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The Determinant Factor of Urinary Stone Formation on Palm Oil Processing Workers at PTPN VII Betung

Sukmawati[1], Novrikasari[2], Miksusanti[3]

[1] Graduate Program of Safety, Occupational and Environmental Health, Faculty of Public Health University of Sriwijaya
[2] Department Safety, Occupational and Environmental Health, Faculty of Public Health University of Sriwijaya
[3] Department of Chemistry, Faculty of Mathematics and Natural Sciences, University of Sriwijaya

*Corresponding author

E-mail address: sukma.afan@gmail.com (Sukmawati).
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Abstract

High temperature of work environment affects fluid and electrolyte balance of workers. It is also affecting the urine production by increasing its concentration and if it lasts for a long time causes urinary crystallization. This work was aimed to analyze the determinant factor of urinary stone formation within palm processing workers at PTPN VII Betung. Population sample in this work is 103 workers which represents total population of workers at PTPN VII of Betung unit. Research was designed quantitatively using cross-sectional study. Data collection was carried out using several instruments i.e. questioner, interview and observation. The obtained data was processed through univariate, bivariate and multivariate analysis. Result shows the number of workers with a positive urinary crystallization are 18 workers (17.5%). Characteristic of respondent are typically aged < 45 years (68%), hydration status was not dehydrated (53.2%). Multiple logistic regression analysis result shows hydration status variable (OR = 5.508) affects the formation of urinary stone with worker's age as confounder.

Keywords : Urinary crystallization, hydration status, worker's age, PTPN VII Betung unit

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1. Introduction

Work productivity is influenced explicitly by environment comfort factor such as temperature. On contrary, uncomfortable condition creates disturbance or even psychological effect and physiological pain. Human body contains a lot of water known as body fluid which comprises mineral electrolytes such as sodium, potassium, calcium and chloride [1]. Fluid balance within body is achieved when water intake is in equilibrium with water being excreted. Water was excreted through urination, faces, respiration and perspiration. Water discharged via respiration and perspiration also known as insensible loss [2].

Loss of fluid and electrolytes via perspiration in large amount must be accompanied by proportional amount of drinking water intake. Unbalanced condition between these two occasions will reduce blood pressure and increase pulse. Excessive fluid loss influence urine production and enhance its saturation (hyper saturation/supersaturation). Such condition if happens in long duration tends to increase the risk of crystal and stone formation within urinary tract [1];[3].

Decrease in body fluid without proper amount of intake will turn body into dehydration [4]. Dehydration decrease urine production but increase its saturation and creates kidney problem risk [5]. Balance-nutrition guidance requires that body fluids must be complied through food and beverage consumption. Water intake needed by human body mostly is fulfilled through drinking water minimum 2 liters/day or approximately 8 glasses of water (size 250 mL). In certain condition such as workers at high temperature environment, water intake needed is larger with minimum amount 6 liters/day [6].

Heat produces during palm oil processing might be spread to whole work environment which cause increase of temperature. Human body response against such temperature would be excreting water which has to be compensate by proper amount of water intake otherwise workers would be dehydrated. Dehydration results a decrease in urine production along with increase its saturation which in turn disturbed kidney if it happens repeatedly [5]; [1].

Muis, [7] suggested high percentage of respondent

with abnormal uric acid is worker whom works in under standard environment. Muis also implied that respondent with water intake below 8 glasses/day has higher uric acid compare to respondent with water intake below 8 glasses/day by 60%. The adequacy of water consumption can be assessed from urine color. Fluid loss from sweating should be compensated to prevent increase of uric acid within urine otherwise urea would crystallize and forms urinary stone within kidney and urinary tract.

Workers is highly exposed by environmental factors which cause physical effect and creates health problem in long duration [8]. PTPN VII is an agribusiness company in annual crop cultivation, seasonal plants and processing plantation products. This work was carried out at PTPN VII Betung unit which has palm oil cultivation and processing unit with 20 tones fresh fruit bunches per hour capacity. Palm oil processing involves fireplace and engines in high temperature condition gave impact in spread of heat and increase the surrounding temperature. One of machine used is sterilizer. It consists of pressurized steam vessel which boiled the palm oil. The vessel works at ± 3 kg/cm3 pressure and temperature ± 145 ^{0}C. The palm oil boiling result was removed to screw press machine.

Screw press machine basically works by giving pressure to fresh fruit bunch (after boiling process) so the oil contained will squeezed out. During its operation, screw press machine release heat having temperature approximately ± 90 ^{o}C. Oilcake remains was removed and crude oil produced was separated further from impurities such as water, oils and sludge. Separation of crude oil from impurities were conducted in sand trap tank. The temperature in this process can be ± 95 ^{o}C. The result was flowed to oil tank which also having temperature approximately ± 95 ^{o}C follows by oil purification within oil purifier machine in similar temperature to reduce water content. The overall process can be last for 24 hours continuously.

Workers at PTPN VII Betung unit hence were exposed by heat almost at whole working time. Hot environment as described above undoubtedly affects health condition and worker stamina particularly fluid balance and electrolyte within worker's body. In this work, author aimed to evaluate the determinant factor of urinary stone formation at worker of palm oil processing PTPN VII Betung unit.

2. Materials and Methods

2.1 Design and Sampling

Research was conducted using quantitative observation method i.e. seeking relationship between independent variable and dependent variable and evaluate the causality i.e. cause-effect using data collected by interview, questioner and measurement [9]. This work is an observational research which applied a cross-sectional design.

Population number was all workers at palm-oil processing PTPN VII Betung unit i.e. 103 respondents.

2.2 Research Methods

Data were collected through interview assisted with questioner contained set of questions and written statement which respondent requested to answers. Questioner was used to gather data on individual and occupational characteristic.

Documentations were created in form of photos, profile, name and worker number. Measurement was carried out to collect 3 data i.e. hydration status, urine density and urinary crystal in the sample.

2.3 Data Analysis

The samples in this study was using the sample formula according to Lemeshow (1977), as follows:

$$n = \frac{Z^2_{1-\alpha/2} P(1-P)}{d^2}$$

n = number of samples
$Z^2_{1-\alpha/2}$ = 1,96
P = 0,305 (Dharma,2008)
d = limit of error or precision specified = 0,1

By using the formula, the number of sample results obtained by the sample is 45 people

2.4 Sampling Technique

The technique for sampling in this study uses nonprobability with accidental sampling techniques. NBM covers 28 sections of skeletal muscle in both right and left sides of the body. Starting from the upper limbs, namely the neck muscles to the very bottom, the muscles in the legs.

Assessment using the NBM questionnaire resulted in an NBM score. This NBM score is obtained from the sum of the complaint levels and the frequency of complaints felt by the operator. In the assessment using scoring.

2.5 Data Analysis

Univariate and bivariate analysis were applied on the data collected. Bivariate analysis was meant to assess correlation between each of independent and dependent variables. Bivariate analysis was conducted using chi-square analysis at alpha 5% using research hypothesis
H1: There is correlation between hydration status and worker age against urinary stone formation

3. Results and Discussion

Univariate analysis consists of worker age, hydration status and urine crystallization.

Table 1. Frequency distribution of worker characteristic at palm oil processing PTPN VII Betung unit

No	Variable	n	%
1	Urine crystalization		
	Positive	18	17.5%
	Negative	85	82.5%
2	Age		
	≥ 45 years	33	32%
	< 45 years	70	68%
3	Dehydration status		
	Dehidrated	24	23.3%
	Not Dehydrated	79	76.7%

Table 1 shows the majority of respondents are workers with negative result on urine crystallization variable i.e. 85 workers (82.5%) whereas positive result is 18 workers (17.5%).

Age variable in this work can be divide into two categories based on male's urine crystallization risk i.e. age < 45 years and age ≥ 45 years. (Ratu, Badji and Harjono 2006; Bushinsky, Coe and Moe, 2008). According to this classification, workers at PTPN VII Betung unit are as follow: respondents with age < 45 years is 70 workers (68%) and respondent with age ≥ 45 years is 33 workers (32%).

Relationship between worker age and urine crystallization at PTPN VII Betung unit

Bivariate analysis on hydration status correlation with urine crystallization was conducted statistically and the result is shown as follows.

Table 2. Worker age correlation with urine crystallization at PTPN VII Betung unit

Age	Urine crystallization				Total		*p-value*	PR (95% CI)
	Positive		Negative					
	n	%	n	%	n	%		
≥ 45 years	3	9.1	30	90.9	33	100	0.207	0.367 (0.098-1.368)
< 45 years	15	21.4	55	78.6	70	100		

Analysis result obtained from worker sample indicate urine crystallization was positive by 9.1% on worker age ≥ 45 years and 21.4% on worker age < 45 years. Statistic test result suggest p-value (0.207) above alpha value (0.05) which means no correlation establish between age and urine crystallization.

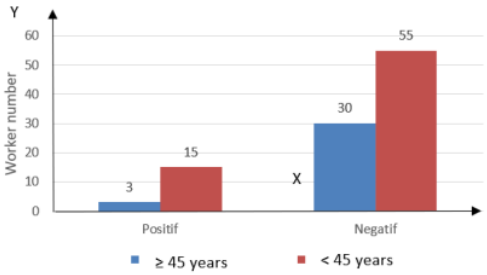

Figure 1. Age correlation with urine crystallization

According to works reported by another authors, age ≥ 45 years has the highest urine crystallization occurrence compare to age < 45 [10]; [11].

Similar result had been reported occurred at Maroko i.e. urolithiasis case at age above 48 years. The decrease of body resisstance against hot environment caused slow adaptation of human body at the observed age. The prevalence of urine crystallization occurrence correlated by human body ablity to adapt and restore body temperature which in this case becomes slower due to aging [12].

The same case has been observed in this work, 9.1% of workers with age ≥ 45 years is positive urine crystallization. At age above 45, body resistance decrease as well as adaptation ability against hot environment hence the prevalence of urine crystallization is increased. Elder human body restore its temperature to normal condition slower than younger which cause urine more likely becomes crystall or stone [13]; [14].

Calculation result on bivariate analysis confirmed no significance correlation between urine crystallization occurrence (p-value = 0.207) but in multivariate model developed, the age variable is considered as confounder of urine crystallization on workers at palm oil processing PTPN VII Betung unit.

Our result is similar to what had been reported by [15] at Karanganyar region. This author found no significance correlation between age and urine crystallization of textile workers (p-value = 0.507).

Increase of age clearly affects physiological condition of worker i.e. lower the body ability to adapt against environment and decrease of body resistance against high temperature at work environment. Workers at PTPN VII Betung unit are facing high temperature work environment combine with age average at almost 40 year old which make them vulnerable to urine crystallization.

Relationship between hydration status and urine crystallization on PTPN workers

Bivariate analysis on the correlation between hydration status and urine crystallization conducted by

statistical method found out 41.7% of dehydrated worker had urine crystallization. Worker with sufficient hydration (not dehydrated) shows lower occurrence of urine crystallization at 10.1%. Statistical analysis confirmed p-value (0.001) smaller than alpha (0.05).

Table 3. Relationship between hydration status and urine crystallization on workers at palm oil processing PTPN VII Unit Usaha Betung

Hidration status	Urine crystallization				Total		*p-value*	PR (95% CI)
	Positive		Negative					
	n	%	n	%	n	%		
Dehydrated	10	41.7	14	58.3	24	100	0.001	6.339 (2.127-18.896)
Not Dehydrated	8	10.1	71	89.9	79	100		

This result suggest there is correlation between hydration status and urine crystallization on PTPN workers. Calculated value for PR was obtained 6.339 (95% CI = 2.127-18.896) which can be interpreted that dehydrated workers has higher risk by 6.339 times to urine crystallization occurrence compare to workers with sufficient hydration (not dehydrated). At larger population, it is believed that 95% of dehydrated workers has higher risk of urine crystallization by 2.127 to 18.896 compare to adequate hydration workers.

Dehydration condition increases secondary urine (as indication of vasopressin activity) caused by increase of serum osmolarity which accompanying water loss in human body. The event mentioned was correlated with kidney vasoconstriction. Long duration of heavily fluid loss within body will lower the value of glomerular filtration rate (GFR). High saturation of urine consequently will increase urine density within human body, in this case workers at PTPN VII Betung unit [16].

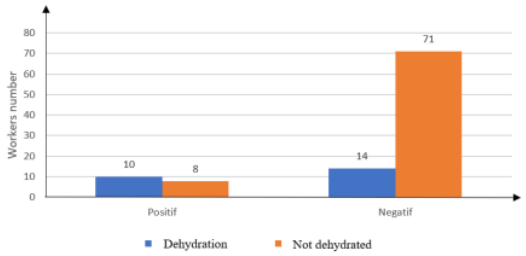

Figure 2. Relationship between hydration status and urine crystallization

Person with diagnose of cronical dehydration shows urine pH tend to decrease while the density in contrary shows increase tendency. Uric acid supersaturation will also increase which causing nucleation of urate crystal. Lack of water consumption triggers calcium precipitation within kidney pelvis due to unbalance water intake. Amount of urine produce will likely dcrease in such case, adequate water consumption would prevent urine becomes darker or colored [17].

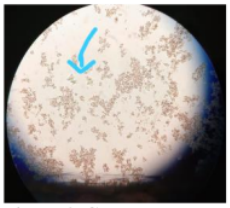

Figure 3. Ca-oxalate sediment in worker's urine

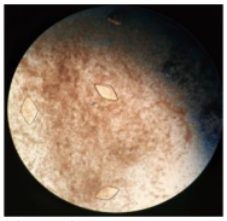

Figure 4. Amorphous urate sediment in worker's urine

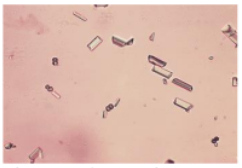

Figure 3. Triple phosphate urine sediment (Source: https://goo.gl/images/bw2fsq)

In this work, we did not found any correlation between water consumption with worker hydration status (p-value = 1.000). The inconsistency correlation might caused by data information on drinking habit was based on worker questioner filling and not based on food recall. The data result might bias because the respondents filled the questioner by guessing. The hydration status data however, was calculated based on urine density measurement so it provide more accurate result.

3.3. Final Model

According to multivariate analysis as shown on table 4, significance correlation exist between urine crystallization and hydration status (p-value = 0.006) while worker age is consider as confounder. Analysis result confirms the PR value for hydrsation status (5.508). This means that hydration status is a determinant factor on urine crystallization occurrence. OR value at 5.508 on hydration status variable can be interpreted that dehydrated workers has urine crystallization tendency 5.508 times higher than workers with sufficient hydration. In more general population, it is estimated that 95% of dehydrated workers has higher positive urine crystallization occurrence between 1.633 to 18.577 compare to non dehydrated workers.

Determinant and conformity analysis of final

model was obtained from multiple logistic regression method and the result is shown on table 5. Table 5 shows -2log likelihood value (70.331) < chi-square table (126.574) which confirms that the final model with independent variable includes i.e. age and hydration status is consistent with the data gathered. Omnibus test result of significance value 0.000 means the addition of independent variables such as age and hydration status gave significance influence simulatneously on urine crystallization. In other words, the final model created is conformed. Determination coefficient value (R2) obtained from this model is 0.358 or 35.8%.

The coefficient value above can be interpreted as contribution percentage of independent variable effect i.e. age and hydration status against dependent variable i.e. urine crystallization is 35.8%. The remaining 64.2% involves other contribution from factors that did not include in this work.

Hypothesis test based on final model developed was conducted by Wald test partially and simultaneously. Test result indicate only hydration status variable and heat stress in the model has Wald test p-value < 0.05 which means hydration status has partially significance effect towards urine crystallization.

Table 4. Initial model of determinant factor for urine crystallization on PTPN VII workers Betung unit

Variables	B	SE	*p-value*	OR (95% CI)
Age	-1.445	0.771	0.061	0.236 (0.052 – 1.067)
Hydration status	1.706	0.620	0.006	5.508 (1.633 – 18.577)

Tabel 5. DeterminanT analysis result and model conformity

Variabel	B	Wald	*p-value*	*-2 Log likelihood*	Omnibus *Test*	R^2
Age	-1.445	3.518	0.061			
Hydration status	1.706	7.565	0.006	70.331	0.000	0.358
Constant	22.539	9.272	0.002			

4. Conclusion

The majority of respondents age is worker at < 45 years i.e. 70 workers (68%) while respondents hydration status mostly is not dehydrated i.e. 79 workers (76.7%) Most of respondents involve in this work has negative urine crystallization i.e. 85 workers (82.5%) whereas positive urine crystallization is 18 workers (17.5%). Variable that can be correlated to urine crystallization is hydration status while age variable is considered as confounder in the model developed.

5. Suggestion

PTPN workers need to increase their water intake in accord with body needs to prevent dehydration and occurrence of urine crystallization. The company must provide more access to drinking water fasility for their workers by increase water gallon and water dispenser or by providing workers with drinking bottle which can be carry easily.

Education process is necessary particularly about water needed for worker whom work in elevated temperature environment, dehydration symptoms, effect of dehydration on body and how to prevent it. Workers whom indicates positive urine crystallization should referred to medical facility to obtain appropriate treatment so the formation of kidney stone can be avoided.

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