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Hydration status assessment and impinging factors among university students in the UAE

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Abstract. – OBJECTIVE: Insufficient water intake has been a global health concern as it is linked to numerous adverse health consequences. Risk factors for dehydration include low fluid intake, sun and heat exposure which is a key element especially in the Gulf region. The aim of this study was to identify the prevalence and the impinging factors of hypohydration among college students in UAE.

SUBJECTS AND METHODS: Bioelectrical Analysis Impedance (BIA), attained using BodyStat 1,500 MDD, was used to assess participants' body water levels. Adequate hydration level was defined as body water level of 50-60% for females and 55-65% for males. Alongside this, a scale and a stadiometer were used to measure the participants' weight and height in order to calculate their BMI. A self-administered questionnaire was also used to assess and correlate the test findings with the risk factors, signs and symptoms, and the level of knowledge awareness of the participants.

RESULTS: Of the 201 university students that participated in the study, 41.3% were hypohydrated, 55.7% were well hydrated and 3% were hyper-hydrated. Among hypohydrated participants, 56.6% were females and 43.4% were males, highlighting that females were at higher risk of becoming dehydrated than males. A major factor that negatively affected hydration status was BMI; as BMI increased, water percentage and therefore hydration status decreased. We checked for numerous signs and symptoms that could indicate hypohydration levels, and the following were the top five most prevalent among our participants: dry lips (51.90%), thirst (46.90%), tiredness (46.80%), dry skin (39.70%) and headache (36.90%). According to The Urine Color Chart (Human Kinetics, Champaign, IL, USA), 3.5% were classified as dehydrated, 46% were in danger of getting hypohydration levels while 19.5% were classified as having good hydration levels. There was no significant correlation between water intake and urine colour chart ($p = 0.334$). Among the study participants, 64.2% acquired their knowledge from internet, 30.80% from TV and radio and 26.90% from books and courses. The behavior aspect of the participants when feeling thirsty, was that 79% of them would resort to water, while 11% resorted to soft drinks and 10% to juices.

CONCLUSIONS: The prevalence of hypohydration levels was 41.3% among the study participants of young university students. The main risk factors affecting hydration levels were BMI and gender. This signifies the importance of good hydration habits which were not commonly practiced among students even though they had adequate knowledge regarding the topic. Regular check-ups held intermittently can aid in recognizing those at risk of dehydration and help in educating about the importance of such topic especially regionally.

Key Words:
Hydration, Hypohydration, Dehydration, Prevalence, Risk factors, UAE, University students.

Introduction

Water makes up approximately 60% of an adult male and 50% of an adult female body weight. Body water is distributed between two main compartments: the extracellular fluid, including the plasma in blood, and the intracellular fluid which accounts for the larger volume. Water serves as a solvent for many chemical reactions constantly taking place in the body. It is also an essential component of the well-known citric acid cycle. The human body homeostasis is directly related to water; thus, it has been reported that any changes in the water composition of the body would result in major imbalances in several functions of the body, such as blood-tissue fluid exchange, blood pressure, renal secretion, and gastro-intestinal reabsorption, among others[1].

Normally at rest, an average adult loses approximately 2.3 liters of body water throughout the day. Insensible water loss, fluid lost in sweat, in feces, water lost by the kidneys and our surrounding environment are the major contributors to the daily

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loss of water[1]. The Middle East and North Africa (MENA) region is well known for its hot humid climate, which might heavily contribute to the daily water loss experienced by its population. This factor, exacerbated by the tendency in most age groups to fail to meet their daily water intake requirement, puts a significant portion of the population in the MENA region at a greater risk of being either hypohydrated or dehydrated[4]. Hypohydration is defined as a body water deficit greater than normal daily fluctuation. Dehydration, on the other hand, is defined as a rapid loss of more than 3% of body weight that is associated with water and electrolyte disturbance from either water or sodium depletion. Dehydration can significantly affect multiple organ systems, such as the gastrointestinal, cardiovascular, renal functions[3], and in some severe cases, it can affect brain structure and function, which is not only restricted to cognitive performance, but also energy and short-term memory[8-11]. It is not uncommon for dehydration to be misdiagnosed with its wide range of signs and symptoms making it difficult to be identified and corrected. The knowledge and awareness of the importance of fluid intake is critical to prevent hypohydration and dehydration. A study in 2016 has shown a higher nutritional knowledge of euhydrated (i.e., normal, and balanced total body water content) university student athletes compared to a non-euhydrated student athletes prior to exercise. This indicates that awareness programs have a direct impact on hydration levels, especially during physical exercise. It is especially important to measure the level of hydration among university students in the UAE, not only because it puts them at a higher risk of dehydration when they are moving between classes in the exceptionally hot climate, but also because it can affect their cognitive functions during learning[10]. Unfortunately, even with the plethora of risk factors that can predispose the population in the MENA region to dehydration, there is very little research being conducted about this topic in this part of the world. In addition, a lack of nutritional knowledge of adequate water intake can negatively impact the healthy fluid intake of the population across the region, not just the UAE.

The goal of our study is to assess the hydration status among university students in UAE. This study also aims at identifying the prevalence and risk factors of hypohydration/dehydration among those students. Furthermore, the behavior of the study participants towards water intake was investigated to determine their level of knowledge about optimum hydration. In conducting this research, we hope to get a preliminary accurate estimate of the hydration status of university students and the risk factors they are most exposed to. We also hope to open the door for more research at a larger scale to be conducted in this region about this topic.

Subjects and Methods

Sample Selected

Based on the number of enrolled students at the University of Sharjah during 2017/2018 academic year, a sample size of 385 was required. Sample size was calculated using Cochran's formula for sample size. Participants were recruited in a random selection, by face-to-face on-campus recruitment and using an online approach to attract different groups of students studying various majors. Participants' inclusion criteria were to be healthy students without any long-standing illnesses, aged between 18-25 and studying in the University of Sharjah, UAE. The exclusion criteria were: the students should not be on any medications (such as diuretics, NSAIDS, phenytoin, lithium, demeclocycline, amphotericin, antidepressants), having a pacemaker, missing a limb, suffering from any gastrointestinal diseases (such as GERD, ulcers), renal diseases, oral diseases, or if they were pregnant.

Study Design

The study is a cross-sectional study with the main objective to assess the hydration status in a college student's population. The cross-sectional design has helped us to collect data to make inferences about our population of interest at one point in time as well as to measure prevalence for all risk factors under investigation and allow us to make comparisons among observed risk factors.

Data Collection

Data collection was conducted exclusively in University of Sharjah campus, Sharjah, UAE from January 2018 through February 2018. A scale (Omron Hn-286, Kyoto, Japan) and stadiometer (Detecto 448, Missouri, MO, USA) were used to measure weight and height respectively. Assessing the urine color for hydration levels was conducted by using The Urine Color Chart (Human Kinetics, Champaign, IL, USA), which consists of 8 colors on the Likert scale ranging from very pale yellow to brownish green. Bioelectrical Impedance Analysis related measurements, such

as body water percentage, body fat percentage, basal metabolic rate as well as other measurements, were taken using the BodyStat 1500 MDD (Bodystat Ltd, British Isles).

Students were approached and enrolled after being informed about the research purpose and its study procedures. In addition to the previously mentioned devices, a questionnaire was also employed. The questionnaire was self-administered and included 40 questions divided into 4 different sections: demographics, risk factors, signs and symptoms, and knowledge and behavior. Demographics included age, sex, major of study, year of study, whether they are smokers or not, and marital status. Risk factors included physical activity, intensity of activity, sedentary lifestyle, water intake, beverage intake, dietary habits, sun exposure, and working hours. The frequency of experiencing signs and symptoms of a lack of hydration include dry lips, dry skin, sunken eyes, postural dizziness, bad breath, headache, and tiredness. In addition, the Urine Color Chart was used to indicate the level of hydration by asking each participant to approximate their usual urine color, as it could give an estimate to the hydration levels[9]. Numerous facts about hydration were listed in the "Knowledge and Behavior" section and participants were asked to state whether they had any prior knowledge about each fact. Furthermore, participants were asked to specify the source to which they acquired their knowledge pertaining to hydration from. An Arabic version of the questionnaire was also made available for Arabic only speakers. Questions not suitable for local culture, such as alcohol consumption were either removed or not added to the questionnaire.

Study Procedure

For further accuracy, the BodyStat 1,500 MDD requires the participant to stop eating 4-5 hours before the test, not to exercise for 12 hours before the test, and to stop caffeine (tea, coffee, and energy drinks) 24 hours before the test. If the student met these requirements in addition to the inclusion and exclusion criteria, they were eligible for the study.

Data collection was performed in one of the clinical labs on the medical campus as it had an examination bed for participants to lie down comfortably. Students who consented to participate in the study were asked to visit the clinical lab during a specified schedule, where all needed measurements were conducted. After explaining the procedure to the participant, an informed consent form was signed, and then, a scale and stadiometer were used to take measurements of the participant's height (in cm, rounded to the nearest whole number) and weight (in kg, to the nearest 0.1 of a kg). Afterwards, the participant would be instructed to remove his/her right shoe and sock, remove any watches or bracelets on the right wrist which may impede the correct placing of electrodes. The participant was then asked to lie down in a supine position, making sure that the right leg and right arm were spread out and not in contact with any other part of the body. Then, the areas of the skin where the electrodes were to be attached were wiped using alcohol wipes to remove any remnants of products on the body, such as any ointments that may affect the results. The participants were then asked to lie down for 5 minutes to allow the body to relax before placing the electrodes; two placed on the right foot and two on the right wrist.

After placing the electrodes, the BodyStat 1,500 MDD was then set up and the participant's demographics needed by the device were entered, including gender, age, height, weight, and their calculated BMI. Following that, the BodyStat 1,500 MDD would assess all the important values and show them on the display screen which were then printed out and attached to the participants' questionnaire.

It is important to note that before each use of the BodyStat 1,500 MDD, the machine would be cleaned using a detergent wipe and the investigators' hands were washed and sanitized before and after every participation was conducted.

Statistical Analysis

Data collected from the questionnaire and BodyStat 1,500 MDD was coded, entered, and analysed using SPSS 24 (Statistical Package for Social Sciences, IBM Corp., Armonk, NY, USA). Differences in water levels and fat free mass index between males and females were analysed using an independent samples *t*-test. Chi-square test was used to compare hydration levels between males and females and among risk factors groups, BMI, and sun exposure levels. A total of 23 questions in the questionnaire tested general hydration knowledge. A score out of 23 was calculated where each correct answer accounted for 1 point. An independent samples *t*-test was then used to compare the mean score across medical and non-medical students. The value of $p < 0.05$ is considered statistically significant for all statistical tests carried out in this study.

Results

Hydration is identified, by the guidance of Bioelectrical Impedance Analysis, as a body water content of 50-60% for females and 55-65% for males. Anything above or below is considered hyperhydration or hypohydration, respectively.

A total of 201 students participated in the study: 104 males and 97 females. According to our results, 55.7% of participants were well hydrated while 41.3% of participants had hypo-hydration levels and 3% were hyper-hydrated (Figure 1). Among those who were hypo-hydrated, males comprised 43.4% and females were 56.6%, (Figure 1). In addition, males were more well hydrated compared to females; 61.9% and 49.5% respectively. (Chi-square, $p < 0\ 01$)

Female students were also closer to the lower end of their normal water percentage range (50-60%) compared to males (55-65%) (*t*-test, $p < 0.0001$). This result was consistent with our hypothesis that females would be more likely to be hypo-hydrated than males. Males also had a higher fat free mass index (*t*-test, $p < 0.001$).

Risk Factors

95.20% of students who were obese were hypo-hydrated, and 65.30% of the overweight students had hypo-hydration levels as well. This is a vast contrast to the 27.20% of participants with normal BMI who had hypo-hydration (chi-square, $p < 0.0001$).

Risk Estimate of students with an abnormal BMI (overweight or obese) were 4.4 times more likely to be hypo-hydrated than students with normal BMI (2.4, 8.0).

The WHO Recommendations for physical activity was used in our questionnaire and our results show that in total, 57% of our participants did not meet WHO recommendations for physical activity (Figure 2). Of these 57%, females comprise 38% and males take up 19%. We did not, however, find any difference between those who exercised and those who did not exercise and their hydration levels.

The duration for the participants' exposure to the sun during day was as follows: 42% of participants are typically exposed for under 30 minutes per day, 25% for 30 minutes up to an hour, and 17% are usually exposed for over 2 hours. We hypothesize that sun exposure would have a drastic effect on hydration levels, however, our results did not show a significant difference (Chi-square, $p<0.07$).

Signs and Symptoms

The questionnaire had an entire section where participants were asked to indicate what applies to them from multiple signs and symptoms that could signify hypo-hydration. Our results showed that 51.90% of participants experienced dry lips most days of the week, 46.90% felt thirsty most hours of the day, 46.80% felt tired on most days, 39.70% had dry skin and 36.90% had multiple episodes of headache often.

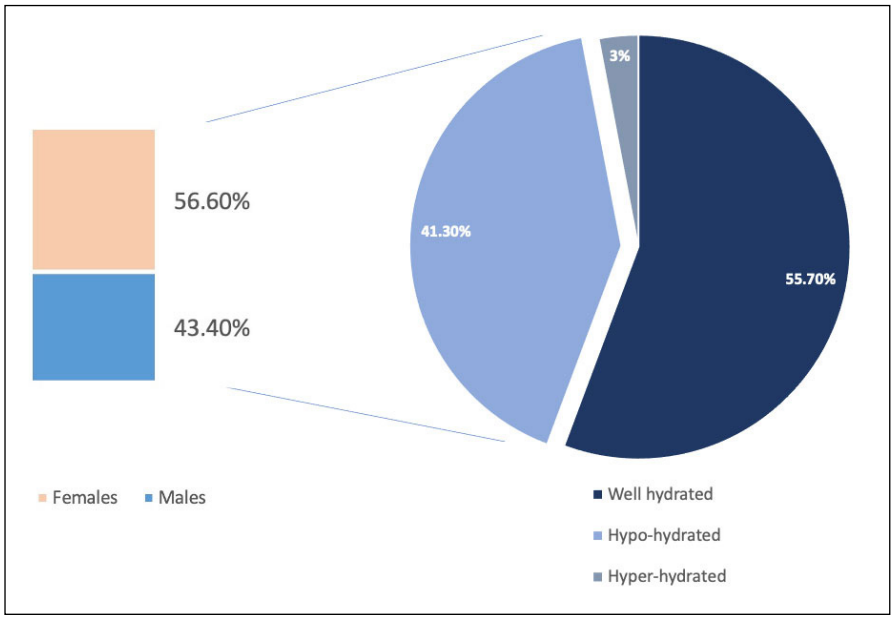

Figure 1. Hydration Status among university students and gender's effect.

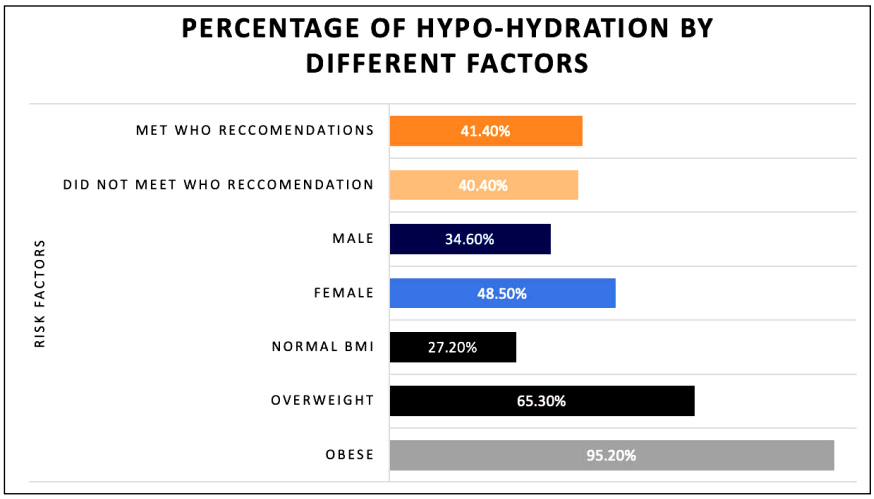

Figure 2. Percentage of hypo-hydration by different factors

Addingly, we incorporated The Urine Color Chart (Human Kinetics, Champaign, IL, USA) to estimate hydration levels. According to this chart, 3.5% of students were classified as dehydrated, 46% were in danger of getting hypo-hydration levels while only 19.5% were classified as having good hydration levels.

Knowledge, Practices and Behavior

Medical students had a higher average score in the knowledge sections of the questionnaire compared to non-medical students (Table I). The mean score for medical students was 13.45 (± 2.74) compared to 11.10 (± 2.211) for non-medical students (*t*-test, $p < 0.001$) (Figure 3). However, when com-

Table I. Percentage of medical and non-medical students correctly identifying statements regarding hydration.

Statements	Medical students	Non-medical students
Urine color can be used to indicate level of hydration	56.6%	23.3%
States of pregnancy and breastfeeding require higher hydration needs	80.9%	58.5%
Infants and children need water not only to replace daily water losses, but also to grow	70.6%	43.9%
The risk of dehydration is the same in adults and elderly	83.8%	61.0%
Everyone should drink about 8 glasses of water a day	60.1%	48.8%
Males or females have different recommendations for water intake	51.0%	27.9%
Thirst is the first indicator of dehydration	55.9%	69.8%
The winter season eliminates chances of dehydration	86.0%	67.4%
Caffeinated drinks dehydrate a person	44.8%	48.8%
Adequate hydration is important for brain performance	58.7%	34.9%
Dehydration only occurs in specific situations such as high temperatures or long periods without liquid	66.4%	58.1%
Dry air due to air conditioning leads to water loss	42.0%	60.5%
All food contributes to the same body hydration	72.7%	51.2%
After intensive exercise, sports drinks are better than water	28.7%	44.2%
Beverages help to reduce road fatigue when driving	49.0%	58.1%
Good hydration may decrease chances of heat stroke	62.9%	44.2%
Our percentage of body water content is roughly the same throughout our entire life	80.1%	73.2%
Hydration comes only from water	90.4%	75.6%
Drinking water copiously is a good way to cleanse the body	82.4%	92.7%
Dehydration is relatively rare and occurs only when the body is deprived of water for several days	76.5%	65.9%
Due to age or some medications, the sensation of thirst can be reduced	63.2%	53.7%

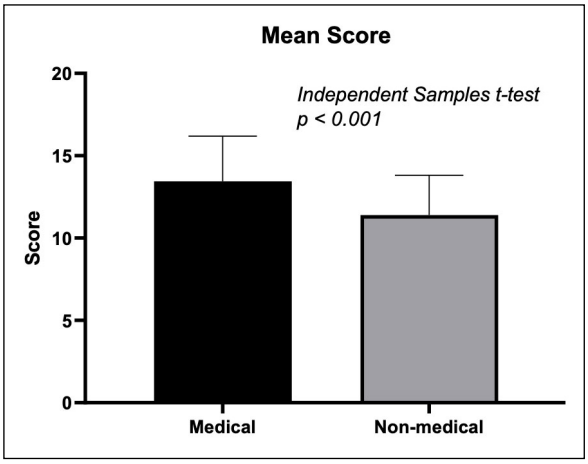

Figure 3. Knowledge score between medical and non-medical students based on their answers in the knowledge sections of the questionnaire.

paring knowledge and practices, this knowledge was not reflected into practice. When asked to estimate how many bottles of water consumed per day, with each bottle being 500 milliliters, 59.2% of participants admitted to drinking 2 or less bottles a day (about less than 1 liter a day). Only 13.9% of participants would consume more than 4 bottles, almost 2 liters a day (Figure 4).

Moreover, the difference in knowledge percentages was not that great between medical students and non-medical students so it really sheds a light on the necessity of not only spreading awareness and education, but also the encouragement of good practices.

When asked what drinks the participants would resort to when thirsty, 79% of participants would opt for water when feeling thirsty, while 11% resorted to soft drinks and 10% to juices.

At last, participants were asked where they attained their knowledge pertaining to hydration from. 64.2% acquired their knowledge from internet, 30.8% from TV and radio and 26.9% from books and courses.

Discussion

Dehydration has a strong negative impact on human body homeostasis[3,4,12,13]. When left without treatment, it can alter the structure of vital organs, such as the brain. This is seen in how distorted hydration levels may lead to brief instabilities in brain tissue and ventricular volumes[8,,]. Despite the numerous risk factors that contribute to dehydration in the MENA region, little to no research has been conducted to investigate its prevalence, risk factors, impact, or levels of knowledge of this imperative issue. Investigating the hydration status of the university students may also improve their academic performance and they will be more receptive of targeted awareness programs[9].

In the current study, the body composition and hydration levels were measured using Bio-electrical Impedance Analysis (BIA) in university student's cohort. In addition, paper-based questionnaires were utilized to obtain demographics, levels of knowledge, physical activity, as well as water intake among other variables. Out of the 201 participants, 41.3% were hypohydrated, and the majority of which were female. Also, BMI was identified as one of the most important risk factors for hypohydration. Participants who were obese (BMI > 30.0) were 4.4 times more likely to be hypo-hydrated comparted to their counterparts

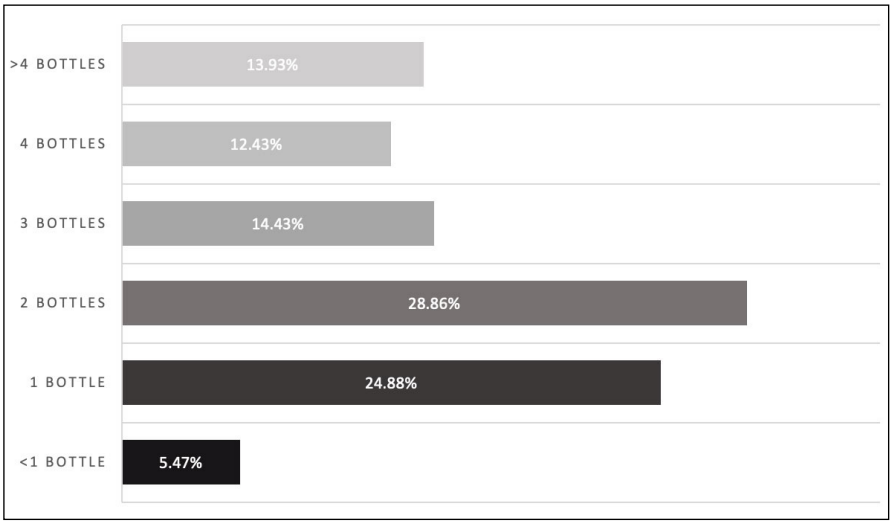

Figure 4. Water intake among college students using small water bottles.

with normal BMI. Consistent with our findings, a previous study[13] in UK conducted among university and club level athletes found that 31.9% of athletes were dehydrated prior to exercise and 43.6% were dehydrated post-exercise. Interestingly, both studies were conducted in drastically different climates, but they both yielded similar results, indicating that although climate may play a vital role in water loss, it may not be the main contributor to lower levels of hydration. It is important to note that our study measured hydration status but did not label participants as dehydrated, as it necessitates invasive procedures not available to us at the time of the study.

BMI and gender had a significant impact on hydration status, as mentioned earlier. In this study, we also compared the effect of gender on the BMI. A higher percentage of female students had a BMI classification of normal compared to male students; as viewed above, 30.8% of females were within normal BMI range, compared to 25.9% of males. At the same time 8.0% of males were obese, compared to females, 2.5%.

Water percentage's relation was correlated with gender. Based on our results, we found out that normal water percentage range for females and males is 50-60% and 55-60% respectively. By using *t*-test it was deduced that female students were closer to the lower end of their normal range compared to male participants.

On the other hand, the relation between basal metabolic rate and gender was also studied. Respectively, female students showed that they had a lower BMR (16.6%) in general compared to male students (24.4%).

Furthermore, the relationship between fat free mass index and gender was analyzed as well. In brief, the results between participants showed that male students had a higher fat free mass index than female students. A previous study[13] conducted among older men and young women found that fat-free mass is increased in women and older men contributing to a decrease in hydration status. In conclusion, our results show the linear relationship that as BMI increases, hydration status decreases. This is due to the fact that as BMI increases, fat comprises a greater proportion of the body mass, and a lesser fat free mass, resulting in a lower body water percentage. Therefore, female participants had a higher risk for dehydration perhaps because females generally have a higher percentage of body fat compared to males.

As expected, overall the medical students did have higher knowledge levels pertaining to hydration than non-medical students; however, a few questions showed varied results. Only a part of medical students (56.6%) identified urine color as an indicator of hydration levels in contrast to the 23.3% of non-medical students who identified that fact. This reflects the lack of knowledge in our society, especially those without any medical background knowledge. The same trend is noticed in how the female or male sex affects water recommendations; only 51% of medical students correctly recognized the importance, and only 27.9% of non-medical students did the same.

In the few questions with varied results, such as the effect of air conditioning on hydration, non-medical students correctly identified the statements more than students from a medical background, 60.5% and 42.0% respectively. The same was also observed when asking if thirst is the first indicator of dehydration; where 69.8% of non-medical students responded correctly to the statement, while only 55.9% of medical students answered it correctly.

At the end, this study has attempted to provide some evidence of the importance of water hydration to our health, as well as the role of obesity and gender in relation to hydration status. Water is essential to maintain homeostasis and appropriate bodily functions. Further studies are warranted to understand the extent of this critical problem and sharpen our focus on the importance of water in human health.

Limitations

The limitations in our current study include using convenience sampling which led to a slightly biased result that did not fully represent university students in the UAE. In addition, the initial plan was to have 385 participants in the study; however, due to lack of resources, it was limited to only 201 participants. Despite those limitations the main strength of our study is that it is the first in UAE to implement Bio-electrical Impedance Analysis and provide objective results when measuring hydration levels in university students.

Conclusions

In conclusion, this study revealed that 41.3% of university student participants were hypohydrated, in which the majority of them were females. A large proportion of hypohydrated students demonstrated a lack of knowledge about hydration compared to euhydrated students. Obesity also was shown in our study to be a very significant risk factor for being hypohydrated.

Furthermore, implementation of awareness programs is warranted to enhance students' knowledge about hydration, sufficient water intake, as well as risk factors and health consequences of dehydration. In addition, decent hydration habits among university students must be encouraged, as adequate hydration knowledge alone is of no benefit without good hydration habits. Regular check-ups held intermittently can also aid in identifying and recognizing hydration status of the students.

Acknowledgments

The authors thank all participants of the study.

Conflict of Interest

The authors declare that they have no conflict of interest.

Ethical Approval

The study has been reviewed and approved by the Research Ethics Committee at the University of Sharjah (Reference number: REC-18-02-07-01-S).

Informed Consent

All participants have read and signed the informed consent form before participating in the study.

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