



The Effect of Body Mass Index, Fluid Intake, and Physical Activity Level on Hydration Status of Rice Farmers in Pakantan Sub-district

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Abstract

Pakantan Sub-district is located in Mandailing Natal Regency, North Sumatra Province, where the majority of the population are rice farmers. Rice farmers are prone to dehydration because they do most of their work outdoors and are exposed to extreme temperatures for longer periods of time. The purpose of this study was to identify the effect of body mass index,

physical activity, and fluid intake on hydration status in rice farmers in Pakantan Sub-district. The sample size in this cross-sectional study was 97 farmers selected by simple random sampling from eight villages in Pakantan Sub-district. Data were analyzed using chi square test (bivariate) and multiple logistic regression test (multivariate). The results showed that rice farmers with low levels of physical activity (Exp (B)=0.012 (95% CI: 0.000–0.893); $p=0.044$) and adequate fluid intake (Exp (B)=0.013 (95% CI: 0.000–0.128); $p<0.001$) had a lower odds of dehydration compared to rice farmers who had high levels of physical activity and inadequate fluid intake. Meanwhile, body mass index had no significant effect ($p=0.158$) on the hydration status of rice farmers in Pakantan Sub-district. Farmers are expected to reduce excessive physical activity and are suggested to bring and drink enough water, at least 2.5 liters per day, to prevent dehydration.

Keywords: Body mass index, Dehydration, Farmer, Fluid intake, Physical activity

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Introduction

Water is an essential component of the body, composing about 62% of the body weight of an adult male and 55% of the body weight of a normal-weight adult female (Lu et al., 2023). Body water is needed to maintain normal physiological functions, as a building material for cells and organs, a regulator of body temperature, a lubricant for joints, a solvent for various organic and inorganic molecules, a transporter of red blood cells that carry oxygen and electrolytes as well as nutrients in plasma and is involved in most metabolic functions. It is excreted through the skin as sweat, through the lungs during breathing, through the kidneys as urine, and through the digestive tract as feces or vomit (Hall, 2018; Iversen & Fogelholm, 2023).

Fluid balance in the body is achieved when the amount of input, including direct fluid intake and consumption of water-containing foods, and output are adequate (Miller et al., 2021). Failure to replace the amount of water lost from the body in such a way can lead to a condition called dehydration. Dehydration can result from increased fluid demands, excessive fluid loss or a combination of both. Symptoms of dehydration include thirst, dry skin and mouth (including lips and tongue), fatigue and dizziness, urinating less frequently than usual, urine is less than usual and darker or more concentrated in color, sunken eyes, and increased pulse and respiration (Taylor et al., 2022). Losing 1–2% of body water (mild dehydration) is reported to cause fatigue and impair cognitive functions, such as concentration and memory. Repeated episodes of dehydration or chronic dehydration can increase the risk of various diseases, ranging from kidney and urinary tract stones to chronic kidney disease, neurological disorders, and metabolic disorders (El-Sharkawy et al., 2015).

The hydration status varies based on individual characteristics, such as age, gender or body mass index. Older adults are 20–30% more prone to dehydration due to immobility, impaired thirst mechanisms, decreased kidney function due to aging and existing comorbidities such as diabetes, kidney disease or cardiovascular disease (Shaban et al., 2022). Fat has much less water content than other body tissues. Thus, women and obese people have relatively less total body water as they have a higher percentage of body fat and are consequently more prone to dehydration



(Ekingen et al., 2022; Lu et al., 2023). Dehydration risk is also influenced by climate or environmental temperature and physical activity. When the body is exposed to high environmental temperatures, the body produces sweat to help reduce body temperature, resulting in greater fluid loss than when in normal environmental temperatures (Pramesti et al., 2024). The intensity and duration of physical activity that a person engages in can also lead to higher than normal fluid loss due to sweating (Laja García et al., 2019). Several conditions or diseases such as fever, diarrhea, vomiting, gastrointestinal bleeding, dysphagia, kidney disease, and certain medications (e.g., diuretics and laxatives) can also trigger dehydration (Shaban et al., 2022). In addition, hydration status is also reported to vary based on the amount and type of fluid consumed (Zhang et al., 2022).

Dehydration can affect any individual. One of the types of work that is quite vulnerable to dehydration is rice farmers. Farmers do most of their work outdoors every day so they may be exposed to varying environmental temperatures, especially hot weather, during their activities of cultivating land, sowing seeds, plowing fields or harvesting rice (Culp & Tonelli, 2019). Pakantan Sub-district is located in Mandailing Natal Regency, North Sumatra Province, which has a significant contribution to the agricultural sector. The majority of the population in this region are working as farmers either as rice field owners or laborers. The results of a preliminary survey conducted by the researcher found that rice farmers in the Pakantan Sub-district generally spend a minimum of ten hours a day working in the fields with a rest period of about 1–2 hours each day. Some of them complain that they often experience fatigue, dizziness, and soreness, especially in the waist. Therefore, we aimed to identify the hydration status and determine the effect of body mass index, physical activity and fluid intake on the hydration status of rice farmers in this area.

Methods

This study used quantitative methods with a cross-sectional design. The research location was in Pakantan Sub-district located in Mandailing Natal Regency, North Sumatra Province. The study population was all rice farmers residing in Pakantan Sub-district which amounted to 2,523 people. The sample size was calculated using the Slovin formula obtained a sample of 97 farmers



to represent the population. Sample collection was conducted by simple random sampling from eight villages in Pakantan Sub-district, which were divided proportionally to represent each village. The inclusion criteria for the sample were farm laborers and rice farmers who owned the rice fields, while the exclusion criteria were farmers who had a history of diabetes and kidney disorders, were fasting at the time of data collection, were not conducting agricultural activities during the past year, were taking diuretic drugs, and were not willing to be interviewed for data collection.

The variables in this study consisted of dependent variable, that is, hydration status and independent variables, consisting of body mass index, fluid intake and physical activity level. Hydration status was measured using urine color chart. Farmers were asked to collect urine in a clear container then the color of the urine in the container was compared with the urine color chart (Figure 1) under an adequate light source such as sunlight or lamp. The measurement was done once when the farmer finished working and the examination was done by a doctor or expert. The urine color chart consists of four scale categories, where darker urine color indicates more severe dehydration. Scale 1–2 means no dehydration, scale 3–4 indicates mild dehydration, scale 5–6 indicates moderate dehydration, and scale 7–8 means severe dehydration. For data analysis, hydration status was categorized into not dehydrated: scale 1–2 and dehydrated: scale 3–8.



Figure 1. Urine color chart (Healthdirect, 2024)



Body mass index (BMI) was obtained by calculating body weight (kg) divided by the square of height in meters (m^2) after measuring body weight using a calibrated body scale and measuring height using a microtoise. The results were categorized into underweight ($<18.5 \text{ kg}/m^2$), normal ($18.5\text{--}24.9 \text{ kg}/m^2$), and obese ($\geq 25 \text{ kg}/m^2$). Fluid intake were measured using the Beverage Intake Questionnaire (BEVQ), which consisted of questions regarding the type of beverages consumed as well as the amount and frequency of consuming it over the past seven days. The results were then categorized into adequate (fluid intake $>2,500 \text{ ml}/\text{day}$) and inadequate (fluid intake $\leq 2,500 \text{ ml}/\text{day}$). Meanwhile, physical activity level was measured using the International Physical Activity Questionnaire (IPAQ), which assessed how much moderate-intensity activity, vigorous-intensity activity, and walking was engaged in over the past seven days including all occupational, home-based, and leisure activities. Next, the total METs (metabolic equivalent of tasks) for the activities engaged in during the week were calculated, where the MET values for walking, moderate activity, and vigorous activity were 3.3, 4 and 8, respectively. The results were categorized into: high activity level (vigorous physical activity >3 days with total METs of at least 1,500 METs minutes/week or a combination of walking, moderate or vigorous activity ≥ 7 days with total METs of at least $>3,000$ METs minutes/week), moderate activity level (vigorous physical activity and/or walking ≥ 3 days for at least 30 minutes/day or moderate physical activity and/or walking ≥ 5 days for at least 30 minutes/day or a combination of walking, moderate or vigorous activity ≥ 5 days with total METs of at least 600 minutes/week), and low activity level (if neither high nor moderate activity level criteria were met).

Data were analyzed in univariate, bivariate and multivariate. Univariate analysis aims to provide an overview of the respondents' characteristics, while bivariate analysis was conducted to determine the association of each independent variable with the dependent variable using the chi-square test. Finally, to determine which independent variable most affects hydration status, multivariate analysis was performed using multiple regression test with a confidence level of 95% and the effect is significant if p-value <0.05 .



Results

The results of the study based on data collection from 97 rice farmers in Pakantan Sub-district are as follows.

Table 1 Characteristics of Rice Farmers in Pakantan Sub-district

Characteristics	n(=97)	% (=100)
Age		
24–59 years	78	80.4
60–65 years	19	19.6
Gender		
Female	54	55.7
Male	43	44.3
Length of work		
0–5 years	30	30.9
6–10 years	20	20.6
11–20 years	21	21.7
21–40 years	26	26.8
Work environment climate		
≤ Threshold value	58	59.8
> Threshold value	39	40.2
Hydration status		
Not dehydrated	18	18.6
Dehydrated	79	81.4

Table 1 shows that most of the rice farmers in this study were between 24–59 years old (80.4%), female (55.7%) and had worked for five years or less (30.9%). Climate measurements in the farmer's work environment in the morning, afternoon and evening using a thermohygrometer found that most rice farmers (59.8%) worked at an environmental temperature that did not exceed the threshold value according to the Regulation of the Minister of Manpower of the Republic of Indonesia Number 5 of 2018 Regarding Occupational Safety and Health in the Work Environment based on the type of work, workload and metabolic rate, which is $\leq 29^{\circ}\text{C}$. The results also showed that the majority of rice farmers were dehydrated (81.4%).



Table 2 Bivariate Analysis Results

Independent variables	Hydration status				Total		p-value
	Dehydrated		Not dehydrated		n(=97)	%	
	n	%	n	%			
Body mass index							
Obese	25	89.3	3	10.7	28	100	0.158
Normal	42	75.0	14	25.0	56	100	
Underweight	12	92.3	1	7.7	13	100	
Fluid intake							
Inadequate	63	98.4	1	1.6	64	100	<0.001
Adequate	16	48.5	17	51.5	33	100	
Physical activity level							
High	77	87.5	11	12.5	88	100	<0.001
Moderate	1	25.0	3	75.0	4	100	
Low	1	20.0	4	80.0	5	100	

The results of the bivariate analysis as seen in Table 2 showed that of the majority of rice farmers in each BMI category were dehydrated, 89.3% in the obese category, 75.0% in the normal category, and 92.3% in the underweight category. However, the results showed a p-value of 0.158 ($p > 0.05$) which means that BMI was not significantly associated with hydration status. Based on fluid intake, both those with adequate and inadequate fluid intake were dominated by dehydrated farmers, but compared to farmers with adequate fluid intake (48.5%), those with inadequate fluid intake were more dehydrated (98.4%). Through the analysis, a p-value of <0.001 ($p < 0.05$) was obtained, indicating that there is an association between fluid intake and hydration status. Meanwhile, based on physical activity, the proportion of rice farmers who had a high level of activity was more than those who had a medium or low level of activity, and of the 88 farmers with a high level of activity, the majority were dehydrated (87.5%). The results showed that physical activity was significantly associated with hydration status with a p-value of <0.001 ($p < 0.05$).



Table 3. Multivariate Analysis Results

Variables	B	p-value	Exp (B)	95% CI	
				Lower	Upper
Step 1 ^a					
Body mass index			Reference		
Obese					
Normal	-2.252	0.057	0.105	0.010	1.069
Underweight	-0.347	0.823	0.707	0.034	14.759
Physical activity level			Reference		
High					
Moderate	-3.291	0.236	0.037	0.000	8.649
Low	-4.463	0.044	0.012	0.000	0.893
Fluid intake			Reference		
Inadequate					
Adequate	-4.322	<0.001	0.013	0.001	0.128

Table 3 above shows the results of multivariate analysis using multiple logistic regression test. The results show that physical activity and fluid intake affect the hydration status of rice farmers in Pakantan Sub-district. Rice farmers with low levels of physical activity (Exp (B)=0.012 (95% CI: 0.000–0.893); $p=0.044$) and adequate fluid intake (Exp (B)=0.013 (95% CI: 0.000–0.128); $p<0.001$) were less likely to be dehydrated compared to rice farmers with high levels of physical activity and inadequate fluid intake. The variable that most affected the hydration status of rice farmers in Pakantan Sub-district was physical activity.

Discussion

Effect of Body Mass Index on Hydration Status of Rice Farmers in Pakantan Sub-district

The results of this study suggest that body mass index does not affect the hydration status of rice farmers ($p=0.158$). This is not consistent with research conducted by Alam & Majid (2023) who found that nutritional status categorized by BMI affects the hydration status of corn farmers in Jeneponto Regency (OR=0.659 (95% CI: 0.337–1.150); $p<0.001$). Abasilim et al. (2024) in their study also suggested that the risk of dehydration among migrant farmers increased significantly with an elevated body mass index ($\beta = 0.016$; 95% CI: 0.003, 0.028). This is probably because obese individuals have a greater percentage of body fat compared to muscle mass. Fat has



much less water content than other body tissues so obese individuals have a lower percentage of total body water and thus are more prone to dehydration. In addition, greater levels of body fluid requirements are reported to increase alongside BMI based on higher energy requirements, greater food consumption, and higher metabolic production (Ekingen et al., 2022; Lu et al., 2023).

In contrast, the results of this study are in line with research conducted by Tarwiyanti et al. (2020) who found that there was no significant relationship between nutritional status as measured by body mass index and hydration status in industrial workers in Probolinggo ($p=0.333$). Kurniawati et al. (2021) in their research also stated that body mass index was not related to the hydration status of expedition courier workers in West Jakarta ($p=0.337$). Another study conducted by Sari et al. (2020) also showed that BMI was not associated with the incidence of dehydration in tempe artisan workers in Jambi City ($p=0.875$). The results of research conducted by Lestari et al. (2022) on tofu factory workers in Jambi City also found that there was no association between body mass index and the risk of dehydration ($p=0.239$). The majority of rice farmers in the Pakantan Sub-district who were sampled in each BMI category experienced dehydration, 89.3% in the obese category, 75.0% in the normal category, and 92.3% in the underweight category so there was no significant difference in hydration status based on BMI. This indicates that dehydration can be experienced by obese, underweight, and normal weight individuals if the fulfillment of fluid needs is not able to exchange fluids that have been excreted or loss from the body.

Effect of Fluid Intake on Hydration Status of Rice Farmers in Pakantan Sub-district

Based on the results of this study, it was found that fluid intake affects the hydration status of rice farmers in Pakantan Sub-district, where rice farmers with adequate fluid intake ($\text{Exp (B)}=0.013$ (95% CI: 0.000–0.128); $p<0.001$) had a lower odds of dehydration compared to rice farmers who had inadequate fluid intake. This is consistent with research conducted by Majid (2021) who found that fluid intake affects the hydration status of corn farmers in Jenepono Regency ($\text{OR}=0.225$ (95% CI: 0.088–0.574); $p=0.003$). Pustisari et al. (2020) in their research also



suggested that fluid intake is the most significant factor affecting the hydration status of apartment project workers in Tangerang ($r=0.666$; $p=0.001$). Another study conducted by Habibati et al. (2022) also showed that there was a significant association between fluid intake and hydration status in banana chip home industry workers in Lumajang ($p=0.032$). Nurfrida & Lestari (2023) found in their research that there was a significant correlation between fluid intake and hydration status of bottled water production workers in Semarang City ($r=0.442$; $p=0.001$). The results of research conducted by Lestari et al. (2022) on tofu factory workers in Jambi City also found that drinking water consumption was significantly associated with the incidence of dehydration ($p<0.001$).

In normal adults, the recommended fluid intake is $\pm 2,500$ ml (2.5 liters) per day sourced from beverages or food consumed (Regulation of the Minister of Health of the Republic of Indonesia Number 28 of 2019 Regarding the Recommended Nutritional Adequacy Rate for Indonesian People). Water is the best and ideal type of drink to fulfill the body's fluid needs. Conversely, some types of drinks such as coffee, tea or other soft drinks will actually make the body release more fluids because they are diuretic or stimulate urination (Kurniawati et al., 2021). The majority of rice farmers in the Pakantan Sub-district have inadequate fluid intake (66%) which is less than 2.5 liters per day, of which 98.4% of farmers whose fluid intake is inadequate, are dehydrated. Most farmers only consume water 3 times a day about 3–4 cups of 230 ml and often consume coffee or tea. Therefore, these farmers should increase their fluid intake by drinking water and reduce the consumption of coffee or tea, because if fluid consumption is adequate to their needs, dehydration can be prevented.

Effect of Physical Activity on Hydration Status of Rice Farmers in Pakantan Sub-district

The results of this study show that physical activity is the most significant factor affecting the hydration status of rice farmers in Pakantan Sub-district, where rice farmers with low levels of physical activity ($\text{Exp (B)}=0.012$ (95% CI: 0.000–0.893); $p=0.044$) have a lower odds of dehydration compared to rice farmers who have high levels of physical activity. This is in line with



research conducted by Pustisari et al. (2020) which shows that there is a significant relationship between physical activity level and hydration status in apartment project workers in Tangerang ($p=0.026$). Alam & Majid (2023) in their research also found that corn farmers with high levels of physical activity had a three times greater risk of dehydration compared to those with low levels of physical activity ($OR=3.430$ (95% CI: 1.963–5.994; $p<0.001$). Another study conducted by Sari et al. (2020) also showed that occupational physical activity was associated with the incidence of dehydration among tempeh workers in Jambi City ($p=0.007$).

Physical activity is a body movement produced by skeletal muscles that results in energy expenditure. Physical activity can affect fluid and electrolyte requirements as it increases the body's metabolism resulting in the excretion of body fluids through sweat. High levels of physical activity also increase invisible water loss due to increased breathing rate and sweating (Laja García et al., 2019). The majority of rice farmers in Pakantan Sub-district have high levels of physical activity (90.7%) and heavy workloads. They work for an average of 8-10 hours/day in the rice fields, then perform other physical activities at home such as gardening and completing various household chores (e.g. sweeping, mopping, washing, etc.). Farmers are also accustomed to walking from home to rice fields or vice versa, as well as when doing activities around their residence. This is why rice farmers in Pakantan Sub-district are at greater risk of dehydration.

Conclusion and Recommendation

The results of this study show that physical activity and fluid intake affect the hydration status of rice farmers, but there is no significant effect between body mass index and the hydration status of rice farmers in Pakantan Sub-district. The rice farmers are recommended to bring and drink enough water which is at least 2.5 liters every day and reduce the consumption of coffee and sweet tea which can trigger the body to urinate frequently, thus increasing the risk of dehydration. Farmers are also expected not to force themselves to do physical activities that are too strenuous, but even if they have to do the work, it is recommended to maintain adequate fluid intake to prevent dehydration.



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