Analysis of determinants of hydration status of medical students at the Universitas Sumatera Utara

Analisis faktor penentu status hidrasi mahasiswa kedokteran Universitas Sumatera Utara

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Abstract

Dehydration can impair the operation of the body's organs and cause mortality because the human body is 60% water. The purpose of this study was to analyze factors related to hydration status. This study used a cross-sectional research design in a descriptive-analytical study. The study was conducted in the Nutrition Department of the Faculty of Medicine, Universitas Sumatera Utara. The study was conducted from September to October 2020. 99 students were chosen at random to participate in the study. Respondent characteristics, physical activity, nutritional status, body composition, fluid intake, and hydration status were among the information gathered. Subject follow-up was carried out for 7 consecutive days. Positive relationships and significance between dietary status (p = 0,014), total body water (p = 0,018), muscle mass (p = 0,012), level of exercise (p = 0,003), and total fluid intake (p = 0,044) were found in the results of the multiple regression test. Additionally, a negative association and significance between visceral fat (p = 0,03) and body fat (p = 0,016) is discovered. Based on the test's findings, a determination coefficient with a value of 85,5% was calculated, meaning that 85,5% of factors influencing hydration status include dietary habits, body composition, visceral fat, total body water, muscle mass, level of exercise, and total fluid intake. Conclusion, nutritional status, total body water, muscle mass, physical activity, and overall fluid intake all have a positive correlation with hydration status. However, there was shown to be a negative correlation between body fat and visceral fat and hydration status.

Keywords: Anthropometric, body composition, fluid consumption

Abstrak

Tubuh manusia tersusun dari 60% cairan sehingga dehidrasi dapat mengganggu fungsi organ tubuh dan berakibat kematian. Tujuan dari penelitian ini adalah untuk menganalisis faktor-faktor yang berkaitan terhadap status hidrasi. Jenis penelitian adalah deskriptif analisis dengan desain penelitian potong lintang. Studi ini dilaksanakan di ruangan Departemen Gizi Fakultas Kedokteran Universitas Sumatera Utara. Penelitian ini dilaksanakan dari bulan September sampai Oktober 2020. Peneliti melibatkan 99 mahasiswa Fakultas Kedokteran Universitas Sumatera Utara yang dipilih secara acak sederhana. Data yang dikumpulkan meliputi karakteristik responden, aktivitas fisik, status gizi, komposisi tubuh, asupan cairan dan status hidrasi. Subjek penelitian dilakukan follow up selama 7 hari berturut-turut. Dari hasil uji regresi didapatkan hasil signifikan dan korelasi yang positif dari status nutrisi (p = 0,014), total cairan tubuh (p = 0,018), massa otot (p = 0,012), tingkat aktivitas (p = 0,003) dan total konsumsi cairan (p = 0,044). Selain itu, hasil signifikan dan korelasi negatif didapatkan pada lemak tubuh (p = 0,016) dan lemak visceral (p = 0,030). Berdasarkan hasil uji koefisien determinasi didapatkan nilai 85,5% yang menandakan bahwa 85,5% status hidrasi dipengaruhi oleh status nutrisi, lemak tubuh, lemak visceral, total cairan tubuh, massa otot, tingkat aktivitas, dan total konsumsi cairan.
Introduction

The majority of the human body, between 50 and 75%, is composed of water. The older a person is, the lower the water content in the body system. Fluid in the body system is divided into two types: intracellular (± 67%) and extracellular space (± 33%). Additionally, the fluid in the extracellular space is divided into two types: interstitial space (75%) and intravascular space (25%) (Brinkman et al., 2023; Chen et al., 2022; Tobias et al., 2022). The compositions of the electrolytes in these spaces showed different concentrations. The compositions of the interstitial and intravascular spaces are generally similar, with sodium and chloride being the main contributors to osmolarity. In the intracellular space, osmolarity is mainly regulated by potassium ions, the rest is regulated by other substances such as phosphate, magnesium, and phosphocreatine (Brinkman et al., 2023; Chen et al., 2022).

Water plays a role in thermoregulation, maintaining intravascular volume, as a transport medium for nutrients and as a solvent for waste products (Liska et al. 2019). Subsequently, fluid loss can affect various bodily functions. For example, mild dehydration, defined by –1-2% fluid loss, causes symptoms such as impaired concentration, memory, and cognition (Kostelnik et al., 2021). The long-term effects of this dehydration were also associated with an increased risk of kidney stones, chronic kidney disease, urinary tract infections, cardiovascular diseases, and metabolic diseases (Nakamura et al., 2020). The fluid intake needed differs among individuals depending on age, gender, and other condition such as pregnancy and lactation. A fluid intake of 2500 ml and 2350 ml is generally recommended for men and women between the ages of 19 and 64 years (Moeloek, 2019).

The hydration status is used to determine whether a person is dehydrated. This status describes the balance between the amount of fluid leaving and entering the body, which is then determined by measuring the concentration of urine. The concentration of urine can be measured using common markers such as urine osmolality, specific gravity, and urine color (Kostelnik et al., 2021). Less common methods include measuring body composition using a Bioelectrical Impedance Analysis (BIA) tool, changes in body weight, and hematological parameters (Kusuma, 2020).

Various studies have shown that body water content is related to body composition and overall health. A balanced amount of body fluid is associated with a low ratio of waist circumference to body fat mass (Carretero-Krug et al., 2021; García et al., 2019). Individuals who are not adequately hydrated have 1.59 times risk of becoming obese (Chang et al., 2016). However, this is not consistent with the study conducted by Kurniawati et al. (2021), where no relationship was found between nutritional and hydration status in male workers (Kurniawati et al., 2021). The amount of fluid intake and physical activity also affect hydration status (Pustisari et al., 2020); however, the study carried out by Merita et al. (2018) also did not find a significant relationship between the nutritional and hydration status of adolescents in Jambi City (Merita et al., 2018).

According to earlier research, students’ levels of hypohydration ranged from 26.9% to 41.3% (Abdulsalam et al., 2022; Nur’aini et al., 2021). Students who are dehydrated may have poorer psychomotor, cognitive, physical, and motivational abilities (Ekpenyong & Akpan, 2017). Since our university has not yet conducted any research on the hydration status of medical students, further research is essential to determine the rate of dehydration among these students and the variables influencing their hydration condition.

Depending on a variety of variables, such as age, physical size, gender, sport, type of work, and place occupied, each person has a varied level of water adequacy. It is important to monitor hydration levels to prevent dehydration, which can harm health and fitness. The study aims to analyze factors related to the hydration status of students. This study aims to analyze factors related to hydration status in college students.
Methods
This study used a cross-sectional observational design to obtain data on the relationship between various factors and hydration status. Furthermore, it was carried out at the residence of each subject by the Department of Nutrition at the Faculty of Medicine, Universitas Sumatera Utara USU, from September to October 2020. This study was authorized by the Universitas Sumatera Utara USU Ethics Committee for Research on June 15, 2020, with reference number 69/KEP/USU/2020.

Sample Size
In this study, the target population included all USU Faculty of Medicine students which were comprised of students of 2017 (254 people), 2018 (249 people), and 2019 (245 people). The respondents were students who were selected using simple random sampling. The sample size was determined using the Taro Yamane formula (Yamane., 1973), where a total population of 748 people with a precision level of 10%, a sample size of 89 respondents was obtained.

\[ n = \frac{N}{1 + N(e)^2} \]

\[ n = \frac{748}{1 + 748(0.1)^2} = 88.2 \approx 89 \text{ respondents} \]

n : sample size l
N : population
e : allowale (10%)

To anticipate the occurrence of dropouts, additional respondents were added based on the following formula (Kang, 2021):

\[ n' = \frac{n}{1 - d} \]

\[ n' = \frac{89}{1 - 0.1} = 98.88 \approx 99 \text{ respondents} \]

n’ : final sample size
n : sample size
d : drop out proportion

Instruments
Primary data collected were respondents’ characteristics, physical activity, nutritional status, body composition, total fluid intake and hydration status were obtained. These data were obtained by questionnaires, which consists of fluid intake, hydration status, as well as measuring body composition and nutritional status.

Body composition measurements, such as categorizing BMI levels, can be used to determine nutritional status. (IMT). The Bio Impedance Analysis tool is used to determine the amount of total body water, body fat, visceral fat, and muscle mass, while a statumeter is used to determine the body height (TB) in meters.

The nutritional status of the respondents was obtained from the calculation of the body mass index (BMI) by comparing body weight in kilograms and height in meters. The results obtained are compared using BMI tables for the Asia Pacific population, namely underweight (< 18.5 kg/m²), normal (18.5-22.9 kg/m²), overweight (23-24.9 kg/m²), and obesity (≥ 25 kg/m²) (Weir & Jan, 2022). The respondents were also asked about physical activity, which was categorized into light, moderate and heavy. It is classified to be light activity 75% of the time used is sitting, moderate if 40% of the time is spent sitting, and heavy if 25% of the time is spent sitting (Almatsier, 2010).

Figure 1. Urine self-examination card (Gunawan et al., 2018).

The collection of fluid intake data was carried out for seven consecutive days at three different times, namely at 10 am, 5 pm and 10 pm using a consumption recall form. Respondents reported independently through the google form application that had been designed by the researcher. The recommended
daily fluid intake for people is around eight glasses of 230 ml each, or a total of 2000 ml. As a result, the researchers divided daily fluid intake into two categories: sufficient consumption (2000 mL or more) and insufficient consumption (less than 2000 mL).

Hydration status was measured by comparing the color of one's urine using a urine self-examination card (PURI card). The status is classified as hydrated when the color of the urine paired with the PURI card shows good and it is categorized as dehydrated when it does not fulfil the criteria.

**Statistical Analysis**

Data processing and analysis were carried out descriptively to determine the frequency distribution of the primary data. The normality test and the colinearity test are used to validate the regression analysis results before the hypothesis is tested. The link between free variables and bound variables is evaluated using the Pearson correlation test.

Furthermore, analytical tests were carried out to determine the factors affecting hydration status using a multiple linear regression method with the equation below:

\[ Y = b_0 + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + b_6X_6 + b_7X_7 + e \]

**Description**

- **Y**: Hydration status
- **X1**: Nutritional status
- **X2**: Body fat
- **X3**: Total body water
- **X4**: Muscle mass
- **X5**: Physical activity
- **X6**: Visceral fat
- **X7**: Total fluid consumption
- **e**: Error term
- **b0**: Constant
- **b1-7**: Regression coefficient

The examiner's tested the uniformity of the data with a normality test to avoid bias for each variable. Furthermore, a multicollinearity test was performed to avoid correlations between independent variables by paying attention to the Variance Inflation Factor (VIF) value, which did not exceed 10 and tolerance value was greater than 0.1. The sustainability of proving the hypothesis was carried out by using a t-test with a limit of coefficient of determination from 0 to 1. Approaching 1 means that the independent variable provides almost all the information needed to predict the dependent variable, and vice versa.

**Result and Discussion**

**Respondents' Characteristics, Body Composition, and Hydration Status**

A total of 99 respondents consisted of 48 male (48.5%) and 51 female (51.5%) with an average age of 20.08 ± 1.08 years. Most of the respondents did relatively light daily physical activity (79.8%) (Table 1).

In this study, the majority of the respondents were female who engaged in light daily physical activity, were overweight, and well hydrated. In previous studies, which conducted on university students, it was reported that the majority of the respondents were female and had good hydration status (Arista & Wahyudin, 2021; Ekpenyong & Akpan, 2017; Nur'aini et al., 2021). The results of previous studies regarding physical activity showed different results. The study carried out on students showed that their activity is classified as moderate (Amaliya, 2018; Merita et al., 2018), and low (Ekpenyong & Akpan, 2017; Nur'aini et al., 2021). The results of the study performed on the nutritional status of students showed that it was classified as normal (Amaliya, 2018; Ekpenyong & Akpan, 2017; Merita et al., 2018; Nur'aini et al., 2021). The difference in the results was due to the difference in the time of sampling. In this study, sampling was carried out during the COVID-19 pandemic, and the learning process was carried out online. This causes a decrease in most of the student's physical activity, which results in an increase in BMI. In addition, the density of learning activities for medical students as respondents causes limited time to do physical activities.

Table 1 also shows that the majority of respondents are overweight (48.45%) and obese (7.1%) with a body fat percentage of 27.73 ± 8.65 and a ratio of visceral fat of 6.02 ± 3.95. Based on the self-examination of urine conducted by respondents, most of them belonged to the category of hydrated (51.5%) and an average daily fluid intake of 2070,07 ± 654,93mL.
Table 1. Respondents characteristics, body composition, and hydration status

<table>
<thead>
<tr>
<th>Respondents characteristics</th>
<th>Mean (SD) or Total n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age in years</td>
<td>20,08 ± 1,08 &gt;0,05</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>48 (48,5)</td>
</tr>
<tr>
<td>Female</td>
<td>51 (51,5)</td>
</tr>
<tr>
<td>Daily physical activity</td>
<td></td>
</tr>
<tr>
<td>Light</td>
<td>79 (79,8)</td>
</tr>
<tr>
<td>Moderate</td>
<td>19 (19,2)</td>
</tr>
<tr>
<td>Heavy</td>
<td>1 (1,0)</td>
</tr>
<tr>
<td>Body weight in kilograms</td>
<td>64,89 ± 15,39</td>
</tr>
<tr>
<td>Body height in meters</td>
<td>1,63 ± 0,08</td>
</tr>
<tr>
<td>Nutritional status</td>
<td></td>
</tr>
<tr>
<td>Normal</td>
<td>44 (44,4)</td>
</tr>
<tr>
<td>Overweight</td>
<td>48 (49,5)</td>
</tr>
<tr>
<td>Obesity</td>
<td>7 (7,1)</td>
</tr>
<tr>
<td>Percentage of total body water</td>
<td>48,64 ± 5,71</td>
</tr>
<tr>
<td>Percentage of body fat</td>
<td>27,73 ± 8,65</td>
</tr>
<tr>
<td>Visceral fat ratio</td>
<td>6,02 ± 3,95</td>
</tr>
<tr>
<td>Muscle mass in kilogram</td>
<td>43,74 ± 10,69</td>
</tr>
<tr>
<td>Hydration status</td>
<td></td>
</tr>
<tr>
<td>Hydrated</td>
<td>51 (51,5)</td>
</tr>
<tr>
<td>Dehydrated</td>
<td>48 (48,5)</td>
</tr>
<tr>
<td>Average of total fluid consumption in milliliters</td>
<td>2070,07 ± 654,93</td>
</tr>
</tbody>
</table>

According to the examination results of body composition (Table 1), the average percentage of respondents' total body water was around 48.64%. In previous studies, it was found that the average total body water in medical students was around 54.4% (Mastria & Adyaksa, 2014). The average percentage of body fat obtained in this study ranged from 27.73%, this result is no different from previous studies which obtained an average percentage of body fat in medical students ranging from 26.7% (Haq et al., 2020) to 28.34% (Widiastuti et al., 2018). Based on the average visceral fat ratio, 6.02 was recorded, while the study done with medical students in China, 4.1 was recorded (Haq et al., 2020). Finally, muscle mass was 43.74 Kg and the study carried out in China obtained an average muscle mass of 41.3 Kg (Haq et al., 2020).

Table 2. Colinearity test for respondents' body composition

<table>
<thead>
<tr>
<th>Model</th>
<th>T</th>
<th>p value</th>
<th>B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>3,682</td>
<td>0,010</td>
<td></td>
</tr>
<tr>
<td>Nutritional status</td>
<td>-4,216</td>
<td>0,014</td>
<td>1,282</td>
</tr>
<tr>
<td>Body fat</td>
<td>-3,585</td>
<td>0,016</td>
<td>-1,318</td>
</tr>
<tr>
<td>Total body water</td>
<td>-3,271</td>
<td>0,018</td>
<td>2,301</td>
</tr>
<tr>
<td>Muscle mass</td>
<td>-4,206</td>
<td>0,012</td>
<td>1,226</td>
</tr>
<tr>
<td>Physical rating</td>
<td>3,044</td>
<td>0,003</td>
<td>1,418</td>
</tr>
<tr>
<td>Visceral fat</td>
<td>3,024</td>
<td>0,030</td>
<td>-1,200</td>
</tr>
<tr>
<td>Total water consumption</td>
<td>4,043</td>
<td>0,044</td>
<td>2,500</td>
</tr>
</tbody>
</table>

Based on the results of the coefficient of determination, a correlation value of 0.892 was obtained (Table 3). This means that the general nutritional status, body fat, total body water,
muscle mass, physical rating, visceral fat and total water consumption can improve hydration status.

**Table 3. Coefficient of determination test**

<table>
<thead>
<tr>
<th></th>
<th>R</th>
<th>R Square</th>
<th>Adjusted R Square</th>
<th>Std. Error</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.892</td>
<td>0.855</td>
<td>0.802</td>
<td>4.849</td>
</tr>
</tbody>
</table>

From the same test, it is also known that the coefficient of determination (R2) is 0.855 (85.5%). Therefore, it can be reported that the 85.5% variation of hydration status in the model can be explained by variables such as nutritional status, body fat, total body water, muscle mass, physical rating, visceral fat and total water consumption. The remaining 14.5% can be influenced by other variables outside the model.

In this study, there was a significant and positive correlation with hydration status for the variables of nutritional status, total body water, muscle mass, physical rating, and total fluid intake. This result is not consistent with the study by (Kurniawati et al., 2021) on male workers and (Nur’aini et al., 2021) on medical students in Palembang (Nur’aïni et al., 2021) as well as with the physical activity variable (Merita et al., 2018; Nur’aini et al., 2021). The results of other studies obtained a significant relationship with the incidence of dehydration in respondents, which can be assessed by specific gravity and urine color. Adequate water consumption is indicated by clearer urine color and a lower urine-specific gravity value (Ekpenyong & Akpan, 2017; Kurniawati et al., 2021).

From the results of the coefficient of determination, it was reported that 85.5% hydration status was influenced by nutritional status, total body water, muscle mass, physical rating, total fluid consumption, body fat, and visceral fat. The remaining 14.5% of hydration status is influenced by other factors outside this study model. These other factors in several studies are knowledge variables (Kurniawati et al., 2021), gender (Amaliya, 2018), age (Bruno et al., 2021), and type of diet that implemented (San Mauro Martin et al., 2019).

The weakness in this study is the number of respondents. Other variables that may affect hydration status such as body temperature, climate (temperature, moist) and type of fluid consumed were not included. Therefore, in a future study, it is hoped that there would be an increase in the number of samples and more variables that affect hydration status can be analyzed.

**Conclusion**

From this study it was found that the variables of nutritional status, total body water, muscle mass, activity level, total fluid consumption, body fat and visceral fat contributed 85.5% to
students' hydration status. This research can be used as a reference for making policies on campus to overcome dehydration in students, for example by providing education on the importance of fluid consumption, increasing physical activity such as routine sports.

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References


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