IJCOM 2022 March;1(3):146-53

The Association of Heat Exposure and Hydration Status among Production Workers in Fish Processing Company

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Abstract

Background: Hot work environment can cause various subjective and objective complaints for workers. When workers perform activities under hot work environment, their body will react by balancing the amount of heat received by the body from outside the body and the loss of water in the body. Hydration status is the condition achieving the balance between water intake and water discharge from the body. Bad hydration status or de-hydration can cause various changes in the body physiological functions. This study was intended to see the association between heat exposure and hydration among production workers in Fish Processing Company Sawangan, Depok.
Method : A cross sectional study with 88 respondents, selected as a total sampling. The study was conducted on November 2017 until January 2018. Data analysis were used by SPSS version 20.0.
Result: There is no significant difference between the specific gravity of urine before and after working (p=0.076). However, 37.5% of the workers had dehydration. There is a significant association between the work environment temperature and hydration status (p=0.002), and also between water intake and status of hydration (p=0.013). Work environment temperature is the most dominant risk factor to influence dehydration (p=0.000; OR= 9.305; 95%CI=2.727-31.748)
Conclusions: There is a significant association between heat exposure and hydration status (p=0.000; OR=9.305). The number of workers that were exposed to heat and experienced dehydration is 33 people (37.5%). Water intake turns to be the individual factor that influences the status of hydration of the workers exposed to heat. The work factor that influences the hydration status of the workers is the work environment temperature.
Keywords: Heat exposure, Hydration status, Fish processing

Abstrak

Latar belakang: *Lingkungan kerja yang panas dapat menimbulkan berbagai keluhan subjektif dan gangguan objektif pekerja. Selama aktivitas pada lingkungan panas, tubuh memberikan reaksi dengan menyeimbangkan antara panas yang diterima dari luar tubuh dengan kehilangan cairan dari dalam tubuh. Tercapainya keseimbangan asupan dan pengeluaran cairan dalam tubuh disebut hidrasi. Status hidrasi buruk atau dehidrasi dapat menyebabkan berbagai perubahan fungsi fisiologis tubuh. Penelitian ini dimaksudkan untuk melihat hubungan antara pajanan panas dan status hidrasi pekerja bagian produksi di Pabrik Pengolahan Ikan Sawangan Depok.*
Metode: *Penelitian cross sectional dengan jumlah sampel 88 orang diambil secara total sampling. Penelitian dilakukan pada bulan Nopember 2017 sampai dengan Januari 2018. Data dianalisis menggunakan SPSS versi 20.0*
Hasil: *Tidak ada perbedaan bermakna antara berat jenis urin sebelum dan sesudah bekerja (p=0,076), 37,5% dari pekerja mengalami dehidrasi. Terdapat hubungan bermakna antara suhu lingkungan kerja dan status hidrasi (p=0,002) dan juga antara asupan cairan dan status hidrasi (p=0,013). Suhu lingkungan kerja merupakan faktor risiko yang paling dominan dalam mempengaruhi terjadinya dehidrasi (p=0.000; OR= 9,305; 95%CI=2,727-31,748)*
Kesimpulan: *Terdapat hubungan bermakna antara pajanan panas dan status hidrasi pekerja (p=0,000;OR=9,305). Pekerja yang mengalami dehidrasi 33 orang (37,5%). Faktor individu yang mempengaruhi status hidrasi pada pekerja adalah asupan air minum. Faktor pekerjaan yang mempengaruhi status hidrasi pekerja adalah suhu lingkungan kerja.*
Kata kunci: *Status hidrasi, pajanan panas, pengolahan ikan*

Background

Hot work environment can cause workers' subjective and objective complains varying from getting tired easily, not feeling well, increased bad temper and others.[1] Workers with hot work environment such as smelter, boiler, oven, or directly exposed to the sun heat may experience heat stress. When performing activities in such hot work environment, workers' body will react by balancing the amount of heat received by the body and the loss of water from the body to maintain a constant work environment.[2] The achievement of balance between water intake and water discharge from the body is called the hydration.[3]

Hydration status is influenced by several factors including individual factors (knowledge, pregnancy, the accompanying illness, consumption of drugs), work-related factors (work apparel, personal protective equipment, the provision of drinking water, toilet) and environmental factors (high temperature of work place). [4] The factors that influence the impact of heat stress and the need for drinking water includes, among others, gender, age, activities, environment, health condition, nutrition status, body surface area, pregnancy and breast feeding.[5,6,7,8,9] Workers' hydration status can be examined through several indicators that can be practically used such as urine colour, drop in body weight and specific gravity of urine. [4]

Status of hydration can be classified into good hydration status and bad hydration. Good hydration or 'euhidrasi' can reduce the risk factor for several diseases such as the formation of kidney stone, asthma, etc.[3,10,11] The bad hydration (dehydration) can cause various changes in the body physiological functions such as reduced concentration and cognitive capability as well as increased possibility for risks of urinary tract infection, urinary tract stone, ischemic, kidney failure, etc.[3,10,11] A study by Andayani confirms that water intake significantly affects workers hydration status. [12] Ensuring that workers have sufficient water intake is the most effective intervention method to maintain worker health and productivity at work. [13]

Su SB and team conducted a study on a worker population at a battery industry in Taiwan using urine specific gravity as the dehydration parameter and found a result of dehydration 24%. [14] In addition, a study in Sidoarjo Regency showed that there is an impact of work environment exceeding NAB on worker health condition such as excessive sweating, thirsty, dehydration, anxiety, fatigue, weak concentration and work in convenience. [15] *The Indonesian Regional Hydration Study* (THIRST) conducted a study in 2009 and reported that the Indonesian people who experienced dehydration was quite high. About 46.1% of adults and teenagers experienced light dehydration. This condition is due to lack of knowledge among the respondents about the function of water for human body.[16] The preliminary survey conducted at Fish Processing Company Sawangan Depok by interviewing 10 workers of Production Department of working indoors indicates that the workers felt less convenient with the high temperature of their work place. In addition, most workers have a number of complains such as excessive sweating, getting thirsty quickly, fatigue and headache.

This study aims to determine the association between heat exposure and hydration status among production workers in Fish Processing manufacture and recommend appropriate mitigation actions to control the conditions.

Methods

A cross sectional study conducted at Fish Processing Company Sawangan, Depok in November 2017 until January 2018. The population for this study is the entire workforce of Production Department the company. The number of samples is 88 people of the production Department who meet the inclusion criteria, selected based on total sampling. The inclusion criteria consist of being worker of Production Department, age above 18 years, and willingness to sign a letter of Informed Concern confirming their agreement to participate in the study. The exclusion criteria consist of employee with kidney illness history, heart disease, urinary tract illness, obesity, and metabolistic complains such DM, pregnancy, absent from work when the study was conducted. The drop out criteria refers to employee who did not follow the research procedure that has been established.

Data collection was conducted by collecting primary data obtained directly from employees. This is done in two ways, subjective way through interviews and objective way by physical examination, urine specific gravity examination before and after working using hand refractometer and measuring the work place temperature using QUESTemp36 ° and had been

approved by The Ethics Committee of the Faculty of Medicine University of Indonesia (No: 0005/UN2.F1/ETIK/2018).

Results

The characteristic of production workers in Fish Processing Company Sawangan Depok is grouped based on age, gender, nutrition status, body surface area, drinking water intake, working period, and work environment temperature. Majority of respondents are below 40 years (80.7%) and male (52.3%). Based on body height and weight, 48.9% of the respondents have good nutrition status as indicated by the IMT score which is normal. Majority of the respondents have normal body surface area. Based on observation while the respondents were working it was found majority of respondents (59.1%) consumed ≥ 1475 ml. It was also noted that 79.5% of respondents have ≥ 3.5 years of working period. The result of measuring the work place temperature, shows that 53.4% of the respondents were assigned in a work place with a temperature of 28°C or higher. Table 1 below showed that workers in Production Department work in several work sections with different temperatures.

Reviewing the result of urine specific gravity measurement before and after working, it can be concluded that there is no significant difference between the urine specific gravity score before and after working. The pre-work scores range 1.001-1.031 and mean = 1,017 while, after-work score ranges the same but the mean is a little lower 1.015. Looking at the hydration status among production workers before and after working, there is no significant difference. The percentage of workers having dehydration before working is 35,2%, while after working 37.5%.

Comparing the hydration status among production workers before and after working with water intake, in can be noted that majority of workers (70%) that did not have dehydration before working and had dehydration after working consumed drinking water of < 1475 ml. More than half (56.5%) of the workers who had dehydration before working and remained had dehydration after working consumed drinking water of < 1475 ml. A smaller portion of workers (29.8%) who did not have dehydration before working and remained without dehydration after working consumed drinking water of < 1475ml. Only 25% of workers who before working had dehydration and did not have dehydration after working, consumed drinking water of < 1475ml.

Reviewing the distribution of hydration status based on work sections among production workers three work sections had significantly high number of workers who experienced dehydration (dough prep, steaming and shaping). Majority of workers in the Dough Preparation Section had dehydration (64,3%). Half of the workers in the Steaming Section (50%) had dehydration. In the Shaping Section A almost half of the workers (48%) had dehydration. There was no worker in the Packaging Section that had dehydration. A small portion of workers in Sharing Section B (22.2%) had dehydration

Comparing hydration status before and after working with work environment temperature among production workers it was found that in the working environment temperature ≥ 28˚ C WBGT, the average urine specific gravity slightly decreased from 1.017 before working into 1.016 after the work and the dehydrated workers increased from 19 people before working into 25 people after work. While workers

Table 1. Distribution of Urine Specific Gravity and Worker Drinking Water Intake, Based on Work Place at Production Department of Fish Processing Company

No	Section	N	(%)	Urine Spesific Gravity (mean)	Min–Max (cc)	Drinking Water Intake (mean)	Min–Max (cc)
1	Dough Prep.	14	15,9	1.016	1.001-1.024	1832 ml	1200-3000
2	Steaming	8	9,1	1.016	1.003-1.027	2100 ml	1500-2900
3	Shaping A	25	28,4	1.016	1.001-1.030	1694 ml	1000-3000
4	Packaging	5	5,7	1.007	1.004-1.015	1630 ml	1300-2000
5	Shaping B	36	40,9	1.014	1.002-1.032	1530 ml	600-2750
	Total	88	100				

who work on the work environment temperature <28C WBGT average urine specific gravity decreased from 1.016 before the work becomes 1.014 after work and workers who are dehydrated decreased from 12 people before working to 8 people after work.

It was noticed from Table 2 that workers of 40 years old or more that had dehydration is 17.6%, while the percentage of workers below 40 years who had dehydration is 42.3%. The result of a statistical test shows p-value of 0.093, which indicates there is no meaningful association between age and hydration status. Meanwhile, an Odd Ratio calculation yields a value of 0.293 which means workers of 40 years old or more have a risk of 0.293 times higher to have dehydration compared to workers below 40 years old. Based on the gender, male workers that had dehydration amounts to 41.3% while for female workers, the number is lower (33.3%). Result of a statistical test shows a value *p*=0.511, meaning that there is no significant association between gender status and hydration status. However, an Odd Ratio calculation yields a value of 0.711, meaning that male workers have a risk of 0.711 times higher than female workers to have dehydration.

Workers with excessive weight (overweight + obesity) that had dehydration amounts to 28.9%. Workers with normal weight (normo-weight) that had dehydration amounts to 46.5%. A statistical test results in a value of p=0.123. This indicates that there is no significant association between nutrition status and hydration status. However, an Odd Ratio calculation yields a value of 0.467, which indicates workers with excessive weight (overweight + obesity) have a risk of 0.467 times higher to have dehydration compared to workers with normal body weight (normo-weight).

Workers with abnormal body surface area that had dehydration amounts to 20% while workers with normal body surface area that had dehydration amounts to 39.7%. A statistical test shows a value of *p*=0.309.

Table 2. Association of Individual and Occupational Factors with Hydration Status among Production Workers in Fish Processing Company

Variable	Dehydration		No Dehydration		ORc	95%CI	P value
	n	%	n	%			
Age							
≥ 40 years	3	17.6	14	82.4	0.293	0.077 – 1.111	0.093
< 40 years	30	42.3	41	57.7	Reference		
Gender							
Female	14	33.3	28	66.7	0.711	0.298 – 1.695	0.511
Male	19	41.3	27	58.7	Reference		
Nutrition Status							
Overweight + Obecity	13	28.9	32	71.1	0.467	0.194 – 1.126	0.123
Normoweight	20	46.5	23	53.5	Reference		
Body Surface Area							
Abnormal	2	20	8	80	0.379	0.075 – 1.905	0.309*
Normal	31	39.7	47	60.3	Reference		
Drinking Water Intake**							
< 1475 ml	20	55.6	16	44.4	3.750	1.511 – 9.306	0.007
≥ 1475 ml	13	25	39	75	Reference		
Working Period							
≥ 3.5 years	29	41.4	41	58.6	2.476	0.739 – 8.291	0.176
< 3.5 years	4	22.2	14	77.8	Reference		
Work Environmet Temperature							
≥ 28° C WBGT	25	53.2	22	46.8	4.688	1.792 – 12.263	0.002
< 28° C WBGT	8	19.5	33	80.5	Reference		

* Fisher Test ** ROC

This indicates that there is no significant association between body surface area and hydration status. However, an Odd Ratio calculation yields in a value of 0.397, which means that workers with abnormal body surface area has a risk of 0.379 higher to have dehydration compared to workers with normal body surface area.

Workers with drinking water intake of less than 1475 ml that had dehydration amounts to 55.6%, while workers with drinking water intake ≥ 1475 ml that had dehydration amounts to 25%. A statistical test results in a value of p=0.007 which indicates there is a significant association between drinking water intake and hydration status. Meanwhile, an Odd Ratio calculation yields in a value of 3.750, meaning that workers with drinking water intake of less than 1475 ml has a risk to have dehydration 3.750 times higher than those with drinking water intake of more than 1475 ml.

Workers with ≥ 3.5 years of working period that had dehydration amounts to 41.4%, while workers with < 3.5 years of working period that had dehydration amounts to 22.2%. Result of a statistical test shows a value of p=0.176, indicating there is no significant association between working period with hydration status. Meanwhile, an Odd Ratio calculation yields in a value of 2.476, meaning that workers with working period ≥ 3.5 years have a risk to has dehydration 2.476 times higher than workers with working period less than 3.5 years.

Workers working in a work place with temperature of ≥ 28°C that had dehydration amounts to 53.2% while the percentage for those working in a work place with < 28°C temperature that had dehydration is only 19.5%. Result of a statistical test shows a value of p=0.002, indicating that there is significant association between hot work environment and hydration status. Meanwhile, an Odd Ratio calculation yields in a value of 4.688, indicating that workers working in a work environment of ≥ 28°C have a risk to experience dehydration 4.688 times higher than those working in a work place with < 28° C.

As can be seen in Table 3, the variable of age and nutrition status have a p value p=0.05 meaning there is no significant association between age and nutrition status with hydration status. Meanwhile, on the variable of drinking water intake and work environment temperature, significant association between the two variables and hydration status was observed. Drinking water intake of less than 1475 ml exposes dehydration risks of 6.529 times higher than drinking water intake of ≥ 1475 ml. Work environment temperature of ≥ 28°C exposes dehydration risks of 9.305 times higher than work environment with temperature of less than 28°C.

Discussion

The limitation of this study is that it was conducted as a one-time cross-sectional exercise so it reduces the ability to describe the actual conditions over time. Yet, in this study bivariate and multivariate analysis was employed to eliminate noise factors of the respondents of the study. Thus, this study can sufficiently supply description of the association of heat exposure with workers' hydration status.

Changes of hydration status in this study were mostly experienced by workers assigned in the sections of dough preparation, steaming, and shaping A where the work environment temperature was ≥ 28° WBGT. This result supports the finding of a study conducted by Basri (2012) on the impact of workplace climate to

Table 3. Individual and Occupational Factors That Have Strongest Association with Hydration Status among production workers in Fish Processing Company

Variabel	B	S.E	Wald	df	Sig.	Exp.(B)	95% C.I	
							Lower	Upper
Age ≥ 40 years	-0.869	0.831	1.093	1	0.296	0.420	0.082	2.138
Nutrition Status	-0.852	0.577	2.180	1	0.140	0.427	0.138	1.322
Drinking Water Intake	1.876	0.594	9.987	1	0.002	6.529	2.039	20.905
Work Environment Temperature	2.231	0.633	1.689	1	0.000	9.305	2.727	31.748

the health condition of workers in the sewing section at Sukoharjo regency, of which the study result confirms that a work climate exceeding the NAB acceptable limit point does impact the workers' health conditions especially the hydration status. [15] People working in a work place with temperature of ≥ 28°WBGT have greater drinking water intake compared to people working in a room with temperature of < 28° WBGT. This is supporting a study conducted by Miller and Bates (2009). Ensuring that people working in high temperature work environment have to consume greater drinking water than people not working in high temperature environment. [9]

Workers that had dehydration (urine specific gravitiy ≥ 1,020) before working totals 31 people (35.2%) while workers had dehydration (urine specific gravitiy ≥ 1,020) after working totals 33 orang (37.5%). From this finding it can be concluded that there is an increase of 2 persons on the number of workers experiencing dehydration after working. This is consistent with the study conducted by Josep Dharmadi Buntoro in 2009 in Karawang, which found that the number of workers had dehydration amount to 15.64%. This result is also consistant with a study conducted by Khairunissa Andayani in 2013 in Semarang, which found that 19.2% the workers experienced dehydration. [13]

Based on these study findings, it can be concluded that on average the number of workers exposed to heat at the work place, that experience dehydration is above 10% while the expectation is 0%. This trend is influenced by several factors such as age, gender, work environment temperature and drinking water intake. Majority of workers (70%) that prior to working did not have dehydration and then had dehydration after working consumed drinking water less than 1475 ml. Majority of workers (75%), that had dehydration before working and did not experience dehydration after working, consumed drinking water ≥ 1475 ml. Workers that had dehydration prior to working and remained has dehydration after working, mostly (56.5%) comsumed drinking water less than 1475 ml. For workers who prior to working did not has dehydration and after working remained with no dehydration, most of them (70.2%) consumed drinking water ≥ 1475 ml. These study findings prove that drinking water intake is very important to influence the hydration status changes.

In this study the age factor did not have any significant association on the hydration status changes. This can be seen in the study results. A total of 30 out of 71 respondents (42.3%) aged below 40 years and 3 of 17 respondents (17.6%) aged above 40 years experienced dehydration. This finding is different from literature that mentions that workers below 40 years old have the ability to adapt to heat better than workers of above 40 yeaars old because they have better heart pumping ability. [6] This happens because workers are able to improve and maintain their hydration status by consuming drinking water. Gender factor did not have any significant association on the workers' hydration status. This can be seen in the study findings that show the number of male workers that had dehydration is greater than female workers. This is not in line with the study conducted by WHO in 1969, which concludes that females cannot do aclimatisation as well as males because males have smaller cardiovascular capacity[5].

In this study, nutritional status did not show a significant association with hydration status (p=0.123). The results of research show workers with IMT normoweight category more dehydrated than workers with IMT overweight category. This is not in line with Josep Buntoro's study which states that 57% of respondents who experience worsening hydration status included in the overweight IMT category mean that workers with normoweight IMT are more resistant to heat. Workers with IMW overweight lead to increased insulation of the body and generate more heat during work.

In this study, body surface area did not show a significant association with hydration status (p=0.309). Can be seen from the results of research showing workers with normal body surface area more dehydrated than workers with abnormal body surface area. This is according to study conducted SB Su et al stating there is no significant association between the hydration status with a area of body size. Due to study conducted by the author and Su SB had a mean body surface area is still in the normal range. In the study was conducted by the Godek SF gave a different statement. Godek SF proves the association of body surface area with sweat level. In this study, body surface area factors did not show association with hydration status because workers could maintain hydration status during work.

In this study, drinking water intake showed a significant association with hydration status (p=0,007). It can be seen from the results of the study that water intake workers less than 1475 ml more dehydrated than workers with water intake according more than1475 ml. This is in accordance with a study conducted by

Miller on workers in Australia, that found that the group of workers who have the appropriate fluid intake needs to have a certain type of urine within the normal limits at the end of work.[13] Working period factor did not show a significant association with hydration status (p=0.176). Similar study in Indonesia also found that outdoor worker who are working in high temperature environment is facing an unavoidable condition including potential heat stress that will caused physiologic response of the body.[17] The results of this study show workers with a working life ≥ 3.5 years more dehydrated than workers with a working period of <3.5 years. This is not in accordance with study conducted by Su SB et al. Which states there is a association between hydration status with the working period. The rising working group Urine Spesific Gravity has a shorter working period.

In this study, the working environment temperature factor had association with hydration status (p=0.002). The results of study show workers at work environment temperature> 28˚C were more dehydrated than workers who are at work environment temperature <28˚C. This is in accordance with Basri's 2012 study on the effect of working climate on the health condition of the sewing employees at Sukoharjo Regency, which found that there is an effect of work climate that exceeds TLV on health conditions such as dehydration, anxiety and impaired concentration.[15]

Multivariate analysis showed water intake <1475 mL gives dehydration risk 6,529 times, higher compared to water intake ≥ 1475 ml. The work environment temperature ≥ 28˚C WBGT provides dehydration risk of 9.305 times higher compared to the work environment temperature <28˚C. Of the four variables in the multivariate test, it was found that the working environment temperature variable was the most influencing risk factor affecting the hydration status of the production worker. This is evidenced by the *p* value of the working environment temperature of 0.000.

Conclusion

There is a significant association between of heat exposure and hydration status among production workers in Fish Processing Company. There was a change of worker hydration status based on urine spesific gravity after 8 hours working in the production department at fish processing. Individual factors that affect the hydration status of workers is water intake. The occupational factor affecting the hydration status of the worker is the temperature of the working environment.

Acknowledments

I would like to express my deep gratitude to my research supervisors at University of Indonesia, for their patient guidance, enthusiastic encouragement, valuable advice and critiques for this research work. I would also like to extend my thanks to the management of CV Sakana Indo Prima for allowing this research to be conducted in their company.

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