. Total water includes the water consumed from foods and beverages. Water consumptions from drinks and food are normally examined using records of diet and total water that is acquired from the food intake databases. Vegetables and fruits make up the largest sources of water from solid foods besides juice and soup after pure water consumption. However, it is important to note that the proportions vary significantly with regards to the diet patterns and climate conditions. Consequently, individuals who live in regions where temperatures are high for more than five months, increased hydration may be experienced and sodium replacement should be considered.

According to Marcos et al. (2014), the 24-hour urine volume is used to determine fluid output, water retention or kidney clearance particularly in hydration studies. Moreover, changes in body weight serve as accurate indicators of the balance of water
when assessed regularly, thus reduction in the total body weight are often as a result of shift in total body water (Marcos et al., 2014).

**Superiority of Plain Water Over Other Beverages**

Plain water offers substantial benefits compared to other beverages, especially sugar-sweetened beverages, as it is necessary for metabolism, proper physiologic functions and provide essential minerals such as calcium, magnesium, and fluoride (Popkin et al., 2006). Furthermore, water is abundant, refreshing, and calorie-free, fulfilling bodily needs, replacing fluids loss and preventing dehydration (Healthy Beverage Guidelines, 2015). All human beings require a certain amount of water to maintain health and ensure proper body functioning (Lee, Shin & Song, 2016). While water plays a crucial role in active tissue within the human body in general, conversely, sugar-sweetened beverages may contribute to a variety of adverse health effects, including type 2 diabetes (DM2), obesity, and increased risk for cardiovascular disease (Malik, Popkin, Bray, Despres & Hu, 2010) In both adults and children, increased consumption of sugar-sweetened beverages is linked to weight gain over time (Malik, Schulze & Hu, 2006). Furthermore, the literature notes that sugar-sweetened beverages are the most significant source of added sugars found in the standard American diet. In guidelines provided by the American Heart Association (AHA), the recommended intake of added sugar should be limited to between 100 and 150 kcal a day for the majority of the population. Pure water thus has a range of significant advantages over sugar-sweetened beverages. Thus, the United States Food and Drugs Administration (FDA) has established a mandatory section in the new nutrition facts label (food label) to include “Added Sugar” section under below “Total Sugars” which should be adopted by
all foods’ manufacturers as soon as June 2018 or by June 2021 at the latest (Labeling and Nutrition, 2016). Human beings of all age groups have strong reasons for avoiding sugar-sweetened beverages, as well as compelling reasons for ensuring their daily plain water intake meets recommended levels.

**Recommendations**

*Recommended Daily Water Intake for Adults*

Recommendations of total water intake are available based on an estimation of average human body needs, but only a relatively small number of published studies have investigated individuals' levels of water intake to as recommendations (Gibson and Shirreffs, 2013). In recent years, advisory panels such as The Institution of Medicine (IOM) and The United States Department of Agriculture (USDA) have put forth recommendations for daily water consumption, which is preferred over other beverages. This recommendation is trying to counteract the growing obesity epidemic by reducing energy intake and promoting better health in the United States (Popkin et al., 2006).

The literature noted that while adult water consumption guidelines tend to vary depending on the individual's lifestyle and overall health; nevertheless, common guidelines have been established for the vast majority of healthy adults. The Institution of Medicine (IOM) has established Dietary Reference Intake (DRI) for nutrients including water based on Adequate Intakes (AIs) levels. The AIs are defined as the recommended average daily nutrient intake, based on experimentally derived approximations of observed mean nutrients intake by a group (or groups) of healthy individuals. The published Dietary Reference Intake (DRI) 2005 of AIs for total water intake for the majority of adult men
every day found to be at least 3.7 liters. Conversely, the majority of adult women requires 2.7 liters of total water every day (Dietary Reference Intakes for Water, 2005).

Le Bellego et al. (2010), discussed the available recommendations of plain water in United Kingdom, France, Mexico, Australia and New Zealand, Canada and United States, and World Health Origination (WHO). They clarified that the existing advices for sufficient plain water intake are derived from surveys of national consumption. In these surveys, mean and median values are calculated which is significant due and offers exact reference values. Nonetheless, as established in these findings, there exist a myriad of circumstances where such reference values are not applicable; e.g. during the specific physiological stages including growing children, pregnant and lactating mothers and elderly, and also in nations where the fluid intake survey has not been done.

Guidelines for Water Intake:

Chapter two of the 2015-2020 Dietary Guidelines stated that “When choosing beverages, both the calories and nutrients they may provide are important considerations. Beverages that are calorie- free—especially water—or that contribute beneficial nutrients, such as fat-free and low-fat milk and 100% juice, should be the primary beverages consumed” (p61). It also preferred to replace sugar sweetened beverages with plain water to reduce the added sugar in the diet (US Department of Health and Human Services, 2017). Considering the importance of water and the general public noncompliance with the recommended levels, these guidelines is considerably insufficient.
Adults who are healthy tend to stay hydrated and very precisely regulate their water balance; however, it is noted that the elderly and young populations may have much more difficulties in maintaining this balance (Jéquier and Constant, 2010). Some diets offer individual guidelines for the timing of consumption of water with meals as a means to both ensure sufficient daily water intake, as well as to prevent over-eating. De Castro, (1988) research findings have demonstrated that there is a clear link between the amount of drinks consumed and the amount of food ingested by individuals. Thus, many diets instruct followers to schedule their drinking of water with meals so as to limit their food consumption and prevent overeating. In addition, these kinds of guidelines are useful to help ensure that individuals who may not get sufficient amounts of water every day, are drinking the quantities of water that are complying with guidelines for maintaining health and the proper functioning of the body.

**Assessment of Water Intake and Drinking Patterns**

The routine of water consumption is more complicated than the routine of food intake. Consequently, the assessment of water intake is a relatively new concept in diet studies and there exists a need for advanced methods of dietary assessment especially with respect to water intake. Water output on the other hand, including the fluid losses via sweat, stool, urine, as well as other insignificant losses from non-sweating perspiration and respiration should be considered.
Assessment of Water Intake Among Different Age Groups in the United States

According to Drewnowski, Rehm, and Constant (2013a), available data in the United States has shown significant differences in total daily water intake among adults in various age groups and demographics. This study data was collected from National Health and Examination Survey (NHANES) by way of two 24-hour dietary recalls for the majority of participants for the following years: 2005-2006, 2007-2008, and 2009-2010. Drewnowski et al. (2013a) classified beverages into nine groups, water (bottle/tap), milk or flavored milk, 100% fruit juices, regular or diet soda and soft drinks, fruit drinks, sport/energy drinks, coffee, tea and alcoholic beverages. In the analysis, National Cancer Institute (NCI) methods were used to calculate the total water, plain water, and water from beverages. The results revealed that approximately 78% of all adults consume plain water on a daily basis and that the average adult intake of water equals 1,138 mL. These results are consistent with Malik et al. (2010) which noted that water and other drinks accounted for between 75% - 84% of all of the dietary water consumed on a daily basis.

Moreover, Drewnowski et al. (2013a) reported that younger adults between 20-50 years of age consumed more plain water (1294 mL, 37.1%) than adults 51-70 years (1020 mL, 32%) and older adults ≥71 years (669 mL, 30.1%). Furthermore, the results showed that plain water, including both bottled (44%) and tap water (65%), accounts for just 30%-37% of all the water consumed by American adults on a daily basis. On the other hand, this study indicated that socioeconomic status is strongly associated with beverages consumption, in which adults with higher income consumed more water as a beverage than adults with lower income. They also reported that race/ethnicity did not affect water intake, whereas other race or mixed-race group consumed the most beverages.
Drinking patterns have been found to be correlated with age, race/ethnicity and income. For example, younger adults, Hispanic (Mexican American) or higher income adults consumed more bottled water, while gender did not have any effect on tap/bottled water. It was noted that plain water, soda, alcoholic drinks and fruits drinks intake decreased with age, while coffee, tea, and total water increased with age (Drewnowski et al., 2013a).

It is worth mentioning that there are fundamental differences in proportions of plain water, water from beverages, and water moisture in food – which represents total water intake – across different age groups. First, adults aged 20-50 years consumed 37% plain water, 17% moisture in foods and 46% water from beverages and, while soda (13%) accounted for the majority of the total followed by coffee (8.5%) and alcohol (8%). Second, adults aged 51-70 years consumed 30% plain water, 27% moisture in foods, and 52% water from beverages, of which coffee represented 16%, soda 10%, tea 9% and alcohol 5% of the total water consumed per day. Third, adults ≥71 years consumed 30% of plain water, 27% from moisture in foods and 46% water from beverages, whereas contribution of coffee (18%) to total water was the highest, followed by tea (7%), soda (6%) and alcohol (2%) (Drewnowski et al., 2013a).

The study also compared the total water intake with IOM AI values and found that, for adults between 20-50 years, 42.7% of men and 40.6% of women failed to meet IOM AI values. However, among adults aged 51-70 years, 59.1% of men and 44.9% of women, and among adult of age ≥71 years group, 92% of men and 82.6% of women failed to meet the recommended values, suggesting that females had a better compliance with IOM AIs compared to males.
Finally, when the total energy intake was calculated, younger adults consumed on average 2437 Kcal, middle age individuals consumed 2061 Kcal/ day and older adults consumed 1643 Kcal/ day, which clearly indicates that the daily energy intake is inversely correlated, with energy intake decreasing as age increases. (Drewnowski et al., 2013a)

Drewnowski et al. (2013a) showed that younger adults tend to have higher levels of daily water intake, and that their intake typically comes close to the recommended Adequate intake AIs. Among older men and women, however, daily water intake often fails to meet the levels of Dietary Reference Intake DRI (Adequate Intake AI). Moreover, Bellisle et al., (2010) study found that 83% of the female subjects and 95% of the male subjects were not meeting their daily recommended water intake levels. These findings suggest that more efforts must be done to encourage older adults to consume more water, as a measure for maintaining overall health and wellness.

Additionally, investigating water intake among children in the United States has yielded important findings. The results showed that the majority of children in the United States did not get sufficient daily water intake compared to the established recommendations for their age group (Drewnowski, Rehm & Constant, 2013b). Moreover, much like adults in the United States, higher levels of daily water intake were associated with higher levels of income (Drewnowski et al., 2013a). However, the research found that unlike adults in the United States, there are serious deficiencies in intake when compared to the recommended levels among all groups of U.S. children. These findings suggest that more studies are needed to investigate the causes of the low levels of water intake among children in the U.S. Efforts to promote increased daily water intake should focus on all
population groups, particularly among those from lower socioeconomic backgrounds due to their increased risk of insufficient fluid intake (Drewnowski et al., 2013b).

Assessment of Beverages Intake of Different Age Groups

A systematic review of multiple publications and studies of fluid intake from beverages was done from the years 2000 to 2013. The study reported that total beverage intake among all three age groups: children, adolescent, and adults, was in the range of 600 - 3500 mL per day in both genders. Among adults, tea, coffee and alcoholic beverages intake found to be higher than the other age groups, while plain water intake contributes to 80% of the beverages consumed. These findings indicated that plain water consumption by adults is considerably higher than children’s plain water intake and adolescents’ plain water intake; 58% and 75%, respectively (Özen, Bibiloni, Pons & Tur, 2015). Indeed, similar findings were reported by Lee et al. (2016).

Furthermore, Lee et al. (2016) other group of researchers found that like in the U.S., daily water intake was associated with factors like socio-demographic status. Another study indicated that water intake was linked to the individual's immediate surroundings and their choices of where to eat (Jéquier & Constant, 2010). Moreover, the data indicate that the average consumption of daily water intake among adults in Korea is comparable with adult daily intake levels in China and Japan, but slightly lower than that observed in Western countries. Researchers have also found a link between water intake and energy intake, noting that for every 100 kcal of energy consumed a day, water intake through both drinks and solid foods had increased (Lee et al., 2015). These findings show a positive relationship between energy intake and water intake in patterns similar to those observed in Western countries.
Park, Blanck, Sherry, Brener and O’Toole (2012) investigated the factors associated with decreased drinking water among a youth representative youth sample. They found that factors are poor diet, physical inactivity, frequent fast food intake and obesity. An assessment of 16,275 adults’ total fluids intake in thirteen countries concluded that there is an insufficient daily intake of water. Maintained records of total fluid intake across several different countries from three different continents including Latin America, Europe, and Asia, revealed that while women and men in the same country tended to have comparable levels of daily water intake, intake levels varied considerably by the individual country in question. Results showed that Germany had the highest fluid intake of 2.47 liters per day, while Japan had the lowest fluid intake of 1.5 liters per day. The median of total fluid intake of the thirteen countries was 1.98 liters per day. Indeed, about 9% of the population consumed less than 50% of the recommended Adequate Intake level established by European Food Safety Agency (EFSA). About 40.5% consumed between 50-100% of the recommended level, and 50% consumed more than the recommended levels. Furthermore, of all the population, 40% of men and 60% of women complied with the recommended levels, while individuals older than 50 years contribute to the biggest non-compliance to (AIs) in this age group (Ferreira-Pêgo et al., 2015). It is important to remember that European Food Safety Agency (EFSA) recommended adequate intake for water is 2 Liters per day for females and 2.5 Liters per day for males (EFSA Panel on Dietetic Products, 2010), which is about 10% less than the total water intake recommended by the Institute of Medicine. These differences in the recommended daily values can partially explain the elevated average intake of total water in the European countries.
Onufak, Park, Sharkey & Sherry (2014) identified the effect of perception of tap water cleanliness and safety on the consumption of sugar sweetened beverages and plain water. Among the 3787 adults’ responses, 13% agreed that the tap water was unsafe to drink, while 26.4% agreed that bottled water was safer to drink. These findings were strongly affected by demographic variables such as age, income, education, region and race/ethnicity in particular. Twice as many Hispanic individuals believe that tap water is unsafe to drink. About 45% of the Hispanics who agreed with the unsafety of tap water, reported the consumption of a minimum of 1 sugar sweetened beverage per day. On the other hand, Hispanics, blacks and non-Hispanic of other races who agreed with the unsafe conditions of tap water, found to be more susceptible to consume a maximum of one glass or bottled of plain water. In general, this study suggested that the perception of the safety of tap water may encourage the consumption of sugar sweetened beverages especially among Hispanics, and discourage consumption of plain water mainly among Hispanics, Blacks, and non-Hispanic other races. In other words, the plain water intake can be influenced by the perception of its safety among different demographic groups.

**Beverages Drinking Patterns**

Popkin (2010) studied the patterns of beverages use across the lifecycle, to evaluate the change of beverages intake patterns between the past and present among adults and children in the United States. The study noted that while the number of beverages categories is considered limited, the number of the new beverages introduced every year in the last 50 years is far higher than the mostly sugar sweetened beverages (SSB), caffeinated drinks or both. The data was collected from various national food intake surveys in the U.S., including Nationwide Food Consumption Survey (NFCS), Continuing
Survey of Food Intake by Individuals (CSFII), National Health and Nutrition Examination Surveys (NHANES) between the years 1977 to 2006. A marked change in milk consumption was observed with a shift towards the consumption of low fat milk. There was also notable shift in the intake of beverages among young individuals aged 2 to 18 years with an increase in sugar sweetened drinks, a rise in juice consumption and a reduction in the intake of milk. The study recorded an increase in the intake of sweetened drinks and juice intake that called for the need to address the public on healthy fluid intake (Popkin, 2010).

Ha, Park, Choi and Cho (1999) on the other hand, conducted a similar study to examine the consumption of beverages in relation to food in young Korean population. The study involved 135 subjects who answered questionnaires and recorded intake of food and liquid for three days. The chosen beverages were dairy drinks, carbonated drinks, sport drinks and fruit juice among others. The beverage taken most frequently by the participants was coffee. The consumption of beverages contributed to the intakes of vitamin B2 and calcium more than any other nutrients. Ha et al. (1999) concluded that it is important to guide young individuals on the right beverages to consume and balanced intake of critical nutrients.

*College Students Drinking Habits*

A study by Block, Gillman, Linakis and Goldman (2013) indicated that despite the importance of water, many groups in the North American society do not get enough to support their body’s healthy functioning. One group that may consistently fail to get sufficient levels of daily water intake is college students. In terms of their overall drinking habits, college students tended to choose their drinking beverages on the basis of their cost,
as well as taste factors, rather than the nutritional information associated with a particular
drink. These findings suggest that college students may be particularly at risk due to their
lack of sufficient water intake, as well as a lack of understanding regarding the need to
adhere to guidelines regarding daily water intake. Block et al. (2013) also suggested that
taste of the beverage and price point tend to be the most important factors affecting the
decisions made by members of this population.

It is also noted by Attila and Çakir (2011) that consumption of sugar-sweetened
beverages, such as energy drinks, is higher among members of this population. College
students may vary in terms of their reasons for drinking energy drinks. Noted reasons
include staying awake, improving performance when engaged in athletics, as well as for
mixing with alcoholic drinks. Despite the fact that consumption of these beverages among
college students is relatively common, many students were unable to comment on their
negative health effects, or even report their ingredients. College students also tend to
consume a significant number of alcoholic beverages, with an average of 65 % drinking
alcohol in a given month (White and Hingson, 2014). Roughly, 36 % of college students
also engage in binge drinking or the consumption of more than five drinks in a single sitting
(White and Hingson, 2014). This information suggests that college students may not only
fail to get enough water as part of their daily diets, but they may also consume excessive
amounts of unhealthy drinks, including alcoholic drinks and sugar-sweetened drinks,
without necessarily having a complete understanding of their adverse health effects.

Another concern among college students is the habit of drinking alcohol mixed with
energy drinks (Brache and Stockwell, 2011). This mixture is believed to have serious
adverse consequences including increased risks of being a heavy drinker in the future, drinking while driving and consequently suffering from injuries.

**Water Intake and Health**

*Water Intake and Diet Quality*

Gazan, Sondey, Maillot, Guelinckx & Lluch (2016) have found that the daily intake of water is associated with a higher quality of diet in France. Researchers found a link between an individual's daily water intake and the quality of their overall diet. In this study, diet quality was assessed with the use of different nutritional standardized measures for assessing diet quality. These assessment tools are Mean Adequacy Density (MAD), Mean Excess Ratio (MER), Probability of Adequate Nutrients Intakes (PANDiet), and Solid Energy Density (SED). The researchers concluded that higher diet quality is associated with more water intake for both women and men. However, the association found to be independent of socioeconomic status for female participants only. These findings suggest that water intake can be influenced by a variety of factors and have an important link to overall diet quality.

It is also important to note a potential link between water intake and the diet consumed by an individual. Kant, Graubard and Atchison (2009) investigated total water intake, meal patterns and body weight among US adults and noted some important links between the individual’s diet and the amount of water consumed on a daily basis. Results showed that the intake of plain water is negatively linked to energy-dense foods, as well as beverage moisture. In other words, the consumption of sugar sweetened beverages, along with the consumption of energy-dense foods may be linked to a reduced daily consumption of plain water in the individual. This shows that drinking water might positively affect the
diet through a reduced reliance on energy-dense foods, as well as beverages other than water, including sugar-sweetened beverages or alcoholic drinks. When individuals get more plain water as part of their daily regimen, they are less likely to choose other unhealthy beverages, and less likely to overeat (Kant et al, 2009). Given the role that sugar-sweetened beverages can cause serious health issues such as obesity and type 2 diabetes (DM2), promoting plain water intake might be a good way to positively impact the diets of many among North Americans. Making water more accessible, especially to college students, might be a good way of promoting additional water intake and promoting optimal health among this population group.

**Water intake and Weight Loss**

In a study by Boschmann et al. (2003), it was found that drinking enough water is associated with weight loss. Results obtained from short-term controlled experiments indicated that drinking water encourages weight loss. Drinking plain water, as noted by the researchers, increased the use of energy and the rate of lipolysis in the body. In this case, lipolysis refers to the breakdown of lipids and fats by use of water (hydrolysis). Consequently, they established that consumption of water in place of caloric drinks decreases the total intake of energy by reducing respective calories. The findings were echoed by Almiron-Roig and Drewnowski (2003) who stated that the absolute increase in water intake could promote loss of weight by modifying the metabolism. Similarly, a study was conducted by Stookey, Constant, Popkin and Gardner (2008) in order to investigate whether the consumption of water is linked to loss of weight in female participants who were overweight and dieting. The study used the Weight Loss A TO Z intervention to
assess whether an increase in the consumption of water was linked to reduction in weight over a period of one year. The study examined the effect of increased water consumption and the outcomes of substituting caloric beverages with consumption of water. Results indicated that the relative and absolute increases in water consumption were linked to significant weight loss. In this light, Stookey et al. (2008) concluded that water consumption may lead to weight loss in females who are overweight and on a weight reduction diet.

A similar study by Vij and Joshi (2014) examined the effects of excess water consumption on body weight and appetite of female subjects who were overweight. The researchers tested the consequences of drinking one and a half liters of water more than usual. The study involved 50 overweight women participants required to consume 500 mL of water 3 times daily. This was to be done 30 minutes before breakfast, lunch and supper. Vij and Joshi (2014) concluded that consuming 1.5 liters of water than normal led to a reduction in weight and reduction of appetite in overweight women.
Water intake and Daily Energy Intake

Although there is a paucity of the studies investigating the relationship between daily water intake and energy intake, it has been noted that there is a potential connection between these two factors. Daniels and Popkin (2010) indicated that adults who consumed sugar sweetened beverages compared to water before a single meal tended to have higher levels of total energy intake. These findings showed that greater intake of plain water over sugar sweetened beverages is indirectly associated with lower intake of energy. Overall, these findings suggest that increasing daily intake of water may be important for preventing obesity and other health related problems.

Moreover, Shamah-Levy, García-Chávez and Rodríguez-Ramírez (2016) studied the association between plain water, sugar sweetened beverages and total energy intake among school age children between 5-11 years old in Mexico. They found that the high plain water intake and low sugar sweetened beverages intake was associated with lower consumption of total daily energy. Consequently, low plain water intake and high sugar sweetened beverages intake was associated with higher total energy intake. This change in the energy intake can be explained as replacing the calories obtained from the high caloric beverages by zero calories obtained from the plain water. Again, these findings suggested that there is an inverse correlation between water and energy intake. In general, these studies indicated the association between consuming sugar-sweetened beverages over water, and increased total daily energy intake. These findings indirectly propose a link between consumption of plain water or unsweetened beverages and a potential decrease in total daily energy intake levels.
Two additional studies provide intriguing findings. The first one was done by Kant et al. (2009) and examined the association between water intake and dietary characteristics, meal consumption, and body weight among US adults. The study reported that the average adult’s consumption is 3.18 liters per day of total water intake in which plain water and other beverages contributes 33% to 48%. Dietary energy intake found to be unrelated to plain water intake, correlated to the moisture content of food, beverages, and total water. Additionally, the second study conducted by An and McCaffrey (2016) examined plain water consumption in relation to energy intake and diet quality among US adults reported different findings. This study concluded that with 1% increase in daily plain water consumption is associated with 8.5 kcal reduction in the mean daily energy intake, this effect was similar among sociodemographic variances such as race, education, income, and Body Mass Index (BMI) except for gender and age.

These two conflicting findings of the relationship between plain water and daily energy initiated the present investigation. Therefore, purpose of this study is to investigate the plain water (pure water) and total water (sum of pure water, water from beverages and water in foods) intake levels among college students specially in one geographic location compared to the recommended Adequate Intakes (AIs) values and to identify their correlation to the total calories consumed per day.
Research Questions

The research questions of this study are:

I. Do college students follow the recommended daily water intake by Adequate Intakes?

II. Is there a relationship between daily water intake and daily energy intake?

- H₀: College student plain water intake does not meet Adequate Intakes (AIs).

H₁: There is a negative correlation between plain water intake and daily energy (Calories) intake, that means an increase of plain water intake (mL) may reduce the daily energy intake (Kcal).
Methods

Sample Selection

Participants were recruited using convenience sampling, of which participants were undergraduate and graduate level students at Montclair State University in Clifton in Montclair, New Jersey in the United States. They were healthy (disease-free) adults between 18 and 32 years of age.

Recruitment

Participants were recruited by emails, flyers and in person plea (Appendix I: Recruitment Material). The emails were sent multiple times to seek volunteers through the listserv by the Department of Nutrition and Food Studies, College of Education and Human Services, and The Graduate School. The flyers were distributed in different places at Montclair State University (MSU) campus. An incentive of $10 was given to every participant who answered the online survey and submitted two 24-hr dietary recalls. Another $100 was assigned to a single participant who was randomly picked at the end of the study.

Pilot Study

A pilot study was conducted on a group of participants to obtain feedback and improve the study design. Five participants were asked to submit one dietary recall using a web-based tool called Automated Self-Administered 24-hour (ASA24®), and their feedback was assessed. Based on the reported comments, few modifications were added. First, the recall period was extended to 36 hours instead of 24 hours, as respondents noted that the website was locked before they finished reporting. Second, a note was added to the consent and form to ensure the data entry will be locked at 12 am on the same agreed day. Moreover, a detailed study procedure and thorough instructions were sent by an email when the students
expressed interest in participation prior to students' approval to participate. The pilot study initial data and results were not included in the analysis of the results.

**Ethical Considerations**

The principal investigator, the co-principal investigator, and the primary investigator are Collaborative Institutional Training Initiative CITI trained with current certification. The study was approved by Montclair State University Institutional Review Board (IRB-FY17-18-702), including the recruitment email, the flyer, the in-person plea, the consent form and the survey (Recruitment Material in Appendix I). All participants provided their informed consent form before submitting the survey and the 24hr dietary recalls, and all data obtained were kept confidential and stored in a password-protected file.

**Study Design**

The study included two stages; first answering an online survey and second submitting two online dietary recalls. When participants expressed their interest in the research by responding to the recruitment email, they received a reply by an email and were asked to read the illustrated study procedure before the agreement to proceed with the participation. Different steps of the study procedure were explained and listed of which the first step included a link to the consent form and the survey, and all participants were encouraged to read the consent form before approval to participate followed by filling out and submitting the two-minute long survey.

The second step stated that if the previous requirements were completed, the participants were asked to send an email to the researcher with their (CWID) in order to be provided
with their username and password to be used in the following step. By the end of this stage, an Excel spreadsheet contained every participant’s name, email, CWID, username, and password was updated and saved, which was used to follow up and record data of the participants required with the study progress. The third step included a link of the (ASA24®) respondents website, instructions on how to use it, the illustrated demo, and reminders about the data entry and submission session timings. The fourth step included an explanation of the food and drinks entries and specified portions that needed to be entered for both the weekday and the weekend. Finally, the final step involved sending an email to the researcher when all required steps are followed and done (Figure 2). On the other hand, the researcher kept continuous tracking of the survey results and the 24hr dietary recalls submission, which was assessed three times per week. Consequently, all participants received feedback and follow up emails when required and upon request.
The Online Survey

The survey was collected using Google Forms and included thirteen questions to assess demographics including age, Body Mass Index BMI (height and weight), gender (male, female or other), ethnicity (Hispanic, Black or African American, White, Asian, American Indian/Alaska Native, Native Hawaii/ other Pacific Islander, or other), and income. Additional questions assessed the activity level (extremely active; daily exercise that is equal to walking 4 hours or spending most of the day doing a heavy physical activity such as bike messenger, moderately active; daily exercise that is equal to walking 30-40 minutes, or sedentary; daily living activities only). Other questions measured participants’ college information, such as year (freshman, second year, third year, fourth year or other), major (to be specified), part or full-time, participation in the meal plan (yes or no) and Campus Wide Identification CWID was added to use it as a verification code for each student.

The Online 24hr Dietary Recall

The Automated Self-Administered 24-Hour (ASA24®) Dietary Assessment Tool was used to collect the two 24hr dietary recalls. ASA24® is a web tool that was developed by National Cancer Institute (NCI) in 2009 and continued upgraded and modified in 2016. The ASA24® is composed of two web-based applications, one for the researcher and another for respondent and used to collect dietary recalls or records. The researcher can create, modify, control and track the studies, while the respondents can only submit their intakes using usernames and passwords provided by the researchers. The application introduces the process to the respondents where every respondent first watched a demo to
illustrate the input steps, then entered his/her consumption of foods and drinks from midnight to midnight or starting from any time specified by the researcher within 24hr. Respondents can report their eating occasion, specify portions using a dynamic users interface which includes about 7 million entries and 10,000 images. The location, supplements, or if meals were eaten alone or with others can also be reported upon researcher preferences (Subar et al., 2012). At the end of the session, every respondent can view his/her intake report. (Appendix II: Intake Report Sample)

The researcher's website allows researchers to create, manage preferences, track and obtain analysis data of responses which uses USDA food codes. All intakes were analyzed to give daily energy intake (Kcal) and the exact micro and macronutrients obtained per one recall of every respondent and listed in an excel sheet that can be downloaded from the researcher website. (Appendix II: Respondent’s Individual Report)

In this study, the ASA24® was used to assess participants daily energy intake Kcal, daily water intake, and daily plain water intake. Each participant received a username and a password to be used on the website, while his/her recall was linked to the survey using their CWID. They had to complete a 24-hr dietary recall for a weekday, and another one for a weekend. The web-tool was opened for the participants’ recalls submission starting from November 2017 until February 2018. Participants were encouraged to finish their recalls within a week or two at the maximum using reminder emails. Once participant began to submit a recall for a specific day, the data entry kept open for 36 hours starting from beginning the recall session, and foods and drinks were allowed to be entered starting from 12:01 am until 11:59 pm of the same day. Upon completion of both the survey and the two 24-hr dietary recalls, the data obtained were retrieved in an Excel spreadsheet.
**Data Analysis**

By 15th of Feb 2018 a hundred and fifty-nine (159) students answered the online survey, and a total of a hundred and ninety-six (196) 24hr dietary recalls were collected. Thirty-two (32) recalls were excluded as the participants who submitted these recalls only submitted one out of the two required or submitted an unrealistic intake. Eighty-two participants submitted all survey and the two 24hr dietary recalls; one hundred and sixty-four 24hr dietary recalls, one participant was excluded during the data analysis due to the misinterpretation of data. A total of 81 participants were the final sample size of this study. Quantitative data including daily energy intake, total daily water intake, carbohydrates, total fat, protein, and alcohol was exported from Automated Self-Administered 24-hour (ASA24®) in an Excel Spreadsheet format.

Calculating the daily plain water intake was performed manually by analyzing the food items data tables obtained from ASA24®. Carbonated and noncarbonated plain water, flavored water, unsweetened or sweetened with low calories sweeteners water, plain coffee and tea of 5 kcal or less were counted as plain water. For every participant, the mean of daily energy intake (kcal), total water intake (mL), plain water intake (mL), carbohydrates (g), protein (g), total fat (g) and alcohol (g) were calculated and used in the analysis.

Data was analyzed using IBM SPSS Statistics 22.0 and tested using Pearson’s correlation, Eta squared, ANOVA and t-tests.

The relationship between the main variables which are the correlation between daily plain water intake (mL) and total daily energy intake (Kcal) and between daily total water intake (mL) and total daily energy intake (Kcal) were calculated using the Pearson correlation coefficient to assess the strength of a linear relationship between two variables.
In addition, Pearson’s correlation was also calculated for investigating the association between plain water intake and other demographic variables including age, gender, ethnicity, income, BMI, employment, income and between plain water intake and students’ college information such as major, year of education, participation in meal plan, part/ full time and in/off campus living status. Additionally, eta- squared was calculated to investigate the association between water and physical activity.

Analysis of demographics was assessed as follows. Mean, and the standard deviation was calculated for age, BMI and income, while frequency distribution was calculated for ethnicity, gender, employment and physical activity.

The t-tests for equality of means was calculated to measure if plain water intake differs between males or females, participation or nonparticipation in the meal plan, nutrition, food and health sciences majors or other majors, on campus or off campus, alcohol intake or no alcohol intake.

ANOVA was calculated to measure the difference of plain water intake between the various age groups (18-21 years, 22-25 years and 26-32 years), ethnic groups (Hispanic, Black/ African American, White, Asian, and other), BMI groups (underweight, normal weight, overweight and obese), year of education (freshman, second year, third year, fourth year and other).

Analysis of the Adequate Intakes (AIs) for plain water and total water for both males and females was assessed using ± 10% interval of the recommended intake. Accordingly, the recommended AIs of total water for males is 3700 mL ± 370 mL which is considered sufficient, while less than 3330 mL is considered below the intake and more than 4070 mL is considered more than the recommended AIs level. In females, the
recommended adequate intake of total water in 2700 mL ± 270 mL, of which less than 2430 mL is considered low intake and more than 2790 mL are considered high intake compared to the recommended AIs. Wherefore, the adequate intake of plain water in males is 3000 ± 300 mL, so less than 2700 mL is considered low intake and more than 3300 is considered high. On the other hand, the recommended Adequate Intakes (AIs) for females is 2200 ± 220 mL, and less than 1980 mL is lower than the recommendations, and more than 2420 mL is higher than the recommendations.

Analysis of the macronutrients obtained from the Automated Self Administrated 24hr (ASA24®) tables, such as carbohydrates (g), total fat (g), protein (g) and alcohol (g), was done by calculating the mean and standard deviation for all participants. The values in grams (g) were converted into calories (Kcal) by using the following conversions, for carbohydrates and protein the values were multiplied by 4, for total fat the values were multiplied by 9 and for alcohol the values were multiplied by 7. For each participant, the carbohydrates (Kcal), total fat (kcal), protein (kcal) and alcohol (kcal) values were added together to find the total daily energy (kcal). After that, the calculated total energy value (Kcal) calculated from the macronutrients was compared to the total energy intake (Kcal) obtained from the Automated Self Administrated 24hr (ASA24®), and the ratio, minimum and maximum values of each of the four components were estimated.
Results

Demographics:

A total of 81 participants between the ages of 18-32 years with mean ± SD 22.7 ± 3.35 years completed the study. The majority of the participants were females (75.3 %), while males sample was only one quarter of the population (25.7 %). The main ethnic group in the study was non-Hispanic white (51.9 %) followed by Hispanic (17.3 %), Black/African American (12.3 %), other ethnic groups (9.9 %) and Asian (8.6 %). About 63 % of the sample population had normal BMI range, while 21 % were overweight, 11 % were obese, and only 5 % were underweight. When participants were asked about their physical activity, most of them reported being moderately active (71.6 %), followed by being extremely active (17.3 %), and only 11 % reported having a sedentary lifestyle. About 60 % of the participants were employed, of which 75 % were working part-time, and the rest (about 25 %) were working full time. On the other hand, about 40 % of the students were unemployed. The mean income found to be $ 13,000 ± $ 17,656 of which many students did not have any income and the highest income was $ 65,000 (Table 1).
Table 1: Demographics (n= 81)

Analysis of physical activity by gender is shown in (Table 2). Physical activity was higher among males, of which 39% of the participants were extremely active compared to only 11% of females, whereas fewer males were moderately active; 44% compared to 76% among females. The percentages of physical inactivity were almost similar among both genders, 13% in females and 17% in males.

Table 2: Physical Activity Levels of Both Genders
Approximately half of the students’ participated in this study were health sciences’ majors including nutrition, food science, public health, exercise science, while the other half was non-health sciences majors. The majority of the students (42 %) were in their fifth year of education or more which included graduate students; whereas, first year students were only 10 % and the remaining 48 % almost equally represented second, third and fourth year students. Only 30% of the students participated in the university meal plan, and about 32% lived on campus compared to the other 68 % who lived off campus (Table 3).

<table>
<thead>
<tr>
<th><strong>Major</strong></th>
<th>Frequency (n= 81)</th>
<th>Percent %</th>
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<tbody>
<tr>
<td>Nutrition/ food/ Health Science</td>
<td>43</td>
<td>53 %</td>
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<tr>
<td>Non-Health Sciences</td>
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<td>47 %</td>
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<td>42 %</td>
</tr>
<tr>
<td><strong>Status</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Part time</td>
<td>10</td>
<td>12 %</td>
</tr>
<tr>
<td>Full time</td>
<td>71</td>
<td>88 %</td>
</tr>
<tr>
<td><strong>Participation in Meal Plan</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>24</td>
<td>30 %</td>
</tr>
<tr>
<td>No</td>
<td>57</td>
<td>70 %</td>
</tr>
<tr>
<td><strong>Living Arrangement</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>On campus</td>
<td>26</td>
<td>32 %</td>
</tr>
<tr>
<td>Off campus</td>
<td>55</td>
<td>68 %</td>
</tr>
</tbody>
</table>

Table 3: Students’ College Information
Assessment of Total Water and Plain Water:

The results of drinking plain water were strongly and positively correlated with total water intake ($r=0.92, p<0.001$). The analysis revealed that the plain water intake of all participants was $1577 \pm 1150$ mL (Mean ± SD), for females it was $1374 \pm 1002$ mL and for males $2183 \pm 1370$ mL. The total water intake for all participants was $2582 \pm 1300$ mL, for females $2351 \pm 1087$ mL and for males $3296 \pm 1623$ mL. There is a gender difference in the recommended Institute of Medicine (IOM) Adequate Intakes (AIs) levels for assessing total water intake, of which it is 2700 mL or men and 2200 mL for women. The number of males who drank plain water as per the suggested recommendations (20%) is double that of the females (9.8%) in this study. Furthermore, IOM AIs for the total water intake, which is 3000 mL for males and 2700 mL for females, found to have more below recommended intakes. Females who got less than the recommended daily intake of total water was 65% of the total female population compared to 60% for the general male’s population. About a quarter of females (25 %) were above the recommended level of total water intake, compared to only 20% for males (Table 4).

<table>
<thead>
<tr>
<th>Gender</th>
<th>Intake Level</th>
<th>Total Water Percent %</th>
<th>Plain Water Percent %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Females</td>
<td>Below Recommendations</td>
<td>65.6 %</td>
<td>82 %</td>
</tr>
<tr>
<td></td>
<td>Recommended Intake</td>
<td>9.8%</td>
<td>5 %</td>
</tr>
<tr>
<td></td>
<td>Above Recommendations</td>
<td>24.6%</td>
<td>13 %</td>
</tr>
<tr>
<td>Males</td>
<td>Below Recommendations</td>
<td>60 %</td>
<td>65 %</td>
</tr>
<tr>
<td></td>
<td>Recommended Intake</td>
<td>20 %</td>
<td>20 %</td>
</tr>
<tr>
<td></td>
<td>Above Recommendations</td>
<td>20 %</td>
<td>16 %</td>
</tr>
</tbody>
</table>

Table 4: Assessment Total and Plain Water Intake by Gender
Whereas, in assessing the adherence to the recommended plain water level it is found that male participants adhered more to the recommendations compared to females and the number of men (20 %) who drank the recommended intake was four times higher the number of females (5 %). Therefore, more females drink less plain water (82 %) compared to males (65 %). While, both women (13 %) and men (16 %) drink above the recommendations (AIs) of plain water (Figure 2). Overall, females drank less plain water compared to males even though both genders drank plain water less than what was recommended.

![Figure 3: Assessment of Total and Plain Water Intake by Gender](chart.png)
Assessment of Energy Intake:

The calculated daily total energy intake equals \(1838 \pm 616\) Kcal for both males and females. This total caloric intake can be divided into the following constituents: carbohydrates (852 \(\pm\) 312 Kcal), fat (674 \(\pm\) 283 Kcal), protein (341 \(\pm\) 182 Kcal) and alcohol (25 \(\pm\) 89 Kcal). Consequently, Carbohydrates make up the highest amount of total energy (46 %), followed by total fat (35 %), protein (18 %) and alcohol (1 %) (Figure 3).

![Figure 4: Macronutrients Percentage in Daily Energy](image-url)
The relationship between Plain Water/ Total water Intake and Daily Energy Intake:

*Energy Intake*

The results of this study revealed that drinking plain water is positively correlated (r=0.3) with daily energy intake with $P \leq 0.005$ (Figure 4).

![Figure 5: Scattered Plot of the Correlation Between Plain Water and Daily Energy](image)

Also, it was found that the daily energy intake (Kcal) was positively correlated (r=0.50) with total water intake (mL) with $p < 0.001$ (Figure 5). Furthermore, the results indicated that the plain water composes 42.5% of the daily total water intake for the whole study sample.
Alcohol contributed to the total energy intake, but alcohol intake was not correlated to the plain water intake ($r = 0.05, p = 0.64$). An independent t-test was used to analyze drinking plain water with alcohol intake. The participants then were divided into two groups no alcohol intake and alcohol intake groups. There was no significant difference between the scores for the no alcohol intake group ($N=68, M=1609 \pm 1152 \text{ mL}$) and the alcohol intake group ($N=13, M=1514 \pm 1093 \text{ mL}$); $t(79) = 0.93, p = 0.78$. These results suggest that alcohol intake does not have an effect on drinking plain water.
Water intake and Demographic Variables:

Age

Drinking plain water is not correlated with age (r= 0.03, p= 0.082). The ANOVA test was used to analyze drinking plain water with the age three groups; 18- 21 years, 22-25 years and 26- 32 years. The 18-21 age group was comprised of 36 students (M = 1481 ± 1063 mL), the 22-25 age group was comprised of 27 students (M = 998 ± 192.12 mL) and the 26-32 age group was comprised of 18 students (M = 1474 ± 348 mL). These group means were found to not be significantly different, F (2,78) = 0.33, p= 0.72 and they did not have any effect on drinking plain water.

Gender

A t-test was analyzed for gender and plain water intake. The plain water intake and gender was found to be significant (t (79) = 2.83, p=0.006). These results indicated that males consumed significantly higher plain water (M= 2351 ± 1087 mL) compared to females (M= 1374 ± 1002 mL). For total water, a t-test was preformed to analyze gender effect on total water intake. Results of t-test was found significant for gender and total water intake (t (79) = 2.96, p=0.004). These results indicated that males consumed significantly higher total water than females (3296 ± 1623 mL and 2351 ± 1087 mL, respectively).
Ethnicity

The findings of this study indicated that drinking plain water is not correlated with ethnicity ($r$=-0.05, $p$=0.60). A between subjects ANOVA was used to analyze drinking plain water with respect to ethnicity. The ethnicity was divided to a Hispanic group that was comprised of 14 students ($M = 1648 \pm 1144$ mL), the Black or African American group that was comprised of 10 students ($M = 1138 \pm 536$ mL), the White group was included of 42 students ($M = 1764 \pm 1304$ mL), the Asian group was comprised of 7 students ($M = 1503 \pm 766$ mL) and the other ethnicity group was comprised of 8 students ($M = 1252 \pm 937$ mL). These groups were found not be significantly different from each other, $F(4,76) =0.83$, $p=0.51$ and ethnicity did not have any effect on drinking plain water.

Body Mass Intake (BMI)

The relationship between BMI and plain water intake was assessed and it was found that drinking plain water was not correlated with BMI ($r= 0.0003$, $p= 0.99$). A between subjects ANOVA was used to analyze drinking plain water with the BMI groups. The groups are divided as underweight ($N=4$, $M = 2090 \pm 2641$ mL), the normal weight ($N=51$, $M = 1523 \pm 1023$ mL), the overweight ($N= 17$, $M = 1667 \pm 1049$ mL) and obese ($N= 9$, $M = 1455 \pm 1295$ mL) were not significantly different from each other, $F(3,81)=0.36$, $p=0.78$. The results suggest that the BMI groups did not have any effect on drinking plain water. It is worth noting that participants who are underweight have the highest plain water intake (2090 mL), while obese participants have the lowest plain water intake (1455 mL).
Physical Activity

Total water and plain water are correlated significantly with physical activity ($\eta^2_p = 0.29$, $p=0.009$ and $\eta^2_p = 0.28$, $p=0.01$ respectively). Age is weakly correlated with physical activity ($r=0.12$, $p=0.28$).

Figure 7: Simple Scatter with Fit Line of Total Water Intake by Physical Activity

Figure 8: Simple Scatter with Fit Line of Plain Water intake by Physical Activity
**Income**

Plain water intake was not correlated with income (r=0.09, p=0.39). An independent t-test was used to analyze drinking plain water with different income groups. There was no significant difference in the scores for the lower income group of $3000/year or less (N=57, M= 1568 ± 1120 mL) and the higher income group (N=24, M= 1655 ± 1197 mL); t (79) = -0.31, p = 0.68. These results suggested that income does not have an effect on drinking plain water. ANOVA test revealed no significant effect of income on plain water intake for the three conditions [F (3, 76) = 0.356, p = 0.785].

**Employment**

A between subjects ANOVA was used to analyze drinking plain water with the employment status: not employed, part time and full time. The ‘not employed’ group was comprised of 31 students (M = 1337 ± 203 mL), the part-time group was comprised of 37 students (M = 1728 ± 1083 mL) and the full-time group was comprised of 13 students (M = 1823 ± 1441 mL). These group means were found not to be significantly different, F(2,81) = 1.33, p = 0.27, therefore employment status did not have any effect on the consumption of plain water.
Water Intake and Students’ College Information:

Meal Plan

Plain water intake was not correlated with whether the participants were in a meal plan ($r=0.03$, $p=0.83$). An independent t-test was used to analyze drinking plain water with participation in meal plan. There was no significant in the scores for participating in a meal plan ($M=1550 \pm 1164$ mL) and not participating in a meal plan ($M=1612 \pm 1134$ mL) with $t(79)=0.22$, $p=0.83$. Specifically, these results suggested that participating in a meal plan did not affect drinking plain water.

Academic Major

Drinking plain water was not correlated with academic major ($r=0.04$, $p=0.74$). An independent t-test was used to analyze drinking plain water and the academic major. There was no significant difference in the scores for Nutrition/Food/Health Science major ($M=1554 \pm 1003$ mL) and other majors ($M=1638 \pm 1283$ mL) with $t(79)=-0.033$, $p=0.74$. Specifically, these findings suggested that the major does not affect drinking plain water.

On Campus/ Off Campus Living Arrangement

The plain water intake was assessed among students who live on and off campus and it was not correlated with either living arrangement ($r=0.05$, $p=0.68$). An independent t-test was used to analyze drinking plain water with living on or off campus. There was no significant difference in the scores for off campus ($M=1558 \pm 1141$ mL) and on campus ($M=1669 \pm 1145$ mL); $t(79)=-0.41$, $p=0.68$. These results suggested that living on or off campus did not affect drinking plain water.
Year of Education

The year of education was divided into three categories, 1-2 years, 3-4 years and ≥ 5 years. Drinking plain water was not correlated with year of education (r= 0.04, p= 0.72). A between subjects ANOVA was used to analyze drinking plain water with respect to years of education among the groups. These groups were found not to be significantly different from each other, F (4,76) =0.15, p=0.96. The freshman group was comprised of 8 students (M = 1555 ± 1169 mL), the second year group was comprised of 12 students (M = 1584 ± 1342 mL), the third year group was comprised of 12 students (M = 1544 ± 1094 ml), the fourth year group was comprised of 15 students (M = 1429 ± 762 mL) and the graduate/other group was comprised of 34 students (M = 1696 ± 1253 mL). All five categories of year of education did not have any effect on drinking plain water. (Figure 9)

Figure 9: Plain Water Intake and Year of Education
**Part Time/ Full Time**

An independent t-test was performed to analyze drinking plain water with full/part time students. There was no significant difference in the scores for full time students (N=71, M= 1554 ± 1036 mL) and part-time students (N=10, M= 1876 ± 1742 mL); t (79)= -0.84 , p = 0.40. These results suggest that being a full or part time student did not have an effect on drinking plain water.
Discussion

The results of this study revealed that the plain water intake (pure water) among all participants, between 18 and 32 years, is $1577 \pm 1150$ (42.5%), and total water intake (water obtained from plain water, beverages and foods) is $2582 \pm 1300$ mL. This is higher than Drewnowski et al. (2013a) assessment of plain water in the younger adults group (20-50 years) which was 1294 mL for plain water and lower than total water 3560 ml. Indeed, the results of assessed total water value are also considered lower than the reported level in Kant and Graubard (2009) study which was 3180 mL conducted from a single 24-hr dietary recall in a national representative sample.

Plain water results are in agreement with Drewnowski et al. (2013a) results which suggested that plain and total water intake are higher in the younger groups. Though this study results indicated that drinking plain water is not associated with age (18- 32 years) which might be affected by the smaller age range (14 years) compared to Drewnowski et al. (2013a) study’s age range (30 years). Our sample population is younger than Drewnowski et al. (2013a) sample and the plain water intake found to be higher than the reported values in their study 1593mL and 1294 mL, respectively, which is coherent with the reported age and plain water negative correlation. Furthermore, the results indicated that participants between the age group of 18 and 21 years (n= 36) and the group between 26- 32 years (n= 18) had a comparable plain water intake, M= 1481 mL, M= 1574 mL respectively. These two groups contributed to the highest water intake groups followed by the 22-25 age group (n= 27) which found to be the lowest intake (M = 998 mL).
Moreover, plain water represents 42.5% of the total water intake, which is higher than the amount reported by Drewnowski et al. (2013a) (37%), but within the 33% - 48% range reported by Kant and Graubard (2009) study.

These results also show that males' plain water intake (2183 ± 1370 mL) is higher than females' plain water intake (1374 ± 1002 mL). Likewise, results of the assessed total water intake by gender showed that males' total water intake (3296 ± 1623 mL) again is higher than females' intake (2351 ± 1087 mL). These findings suggested that in this study the male sample had a higher intake of pure water and of fluids obtained from pure water, beverages and foods.

The Institute of Medicine Adequate Intakes (IOM AIs) recommends males and females consume 3700 mL and 2700 mL of total water, respectively); in the current study, 60% of males and about 66% of females failed to meet the recommended values of total water. This indicates that men had slightly better compliance with the total water recommendation (IOM AIs).

Similarly, females' plain water intake was found to equal 1374 mL, and males' plain water was 2183 mL, while 82% of females and only 66% of males failed to adhere to the recommended IOM AIs (males: 3000mL; females: 2200 mL). These results are coherent with Bellisle et al. (2011) findings: the percentage of females who failed to adhere to AIs which was 83%. While the sample of males who failed to adhere to AIs in Bellisle et al. (2011) is considerably higher than our findings (95% compared to 66%), this can be explained by the number of participants and the differences in methodology. The number of adult participants in Bellisle et al.’s study (2011) was 90% higher than our study sample, and water consumption was assessed using the seven-day intake tool.
In general, 75% of the students failed to comply with the recommended levels of pure water by IOM AIs. This is in line with the conclusion reached by Block et al. (2013) who concluded that college students are considered at risk of low water intake because of the factors influencing their beverages choices (cost and taste).

The results of the current study suggest that gender is associated with total water intake and plain water intake, of which men had better adherence to the recommended intake levels. On the contrary, Ferreira-Pêgo et al.’s study (2015) revealed that in all thirteen countries (United Kingdom, Spain, France, Germany, Poland, Turkey, Iran, Indonesia, Japan, China, Brazil, Mexico, and Argentina) investigated, men showed lower adherence to recommended levels compared to women, who showed more two-fold increase in the likelihood of adherence to water consumption recommendations. Similarly, the results are discounted by Bellisle et al. (2011) who found that females have better compliance with the recommended AIs levels.

Moreover, our results are not consistent with Drewnowski et al. (2013a) who found that gender does not affect water intake. However, the sample size (n= 15,702) and gender distribution (males: 48.5%; females: 51.5%) in Drewnowski et al.’s study (2013a) was drastically different compared to out study. Our study sample size is 81 students, and gender distribution was 25% males and 75% females, which might influence the findings.

Body Mass Index (BMI) results showed that underweight participants consumed the highest amount of plain water (2090 mL), followed by the overweight (1667 mL), normal weight (1523 mL), and obese (1455 mL). Although underweight group represented the highest plain water and the obese group represents the lowest plain water intake, the statistical analysis basically suggests that there is no association between BMI and plain
water intake (p= 0.99). This can be explained as the obese group may obtain more daily
energy from food and high caloric beverages and less from plain water, whereas the
underweight group may practice the opposite behavior. Paradoxically, overweight group
plain water intake was about 140 ml higher than the normal weight group. The BMI results
are not consistent with Stooky et al. (2008), and Almiron-Roig and Drewnowski (2003)
findings which reported that the increased intake of water is associated with weight loss.
This can be explained as these studies are experimental studies that were conducted on
overweight participants.

Physical activity found to be positively correlated to both plain water and total
water intakes. These results are consistent with Park et al. (2012) study, which found that
low is associated with physical inactivity. In this study, more males were extremely active
compared to females (about 40% and 10%, respectively) Thus, men consumption of water
was higher than women consumption.

Ethnicity analysis shows that the White ethnic group drank the highest amount
of plain water (1764 mL), and Black or African American (1138.20 mL) drank the lowest
amount of water. While Hispanic group (1648 mL) drank plain water more than Asian
ethnic group (1503 mL), and other ethnic groups (1252 mL). The results are consistent
with Onufra et al. (2014) study results which concluded that Hispanics, African
Americans, and non-Hispanic other races drank less plain water because they did not trust
the safety of their local tap water.

Although the analysis of students' employment status and income rate did not have
any significant influence on the plain water intake, it was found that students worked full
time had the highest plain water intake (1832 mL), followed by the part-time employed student (1728 mL) and unemployed students (1337 mL). Moreover, students with an income of ≤ $13,000/year and the students with an income of ≥ $13,000/year have a comparable plain water intake, 1568 mL and 1655 mL, respectively.

The results of this study further revealed that student participation in meal plan did not have any correlation with drinking plain water (t (79) =0.22, p = 0.83). Comparing the plain water intake among students participating and those who are not participating in the meal plan is slightly different but not significant, 1550 mL vs. 1612 mL respectively. Student year of education is also not correlated with drinking plain water, which is precisely shown in the mean water intake of the different groups. Graduate students (five years or more) drank the highest plain water level (1696 mL), followed by "second-years" (1584 mL), "freshmen" (1555 mL), "third-years" (1544 mL) and "fourth-years" (1429 mL).

Interestingly, nutrition, food science or health sciences majors that contributed to 53% the total sample population were not correlated to plain water intake (r= 0.04, p=0.74). Indeed, the mean water intake found to have comparable values (1554 mL and 1638 mL as in other majors). Similarly, the living arrangement of on-campus/ off-campus did not have any significant correlation with plain water intake. In addition, part-time students on average drank more plain water (1876 mL) compared to the full-time student (1554 mL), while the t-test results indicate an insignificant correlation (p = 0.40). These results may have been affected by the small sample size.

The daily energy intake was found to be 1838 ± 616 Kcal, which is typically acceptable based on the eighth edition of the Dietary Guidelines for Americans 2015-2020
(US Department of Health and Human Services, 2017). The Guidelines noted that for women the recommended energy intake is 1600-2400 Kcal/day, whereas for men it is 2000-3000 Kcal/day. Since the number of women participants in this study is three times more than the men, this might explain the decreased daily energy value.

The macronutrients distribution shows that carbohydrate contributed to 46% of the calories consumed per day, fat 35%, and protein 18% respectively. These values considered acceptable compared to the National Academy of Science (NAS) Acceptable Macronutrients Distribution Rate (AMDR) which note that the recommended carbohydrates intake per day should equal 45-65%, fat 20-35% and protein 10-35% of the total calories intake (Institute of Medicine, 2007).

The results found that daily energy intake is positively correlated to both plain water and total water intake, which is supported by Lee et al.’s research (2016). However, our results contradict the negative correlation discovered by Ann and McCaffrey (2016) who reported with every 1% increase of plain water in total water, the daily energy decreased by 8.5 Kcal. Alternatively, findings from Kant and Graubard (2009) stated that dietary energy intake is unrelated to plain water intake. Kant and Graubard (2009) also noted that dietary energy is correlated to the moisture of food, shown in our results; we found that total water that includes food moisture is positively related to daily energy intake.
Conclusion

By assessing the water intake levels and investigating its association with daily energy among college students, we found that the calculated mean of plain water intake was 1593 mL/ day and for the total water was 2584 mL/ day. Although both values are considered lower than the recommended IOM AI, the total water intake in this population has better compliance than plain water intake.

By comparing the findings of this study to the recommended IOM AI levels, it was found that plain water intake of all participants in the sample was about 40% less than the midpoint value of both genders which is 3200 mL. On the other hand, the total water intake of both genders is only 20% from the midpoint value which is 2600 mL, which is considered better than the plain water intake.

When tested statistically, findings showed that plain water and total water intake was positively associated with daily energy intake. Additionally, drinking plain water or obtaining water from both food and beverages was positively associated with the daily physical activity (ηp² = 0.28 and ηp² = 0.28, respectively); which drinking water increased with the increase of the physical activity. These results are consistent Park et al. (2012) findings which indicated that low water intake is associated with physical inactivity.

Other demographic variables including, age, Body Mass Index (BMI), race/ethnicity, annual income and employment status did not have any correlation with drinking plain water or the consumed total water. Additionally, all assessed students’ college information did not show any relationship with total and plain water, including major, year of education, part-time/ full-time, participation in the meal plan and living on campus/ off campus.
Limitations

The research study was restricted in its sample size and demographics. The sample was obtained from Montclair State University (MSU) students in New Jersey, which is restricted in one geographic area. A broader study sample would represent a proportion of the US population with a wider age range and may reveal different conclusions.

The sampling method was voluntarily online surveys, and two recalls filled over a period of 24-hours for each participant. Online, self-report sampling methods suffer from biases and are occasionally filled inaccurately. Recalls were subjected to human error, or memory bias, as participants were required to fill two detailed recalls for every food and beverage consumed during 24-hours.

In addition, the study data has been conducted during the fall/ winter season, of which all participants completed their surveys and recalls. In general, drinking water is considerably higher in warm seasons in the year vs. colder seasons, as reported by Balaghi et al. (2011). A more comprehensive and extensive data collection period that spreads across the year would eliminate any impact of seasonality.
Implications

While a few studies have examined plain water intake with respect to recommended intake levels, even fewer have investigated this intake level in individuals sharing common environmental/living factors (e.g. college students). The purpose of this study was to investigate whether college students are fulfilling their water requirements, which will help gauge their understanding of the importance of optimal water intake level, shedding light on an area that is infrequently investigated.

Proper nutrition education interventions and public health efforts should be adjusted to improve college students' water consumption by using different programs that aim to make water a more preferable beverage, educate this demographic on the recommended levels to maintain bodily function and to enhance plain water accessibility on campuses. Alternatively, with a more extensive investigation of this topic, these findings can be used to develop a reference module to educate other age groups such as children and elderly population. Certainly, more studies are needed to emphasize the factors influencing water intake patterns in order to develop optimal dietary behaviors.

Furthermore, assessing the link between daily water intake and energy consumption among college-age students can provide important information to dietitians and healthcare providers who are responsible for designing and developing health programs for this age group. Educating students at risk of low water intake assesses improving protecting measures of adverse consequences. After establishing whether there is a link between daily water intake and energy consumption among college students, one can address their obesity-related health risk factors and help students to make more informed and healthier decisions when it comes to their dietary choices.
The study, of course, raises more questions that should be investigated in future studies to evaluate and modify the recommended level of daily water intake. Our results indicate that about 75% of both genders drank less than the recommended amount of plain water, and results from other studies in the United States concluded that water consumption in different age groups are significantly lower than IOM AIs. This further indicates the need to validate and to reconfirm the recommended levels of water intake among all ages. It is also essential to use these findings to review the dietary guidelines and to explicitly include well-defined recommendations of plain water intake, especially given the broad current recommendations.

Another potential area for future study is expanding the period of recalls to longer timeframes, perhaps by extending the diet record to a week or more, thereby decreasing errors. Additionally, as indicated before, collecting data during all seasons such as the summer and winter periods, will avoid the impact of seasonality on water consumption.
Bibliography


**Appendix I**
Recruitment Material

Recruitment Email:

Dear MSU Students,

We would like to invite you to participate in a research study called “Daily Plain Water Intake Level and Its Association with Total Energy Intake Among College Students.” The research will assess daily water intake and identify its relation to energy (calories) consumed per day. This study is conducted by Maria Alanazi, a graduate student in the Nutrition and Food Studies Department at Montclair State University. Participants will be required to answer a short online survey, and complete two 24-hr recalls (A record of food and drink consumed per day) via an online tool called ASA24.

It will take approximately 50min in total to answer the survey and fill in both 24-hr dietary recalls. You will be asked to submit two recalls on two different dates, which will be announced later.

If you are a healthy college student and your age between 18-30 years, you are eligible to participate.

If you have any questions, please contact Maria Alanazi at alanazim1@montclair.edu / (917)930-0377.

Thank you for considering participation in this study, which will help to improve the understanding of the association between daily water consumption and calories intake. This in turn, will support the role of water in weight management programs.

The study has been approved by the Montclair State University Institutional Review Board (IRB). MSU IRB #FY17-18-702

Sincerely,

Maria Alanazi, Master’s Student
Department of Nutrition and Food Studies, Montclair State University

In Person Plea:
Hi
I am Maria Alanazi, a graduate student in The Nutrition and Food Studies Department. I am conducting a study on the topic of water and daily energy (calories) intake among college students. I am seeking volunteers to participate in this study by submitting their daily intake of food and drinks. These data will be submitted online for two separate days. Further details are available in the flyer. All participants will receive $10 in cash and one participant will win a $100 prize through a raffle drawing.
Please let me know if you are interested in participating.
Thank you.

*Flyer:*

Are You a Healthy College Student? Your Age Between 18-30?

Research Participants Wanted.

- Participants will be required to complete a short survey, and submit online two dietary recalls (a record of food and drink consumed per day).
- This study will take approximately 50 min, 2 min for the survey and 24 min for each dietary recall that will be collected in two different dates.
- All participants will receive $10 in cash and one participant will be chosen randomly to win a $100 cash prize.

Marla Alanazi, Master Student in the Nutrition and Food Studies Department is conducting this study. If you are interested in participating or have more questions, please contact me at (917) 930-0377 or alanaziml@montclair.edu

This study has been approved by the Montclair State University Institutional Review Board, MSU IRB #FY17-18-702
An Assessment of Daily Plain Water Intake Level and its Association with Total Energy Intake Among College Students

* Required

Consent Form

Dear Students,

You are invited to participate in a study of "An Assessment of Plain Water Intake Level and its Association with Total Daily Energy Intake Among College Students." This study will measure the daily plain water intake among college students to find out if they are meeting the recommended intake levels. It will also compare plain water intake to the energy (calories) intake obtained from food and beverages to find out if there is a relationship between these two factors.

I hope to learn the correlation between drinking water and daily calories intake. You were selected to participate in this study because you are a healthy student and your age between 18-30 yrs.

If you decide to participate, please complete the following survey, then send us an email with your CWID to get your username and password for ASA24 (alanazim1@montclair.edu). The survey is designed to determine your demographic data and the recall is used to record your daily intake of food and beverages. This study will take approximately 50 min, requiring 2 min for answering the survey and 24 min for each 24-hr dietary recall. You may enter your intake once or multiple times of the assigned day before 12am, at which point the data entry will be locked.

You are going to be asked to answer questions about yourself, enter what you drank and ate within 24 hours and identify the portions of your intake. You may not directly benefit from this research; however, you may benefit by identifying your calories and nutrients intake report that will be displayed after completing your submission. Moreover, you may understand the effect of drinking water on your daily caloric intake. There are benefits of the study to the nutrition field, as it will increase knowledge about students’ water intake levels and if drinking water affects the daily calories intake.

As per taking this study, there will be no more risk than ordinary daily life. Data will be collected using the Internet. There are no guarantees on the security of data sent on the Internet. Your confidentiality will be our highest priority to the degree permitted by the technology used.

If you decide to participate, you are free to stop at any time. You may skip questions you do not want to answer.
To compensate you for the time you spend in submitting your recalls, you will receive $10 in cash and one participant will be win a $100 cash prize through a raffle drawing. If you do not complete both dietary recalls, you will not receive any compensation.

Please feel free to ask questions regarding this study. You may contact me or my Faculty Advisor if you have additional questions at Maria Alanazi (917)-930-0377 alanazim1@montclair.edu.

Any questions about your rights may be directed to Dr. Katrina Bulkley, Chair of the Institutional Review Board at Montclair State University at reviewboard@mail.montclair.edu or 973-655-5189.

Thank you for your time.
Sincerely,
Maria Alanazi
College of Education and Human Services
Department of Nutrition and Food Studies
Phone : 973-655-3765

By clicking the link below, I confirm that I have read this form and will participate in the project described. Its general purposes, the particulars of involvement, and possible risks and inconveniences have been explained to my satisfaction. I understand that I can discontinue participation at any time. My consent also indicates that I am 18 years of age.

[Please feel free to print a copy of this consent.]

The study has been approved by the Montclair State University Institutional Review Board. MSU IRB #FY17-18-702

Please feel free to print a copy of this consent *

☐ agree to participate

☐ decline (Not eligible to continue with this survey)

CWID

Your answer

Email *

Your answer
Are currently working?

- No
- Yes, part time
- Yes, Full time

What is your annual income? (type zero if you are not working) *

Your answer

Describe your daily physical activity

- Extremely active. (e.g. daily exercise that is equal to walking 4 hours or spending most of the day doing heavy physical activity such as bike messenger)
- Moderately active. (e.g. daily exercise that is equal to walking 30-40 minutes)
- Sedentary. (e.g. daily living activities only)

College Year

- Freshman
- Second year
- Third year
- Fourth year
- Other: 

What is your major? Please specify,

Your answer
As a college student are you,

- Full time student
- Part time student

What is your living arrangement?

- In Campus
- Off campus

Do you participate in university meal plan?

- Yes
- No
Appendix II

Automated Self Administered 24hr Recall (ASA24)
Researchers/Respondents Interface

Welcome to ASA24, the Automated Self-Administered Recall System.
Please enter your username and password to login and begin ASA24.

Username
Password

Login
### Sample of Analysis Data Table (Items Records):

<table>
<thead>
<tr>
<th>Field Name</th>
<th>Description</th>
<th>Data Type</th>
<th>Length</th>
<th>Codes</th>
</tr>
</thead>
<tbody>
<tr>
<td>USERNAME</td>
<td>Study abbreviation plus researcher provided ID</td>
<td>Character</td>
<td>30</td>
<td>Assigned per project</td>
</tr>
<tr>
<td>USERID</td>
<td>Unique system ID</td>
<td>Character</td>
<td>38</td>
<td>System assigned GUID such as 40C29DAB-4C7B-423F-956C-8A86B5E77B39</td>
</tr>
<tr>
<td>RECORDNO</td>
<td>Recall number.</td>
<td>Numeric</td>
<td>2</td>
<td>1-99</td>
</tr>
<tr>
<td>RECORDSTATUS</td>
<td>The final status of this recall</td>
<td>Numeric</td>
<td>1</td>
<td>2=Complete; 5=Break of/Quit</td>
</tr>
<tr>
<td>INAKESTARTDATE</td>
<td>Date and time of the start of the 24 hour period for which intake is being</td>
<td>Date</td>
<td>22</td>
<td>MM/DD/YYYY hh:mm</td>
</tr>
<tr>
<td>INAKEENDDATE</td>
<td>Date and time of the end of the 24 hour period for which intake is being</td>
<td>Date</td>
<td>22</td>
<td>MM/DD/YYYY hh:mm</td>
</tr>
<tr>
<td>REPORTINGDATE</td>
<td>The date that the last data were reported within the reporting period.</td>
<td>Date</td>
<td>8</td>
<td>MM/DD/YYYY</td>
</tr>
<tr>
<td>LANG</td>
<td>Language used for recall.</td>
<td>Numeric</td>
<td>1</td>
<td>1=English; 2=Spanish</td>
</tr>
<tr>
<td>OCC_NO</td>
<td>System assigned sequence number for this eating occasion; eating occasions (meals) are sorted chronologically based on the times reported by respondent. By default, supplements are assigned the final</td>
<td>Numeric</td>
<td>2</td>
<td>1--99</td>
</tr>
<tr>
<td>OCC_TIME</td>
<td>Time of eating occasion; supplements are assigned a default time of midnight on the intake day.</td>
<td>Date</td>
<td>19</td>
<td>MM/DD/YYYY hh:mm</td>
</tr>
<tr>
<td>OCC_NAME</td>
<td>Name of eating occasion.</td>
<td>Numeric</td>
<td>1</td>
<td>1=Eat Alone; 2=Family Member(s); 3=Other(s); 4=Family Member(s) and Other(s); 9=Don't know, Blank = Not applicable</td>
</tr>
<tr>
<td>EATWITH</td>
<td>Who was with the respondent for the meal</td>
<td>Numeric</td>
<td>1</td>
<td>2=Using a computer; 3=Using a mobile phone or tablet; 4=None of these; Blank = Not Applicable (no change)</td>
</tr>
<tr>
<td>WATCHTVUSECOMPUTER</td>
<td>Respondent's TV and computer use during the meal</td>
<td>Numeric</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Field Name</td>
<td>Description</td>
<td>Data Type</td>
<td>Length</td>
<td>Codes</td>
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<tr>
<td>------------</td>
<td>-------------</td>
<td>-----------</td>
<td>--------</td>
<td>-------</td>
</tr>
<tr>
<td>LOCATION</td>
<td>Respondent's location while eating the meal</td>
<td>Numeric</td>
<td>2</td>
<td>restaurant; 3=Other restaurant; 4=Cafeteria; 5=Bar or tavern; 6=Work (not in cafeteria); 7=Car; 8=Sports or entertainment venue; 9=Some place else; 10 (Kids version only)=School, cafeteria; 11 (Kids version only)=School, not in cafeteria; 98=Don't know; Blank=Not applicable</td>
</tr>
<tr>
<td>FOODNUM</td>
<td>Food/Lot Termin (FLT) or Supplement Sequence number within the recall</td>
<td>Numeric</td>
<td>3</td>
<td>1 – 999</td>
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<tr>
<td>FOODTYPE</td>
<td>Type of food reported</td>
<td>Numeric</td>
<td>1</td>
<td>1=Primary; 2=Addition; Blank=Not Applicable</td>
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<tr>
<td>FOODSRCOE</td>
<td>Source of the food/most of the ingredients for the food</td>
<td>Character</td>
<td>250</td>
<td>Study specified Food Source answer</td>
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<tr>
<td>CODENUM</td>
<td>Food code sequence number within a meal</td>
<td>Numeric</td>
<td>2</td>
<td>1 – 999=Food code number</td>
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<tr>
<td>FOODCODE</td>
<td>USDA Food and Nutrient Database for Dietary Studies (FNDDS) Food code</td>
<td>Numeric</td>
<td>8</td>
<td>11000000-99999999=Food code</td>
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<tr>
<td>MODCODE</td>
<td>Recipe Modification Code from FNDDS</td>
<td>Numeric</td>
<td>6</td>
<td>0=No modification; 100000-999999=Modification code</td>
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<tr>
<td>HOWMANY</td>
<td>Amount of the food model represented in the field</td>
<td>Numeric</td>
<td>8.3</td>
<td>0.001 – 9999.999</td>
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<tr>
<td>SUBCODE</td>
<td>Portion subcode from FNDDS</td>
<td>Numeric</td>
<td>7</td>
<td>0=Not applicable; 1-</td>
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<tr>
<td>PORTIONCODE</td>
<td>Food measure code from FNDDS</td>
<td>Numeric</td>
<td>5</td>
<td>0=Not applicable; MEASURE was GM, LB, or WO; 1-99999=Code; 98-1 gram</td>
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<tr>
<td>FOODAMT</td>
<td>Amount of food in grams; calculated using HOWMANY, SUBCODE, and PORTIONCODE data</td>
<td>Numeric</td>
<td>8.2</td>
<td>0.01 – 99999.99=Amount in grams; Blank=Not applicable</td>
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<tr>
<td>KCAL</td>
<td>Energy (kcal)</td>
<td>Numeric</td>
<td>12.6</td>
<td></td>
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<tr>
<td>PROT</td>
<td>Protein (g)</td>
<td>Numeric</td>
<td>12.6</td>
<td></td>
</tr>
<tr>
<td>TFAT</td>
<td>Total Fat (g)</td>
<td>Numeric</td>
<td>12.6</td>
<td></td>
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<tr>
<td>CARB</td>
<td>Carbohydrate (g)</td>
<td>Numeric</td>
<td>12.6</td>
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<tr>
<td>MOIS</td>
<td>Water (g)</td>
<td>Numeric</td>
<td>12.6</td>
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<tr>
<td>ALC</td>
<td>Alcohol (g)</td>
<td>Numeric</td>
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<td></td>
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<tr>
<td>CAFF</td>
<td>Caffeine (mg)</td>
<td>Numeric</td>
<td>12.6</td>
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<tr>
<td>THEO</td>
<td>Theobromine (mg)</td>
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<td>SUGR</td>
<td>Sugars, total (g)</td>
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<td>Fiber, total dietary (g)</td>
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<td>CALC</td>
<td>Calcium (mg)</td>
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<tr>
<td>IRON</td>
<td>Iron (mg)</td>
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<td>Phosphorus (mg)</td>
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<td>POTA</td>
<td>Potassium (mg)</td>
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<td>Sodium (mg)</td>
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<td>Zinc (mg)</td>
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<tr>
<td>COPP</td>
<td>Copper (mg)</td>
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<tr>
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<td>Selenium (mcg)</td>
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<td>Field Name</td>
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<td>Data Type</td>
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<tr>
<td>VC</td>
<td>Vitamin C (mg)</td>
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<tr>
<td>VB1</td>
<td>Thiamin (mg)</td>
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<tr>
<td>VB2</td>
<td>Riboflavin (mg)</td>
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<tr>
<td>NIAC</td>
<td>Niacin (mg)</td>
<td>Numeric</td>
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</tr>
<tr>
<td>VB6</td>
<td>Vitamin B-6 (mg)</td>
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<tr>
<td>FOLA</td>
<td>Folate, total (mcg)</td>
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<tr>
<td>FA</td>
<td>Folic acid (mcg)</td>
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<td></td>
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<tr>
<td>FF</td>
<td>Folate, food (mcg)</td>
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<tr>
<td>FDFE</td>
<td>Folate, DFE (mcg)</td>
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<tr>
<td>VB12</td>
<td>Vitamin B-12 (mcg)</td>
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<tr>
<td>VARA</td>
<td>Vitamin A, RAE (mcg, RAE)</td>
<td>Numeric</td>
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<tr>
<td>RET</td>
<td>Retinol (mcg)</td>
<td>Numeric</td>
<td>12.6</td>
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</tr>
<tr>
<td>BCAR</td>
<td>Carotene, beta (mcg)</td>
<td>Numeric</td>
<td>12.6</td>
<td></td>
</tr>
<tr>
<td>ACAR</td>
<td>Carotene, alpha (mcg)</td>
<td>Numeric</td>
<td>12.6</td>
<td></td>
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<tr>
<td>CRYP</td>
<td>Cryptoxanthin, beta (mcg)</td>
<td>Numeric</td>
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<tr>
<td>LYCO</td>
<td>Lycopene (mg)</td>
<td>Numeric</td>
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<tr>
<td>LZ</td>
<td>Lutein + zeaxanthin (mcg)</td>
<td>Numeric</td>
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<tr>
<td>ATOC</td>
<td>Vitamin E, alpha-tocopherol (mg)</td>
<td>Numeric</td>
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<td></td>
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<tr>
<td>VK</td>
<td>Vitamin K, phylloquinone (mcg)</td>
<td>Numeric</td>
<td>12.6</td>
<td></td>
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<tr>
<td>CHOLE</td>
<td>Cholesterol (mg)</td>
<td>Numeric</td>
<td>12.6</td>
<td></td>
</tr>
<tr>
<td>SFAT</td>
<td>Fatty acids, total saturated (g)</td>
<td>Numeric</td>
<td>12.6</td>
<td></td>
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<tr>
<td>S040</td>
<td>4:0, Butanoic acid (g)</td>
<td>Numeric</td>
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<tr>
<td>S060</td>
<td>6:0, Hexanoic acid (g)</td>
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<td>S080</td>
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<td>S100</td>
<td>10:0, Decanoic acid (g)</td>
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<td>S120</td>
<td>12:0, Dodecanoic acid (g)</td>
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<tr>
<td>S140</td>
<td>14:0, Tetradecanoic acid (g)</td>
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<tr>
<td>S160</td>
<td>16:0, Hexadecanoic acid (g)</td>
<td>Numeric</td>
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<tr>
<td>S180</td>
<td>18:0, Octadecanoic acid (g)</td>
<td>Numeric</td>
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<tr>
<td>MFAT</td>
<td>Fatty acids, total monounsaturated</td>
<td>Numeric</td>
<td>12.6</td>
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<tr>
<td>M161</td>
<td>16:1, Hexadecenoic acid, undifferentiated (g)</td>
<td>Numeric</td>
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</tr>
<tr>
<td>M181</td>
<td>18:1, Octadecenoic acid, undifferentiated (g)</td>
<td>Numeric</td>
<td>12.6</td>
<td></td>
</tr>
<tr>
<td>M201</td>
<td>20:1, Eicosenoic acid, undifferentiated (g)</td>
<td>Numeric</td>
<td>12.6</td>
<td></td>
</tr>
<tr>
<td>M221</td>
<td>22:1, Docosenoic acid, undifferentiated (g)</td>
<td>Numeric</td>
<td>12.6</td>
<td></td>
</tr>
<tr>
<td>PFAT</td>
<td>Fatty acids, total polyunsaturated (g)</td>
<td>Numeric</td>
<td>12.6</td>
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</tr>
<tr>
<td>P182</td>
<td>18:2, Octadecadienoic acid (g)</td>
<td>Numeric</td>
<td>12.6</td>
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<tr>
<td>P183</td>
<td>18:3, Octadecatrienoic acid (g)</td>
<td>Numeric</td>
<td>12.6</td>
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<tr>
<td>P184</td>
<td>18:4, Octadecatetraenoic acid (g)</td>
<td>Numeric</td>
<td>12.6</td>
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<tr>
<td>P204</td>
<td>20:4, Eicosatetraenoic acid (g)</td>
<td>Numeric</td>
<td>12.6</td>
<td></td>
</tr>
<tr>
<td>P205</td>
<td>20:5 n-3, Eicosapentaenoic acid [EPA] (g)</td>
<td>Numeric</td>
<td>12.6</td>
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<tr>
<td>P225</td>
<td>22:5 n-3, Docosapentaenoic acid [DPA] (g)</td>
<td>Numeric</td>
<td>12.6</td>
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</tr>
<tr>
<td>P226</td>
<td>22:6 n-3, Docosahexaenoic acid [DHA] (g)</td>
<td>Numeric</td>
<td>12.6</td>
<td></td>
</tr>
<tr>
<td>VITD</td>
<td>Vitamin D (D2 + D3) (mcg)</td>
<td>Numeric</td>
<td>12.6</td>
<td></td>
</tr>
<tr>
<td>Field Name</td>
<td>Description</td>
<td>Data Type</td>
<td>Length</td>
<td>Codes</td>
</tr>
<tr>
<td>------------------</td>
<td>-----------------------------------------------------------------------------</td>
<td>-----------</td>
<td>--------</td>
<td>-------</td>
</tr>
<tr>
<td>CHOLN</td>
<td>Choline, total (mg)</td>
<td>Numeric</td>
<td>12.6</td>
<td></td>
</tr>
<tr>
<td>VITE_ADD</td>
<td>Added Vitamin E (mg)</td>
<td>Numeric</td>
<td>12.6</td>
<td></td>
</tr>
<tr>
<td>B12_ADD</td>
<td>Added Vitamin B-12 (mg)</td>
<td>Numeric</td>
<td>12.6</td>
<td></td>
</tr>
<tr>
<td>F_TOTAL</td>
<td>Total intact fruits (whole or cut) and fruit juices (cup eq.)</td>
<td>Numeric</td>
<td>12.6</td>
<td></td>
</tr>
<tr>
<td>F_CITMLB</td>
<td>Intact fruits (whole or cut) of citrus, melons, and berries (cup eq.)</td>
<td>Numeric</td>
<td>12.6</td>
<td></td>
</tr>
<tr>
<td>F_OTHER</td>
<td>Intact fruits (whole or cut); excluding citrus, melons, and berries (cup eq.)</td>
<td>Numeric</td>
<td>12.6</td>
<td></td>
</tr>
<tr>
<td>F_JUICE</td>
<td>Fruit juices, citrus and non citrus (cup eq.)</td>
<td>Numeric</td>
<td>12.6</td>
<td></td>
</tr>
<tr>
<td>V_TOTAL</td>
<td>Total dark green, red and orange, starchy, and other vegetables; excludes legumes (cup eq.)</td>
<td>Numeric</td>
<td>12.6</td>
<td></td>
</tr>
<tr>
<td>V_DRKGR</td>
<td>Dark green vegetables (cup eq.)</td>
<td>Numeric</td>
<td>12.6</td>
<td></td>
</tr>
<tr>
<td>V_REDOF_TOTAL</td>
<td>Total red and orange vegetables (tomatoes and tomato products + other red and orange vegetables (cup)</td>
<td>Numeric</td>
<td>12.6</td>
<td></td>
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<tr>
<td>V_REDOF_TOMATO</td>
<td>Tomatoes and tomato products (cup)</td>
<td>Numeric</td>
<td>12.6</td>
<td></td>
</tr>
<tr>
<td>V_REDOF_OTHER</td>
<td>Other red and orange vegetables, excluding tomatoes and tomato products (cup eq.)</td>
<td>Numeric</td>
<td>12.6</td>
<td></td>
</tr>
<tr>
<td>V_STARCHY_TOT</td>
<td>Total starchy vegetables (white potatoes + other starchy vegetables)</td>
<td>Numeric</td>
<td>12.6</td>
<td></td>
</tr>
<tr>
<td>V_STARCHY_POTA</td>
<td>White potatoes (cup eq.)</td>
<td>Numeric</td>
<td>12.6</td>
<td></td>
</tr>
<tr>
<td>V_STARCHY_OHE</td>
<td>Other starchy vegetables, excluding white potatoes (cup eq.)</td>
<td>Numeric</td>
<td>12.6</td>
<td></td>
</tr>
<tr>
<td>V_OTHER</td>
<td>Other vegetables not in the vegetable components listed above (cup eq.)</td>
<td>Numeric</td>
<td>12.6</td>
<td></td>
</tr>
<tr>
<td>V_LEGUMES</td>
<td>Beans and peas (legumes) computed as vegetables (cup eq.)</td>
<td>Numeric</td>
<td>12.6</td>
<td></td>
</tr>
<tr>
<td>G_TOTAL</td>
<td>Total whole and refined grains (oz)</td>
<td>Numeric</td>
<td>12.6</td>
<td></td>
</tr>
<tr>
<td>G_WHOLE</td>
<td>Grains defined as whole grains and contain the entire grain kernel ? the bran, germ, and endosperm (oz. eq.)</td>
<td>Numeric</td>
<td>12.6</td>
<td></td>
</tr>
<tr>
<td>G_REFINED</td>
<td>Refined grains that do not contain all of the components of the entire grain kernel (oz. eq.)</td>
<td>Numeric</td>
<td>12.6</td>
<td></td>
</tr>
<tr>
<td>PF_TOTAL</td>
<td>Total meat, poultry, organ meat, cured meat, seafood, eggs, soy, and nuts and seeds; excludes legumes (oz. eq.)</td>
<td>Numeric</td>
<td>12.6</td>
<td></td>
</tr>
<tr>
<td>PF_MPS_TOTAL</td>
<td>Total of meat, poultry, seafood, organ meat, and cured meat (oz. eq.)</td>
<td>Numeric</td>
<td>12.6</td>
<td></td>
</tr>
<tr>
<td>PF_MEAT</td>
<td>Beef, veal, pork, lamb, and game meat; excludes organ meat and cured meat (oz. eq.)</td>
<td>Numeric</td>
<td>12.6</td>
<td></td>
</tr>
<tr>
<td>PF_CUREDMEAT</td>
<td>Frankfurters, sausages, corned beef, and luncheon meat that are made from beef, pork, or poultry (oz. eq.)</td>
<td>Numeric</td>
<td>12.6</td>
<td></td>
</tr>
<tr>
<td>Field Name</td>
<td>Description</td>
<td>Data Type</td>
<td>Length</td>
<td>Codes</td>
</tr>
<tr>
<td>----------------</td>
<td>-----------------------------------------------------------------------------</td>
<td>-----------</td>
<td>--------</td>
<td>-------</td>
</tr>
<tr>
<td>PF_SEAFD_HI</td>
<td>Seafood (finfish, shellfish, and other seafood) high in n-3 fatty acids (oz.)</td>
<td>Numeric</td>
<td>12.6</td>
<td></td>
</tr>
<tr>
<td>PF_SEAFD_LOW</td>
<td>Seafood (finfish, shellfish, and other seafood) low in n-3 fatty acids (oz.)</td>
<td>Numeric</td>
<td>12.6</td>
<td></td>
</tr>
<tr>
<td>PF_EGGS</td>
<td>Eggs (chicken, duck, goose, quail) and egg substitutes (oz. eq.)</td>
<td>Numeric</td>
<td>12.6</td>
<td></td>
</tr>
<tr>
<td>PF_SOY</td>
<td>Soy products, excluding calcium fortified soy milk and immature soybeans (oz. eq.)</td>
<td>Numeric</td>
<td>12.6</td>
<td></td>
</tr>
<tr>
<td>PF_NUTSDS</td>
<td>Peanuts, tree nuts, and seeds; excludes coconut (oz. eq.)</td>
<td>Numeric</td>
<td>12.6</td>
<td></td>
</tr>
<tr>
<td>PF_LEGUMES</td>
<td>Beans and Peas (legumes) computed as protein foods (oz. eq.)</td>
<td>Numeric</td>
<td>12.6</td>
<td></td>
</tr>
<tr>
<td>D_TOTAL</td>
<td>Total milk, yogurt, cheese, whey. For some foods, the total dairy values could be higher than sum of D_MILK, D_YOGURT, and D_CHEESE because Misc dairy component composed of whey which is not included in FPED as separate variable. (cup eq.)</td>
<td>Numeric</td>
<td>12.6</td>
<td></td>
</tr>
<tr>
<td>D_MILK</td>
<td>Fluid milk, buttermilk, evaporated milk, dry milk, and calcium fortified soy milk (cup eq.)</td>
<td>Numeric</td>
<td>12.6</td>
<td></td>
</tr>
<tr>
<td>D_YOGURT</td>
<td>Yogurt (cup eq.)</td>
<td>Numeric</td>
<td>12.6</td>
<td></td>
</tr>
<tr>
<td>D_CHEESE</td>
<td>Cheeses (cup eq.)</td>
<td>Numeric</td>
<td>12.6</td>
<td></td>
</tr>
<tr>
<td>OILS</td>
<td>Fats naturally present in nuts, seeds, seafood; unhydrogenated vegetable oils, except palm oil, palm kernel oil, coconut oils; fat in avocado and olives above allowable amount; 50% of fat present in stick/tub margarines, margarine spreads (grams)</td>
<td>Numeric</td>
<td>12.6</td>
<td></td>
</tr>
<tr>
<td>SOLID_FATS</td>
<td>Fats naturally present in meat, poultry, eggs, dairy (lard, tallow, butter); hydrogenated/partially hydrogenated oils; shortening, palm, palm kernel, coconut oils; coconut meat, cocoa butter; 50% of fat in stick/tub margarines, margarine</td>
<td>Numeric</td>
<td>12.6</td>
<td></td>
</tr>
<tr>
<td>ADD_SUGARS</td>
<td>Foods defined as added sugars (tsp.)</td>
<td>Numeric</td>
<td>12.6</td>
<td></td>
</tr>
<tr>
<td>A_DRINKS</td>
<td>Alcoholic beverages and alcohol (ethanol) added to foods after cooking (no. of drinks)</td>
<td>Numeric</td>
<td>12.6</td>
<td></td>
</tr>
<tr>
<td>FOODCOMP</td>
<td>This is an indicator which shows, per food, if the portion and/or nutrient data is complete or missing</td>
<td>Numeric</td>
<td>1</td>
<td>1=Data Complete; 2=Data Missing</td>
</tr>
<tr>
<td>FOOD_DESCRIPTION</td>
<td>Description of Food, from either the FNDDS FoodCode Description or, where applicable, the ModCode description</td>
<td>Character 255</td>
<td>Text</td>
<td></td>
</tr>
</tbody>
</table>
**Sample of Analysis Data Tables (Responses Records):**

<table>
<thead>
<tr>
<th>Field Name</th>
<th>Description</th>
<th>Data Type</th>
<th>Length</th>
<th>Codes</th>
</tr>
</thead>
<tbody>
<tr>
<td>USERNAME</td>
<td>Study abbreviation plus researcher provided ID</td>
<td>Character</td>
<td>30</td>
<td>Assigned per project</td>
</tr>
<tr>
<td>USERID</td>
<td>Unique system ID</td>
<td>Character</td>
<td>38</td>
<td>System assigned GUID such as {40C29DAB-4C7B-423F-956C-8A86B5E77B39}</td>
</tr>
<tr>
<td>RECORDNO</td>
<td>Recall number</td>
<td>Numeric</td>
<td>2</td>
<td>1 = -- 99</td>
</tr>
<tr>
<td>RECORDSTATUS</td>
<td>The final status of this recall</td>
<td>Numeric</td>
<td>1</td>
<td>2 = Complete; 5 = Breakoff/Quit</td>
</tr>
<tr>
<td>INTAKESTARTDATETIME</td>
<td>Date and time of the start of the 24 hour period for which intake is being reported</td>
<td>Date</td>
<td>22</td>
<td>MM/DD/YYYY hh:mm</td>
</tr>
<tr>
<td>INTAKEENDDATETIME</td>
<td>Date and time of the end of the 24 hour period for which intake is being reported</td>
<td>Date</td>
<td>22</td>
<td>MM/DD/YYYY hh:mm</td>
</tr>
<tr>
<td>REPORTINGDATE</td>
<td>The date that the last data were reported within the reporting period. Reporting period is the time within which respondents are allowed to report their intake</td>
<td>Date</td>
<td>8</td>
<td>MM/DD/YYYY</td>
</tr>
<tr>
<td>LANG</td>
<td>Language used for recall</td>
<td>Numeric</td>
<td>1</td>
<td>1 = English; 2 = Spanish</td>
</tr>
<tr>
<td>AMTUSUAL</td>
<td>Respondent's assessment of amount of food consumed on intake day</td>
<td>Numeric</td>
<td>1</td>
<td>1 = Much more than usual; 2 = Usual; 3 = Much less than usual; 8 = Don't know</td>
</tr>
<tr>
<td>SALTTYPE (For Future Use)</td>
<td>Type of salt added to foods at the table</td>
<td>Numeric</td>
<td>1</td>
<td>field not used</td>
</tr>
<tr>
<td>SALTREQ (For Future Use)</td>
<td>How often salt is added to foods at the table</td>
<td>Numeric</td>
<td>1</td>
<td>field not used</td>
</tr>
<tr>
<td>SALTUSED (For Future Use)</td>
<td>How often regular or seasoned salt is added to foods during preparation</td>
<td>Numeric</td>
<td>1</td>
<td>field not used</td>
</tr>
<tr>
<td>OCC NO</td>
<td>System assigned sequence number for this eating occasion; eating occasions (meals) are sorted chronologically based on the times reported by respondent. By default, supplements are assigned the final sequence number in the intake</td>
<td>Numeric</td>
<td>2</td>
<td>1 = -- 99</td>
</tr>
<tr>
<td>OCC TIME</td>
<td>Time of eating occasion; supplements are assigned a default time of midnight on the intake day.</td>
<td>Date</td>
<td>19</td>
<td>MM/DD/YYYY hh:mm</td>
</tr>
<tr>
<td>OCC NAME</td>
<td>Name of eating occasion</td>
<td>Numeric</td>
<td>1</td>
<td>1 = Breakfast; 2 = Brunch; 3 = Lunch; 4 = Dinner; 5 = Supper; 6 = Snack; 7 = Just a Drink; 8 = Just a Supplement</td>
</tr>
<tr>
<td>EATWITH</td>
<td>Who was with the respondent for the meal</td>
<td>Numeric</td>
<td>1</td>
<td>1 = Eat Alone; 2 = Family Member(s); 3 = Other(s); 4 = Family Member(s) and Other(s); 9 = Don't know; Blank = Not applicable</td>
</tr>
<tr>
<td>Variable</td>
<td>Description</td>
<td>Type</td>
<td>Value</td>
<td></td>
</tr>
<tr>
<td>---------------</td>
<td>------------------------------------------------------------------------------</td>
<td>--------</td>
<td>-------</td>
<td></td>
</tr>
<tr>
<td>WATCHTVUSECOMPUTER</td>
<td>Respondent's TV and computer use during the meal</td>
<td>Numeric</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>LOCATION</td>
<td>Respondent's location while eating the meal</td>
<td>Numeric</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>FOODNUM</td>
<td>FoodListTerm (FLT) or Supplement sequence number within the recall</td>
<td>Numeric</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>FOODTYPE</td>
<td>Type of food reported</td>
<td>Numeric</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>FOODSRCE</td>
<td>Source of the food/most of the ingredients for the food</td>
<td>Character</td>
<td>250</td>
<td></td>
</tr>
<tr>
<td>COMBONUM</td>
<td>Combination number; assigned sequentially to foods reported as &quot;primary&quot; plus &quot;addition&quot;</td>
<td>Numeric</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>LINENUM</td>
<td>Line number of interview data within each reported food/beverage</td>
<td>Numeric</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>VARIABLE</td>
<td>Food List Term or shorthand Question Name</td>
<td>Character</td>
<td>255</td>
<td></td>
</tr>
<tr>
<td>RESPONSE</td>
<td>Answer text</td>
<td>Character</td>
<td>255</td>
<td></td>
</tr>
<tr>
<td>RESPONSEEOS</td>
<td>Respondent-entered text for Unfound Food description or entry for &quot;Other&quot; response</td>
<td>Character</td>
<td>255</td>
<td></td>
</tr>
<tr>
<td>SPINDIAL1</td>
<td>Value entered by respondent for a portion larger than the options listed</td>
<td>Numeric</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>SPINDIAL2</td>
<td>Value entered by respondent for a portion larger than the options listed; used only for foods with two probes regarding portion eaten (e.g., omelet)</td>
<td>Numeric</td>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>

Key:
1 = Watching TV
2 = Using a computer
3 = Using a mobile phone or tablet
4 = None of these
5 = Watching TV, using a computer, and using a mobile phone or tablet
6 = Watching TV and using a computer
7 = Watching TV and using a mobile phone or tablet
8 = Using a computer and using a mobile phone or tablet
Blank = Not Applicable
Respondent's Individual Report: 
Intake Data Sample

ASA24
Nutrition Profile

Caloric Intake By Meal

To achieve a healthy eating pattern, the Dietary Guidelines for Americans encourage you to:

https://asa24.nal.usda.gov/2016/user-profile
- Make half your grains whole grains. Limit products made with refined grains, especially those high in fat, sugars, and/or sodium such as cookies, cakes, and some snack foods.
- Eat a variety of fruits, emphasizing whole fruits. When consuming juice, choose 100% juices without added sugars.
- Eat a variety of colors and types of vegetables, including dark greens, red and orange, and legumes (beans and peas).
- Choose fat-free or low-fat dairy, including milk, yogurt, cheese, and/or fortified soymilk beverages.
- Eat a variety of protein foods, with an emphasis on seafood and plant proteins, such as legumes (beans and peas), nuts, seeds, and soy products.

### Nutrients Intake Report

<table>
<thead>
<tr>
<th>Nutrients</th>
<th>Target</th>
<th>Actual Enter</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calories (kcal)</td>
<td>2,200</td>
<td>2,300</td>
<td>OVER</td>
</tr>
<tr>
<td>Carbohydrate (g)</td>
<td>250</td>
<td>250</td>
<td>OK</td>
</tr>
<tr>
<td>Cholesterol (mg)</td>
<td>200</td>
<td>120</td>
<td>OK</td>
</tr>
<tr>
<td>Sodium (mg)</td>
<td>2,300</td>
<td>2,300</td>
<td>OK</td>
</tr>
<tr>
<td>Vitamin A (IU)</td>
<td>10,000</td>
<td>10,000</td>
<td>OK</td>
</tr>
<tr>
<td>Vitamin C (mg)</td>
<td>75</td>
<td>75</td>
<td>OK</td>
</tr>
<tr>
<td>Vitamin D (IU)</td>
<td>100</td>
<td>100</td>
<td>OK</td>
</tr>
<tr>
<td>Vitamin E (mg)</td>
<td>15</td>
<td>15</td>
<td>OK</td>
</tr>
<tr>
<td>Vitamin K (mg)</td>
<td>100</td>
<td>100</td>
<td>OK</td>
</tr>
<tr>
<td>Total Fat (g)</td>
<td>32</td>
<td>32</td>
<td>OK</td>
</tr>
<tr>
<td>Saturated Fat (g)</td>
<td>9</td>
<td>9</td>
<td>OK</td>
</tr>
<tr>
<td>Cholesterol (mg)</td>
<td>120</td>
<td>120</td>
<td>OK</td>
</tr>
<tr>
<td>Sodium (mg)</td>
<td>1,500</td>
<td>1,500</td>
<td>OK</td>
</tr>
</tbody>
</table>

### Food Type Intake

<table>
<thead>
<tr>
<th>Category</th>
<th>Unit</th>
<th>Actual Enter</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Calories</td>
<td>kCal</td>
<td>2,300</td>
<td>OVER</td>
</tr>
<tr>
<td>Saturated Fat</td>
<td>g</td>
<td>9</td>
<td>OK</td>
</tr>
<tr>
<td>Added Sugars</td>
<td>g per day</td>
<td>4g</td>
<td>OK</td>
</tr>
<tr>
<td>Fiber</td>
<td>g per day</td>
<td>15</td>
<td>OK</td>
</tr>
<tr>
<td>Trans Fat</td>
<td>g per day</td>
<td>0.5</td>
<td>OK</td>
</tr>
<tr>
<td>Sodium</td>
<td>mg per day</td>
<td>320</td>
<td>OVER</td>
</tr>
</tbody>
</table>

**Print**

https://twe24.nhlbi.nih.gov/2016/user-profile

Page 2 of 2
**Intake Charts Sample**

**ASA24°**

**Nutrition Profile**

**Caloric Intake By Meal**

- Breakfast: 20%
- Lunch: 24%
- Dinner/Supper: 26%
- Dinner/Supper: 28%
- Dinner/Supper: 29%

### Daily Calorie Intake

<table>
<thead>
<tr>
<th>Date</th>
<th>Calories</th>
<th>Activity Level</th>
<th>Total Calories</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apr 14</td>
<td>1,800</td>
<td>Sedentary</td>
<td>1,500</td>
</tr>
</tbody>
</table>

### Daily Food Group Targets

#### Grains

- Whole grains: Target: 3 cups
- Refined grains: Target: 0 cups
- Total Grains: Target: 6 cups

#### Fruits

- Weekly: Target: 6 cups
- Total: Target: 1 cup(s)

#### Dairy

- Milk: Target: 3 cups
- Yogurt: Target: 1 cup
- Cheese: Target: 1 cup
- Total Dairy: Target: 5 cups

#### Vegetables

- Dark Orange vegetables: Target: 1 cup
- Red and Orange vegetables: Target: 1 cup
- Legumes (beans and peas): Target: 1 cup
- Cabbage vegetables: Target: 1 cup
- Other vegetables: Target: 1 cup
- Total Vegetables: Target: 5 cups

#### Protein Foods

- Meat, Poultry, and Fish: Target: 3 cups
- Seafood: Target: 1 cup
- Nuts, Seeds, and Soy: Target: 1 cup
- Total Protein: Target: 5 cups

*The Protein Foods Group consists of meat, poultry, seafood, eggs, nuts and seeds, legumes (other than soybeans), and soy products.*

---

https://asa24.nhlbih文字和图像的OCR识别需要更清晰的图像，因此在这里我将不进行OCR识别。
To achieve a healthy eating pattern, the Dietary Guidelines for Americans encourage you to:

- Make half your grains whole grains. Limit products made with refined grains, especially those high in fat, sugars, and/or sodium, such as cookies, cakes, and some snack foods.
- Eat a variety of fruits, emphasizing whole fruits. When consuming juice, choose 100% juices without added sugars.
- Eat a variety of colors and types of vegetables, including dark green, red and orange, and legumes (beans and peas).
- Choose fat-free or low-fat dairy, including milk, yogurt, cheese, and/or fortified soy beverages.
- Eat a variety of protein foods, with an emphasis on seafood and plant proteins, such as legumes (beans and peas), nuts, seeds, and soy products.

**Nutrients Intake Report**

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Target</th>
<th>Actual Eaten</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calcium (mg)</td>
<td>1,300</td>
<td>1,041</td>
</tr>
<tr>
<td>Carbohydrate (g)</td>
<td>130</td>
<td>202</td>
</tr>
<tr>
<td>Cholesterol (mg)</td>
<td>No Daily Target</td>
<td>135</td>
</tr>
<tr>
<td>Choline (mg)</td>
<td>370</td>
<td>189</td>
</tr>
<tr>
<td>Copper (mg)</td>
<td>0.7</td>
<td>1</td>
</tr>
<tr>
<td>Folate (µg DFE)</td>
<td>600</td>
<td>580</td>
</tr>
</tbody>
</table>