

## **Summer Crash Course: Environmental and Occupational Health Seminar (SEOH) 2018**

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## EXTENDED ABSTRACT

# Determinants of Compliance to Work Instructions among Forklift Operators in a Steel Industry

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### SUMMARY

Safe behavior is a form of behavior to act safely during work, to reduce and prevent work accidents. This study aimed to look at correlation between age, job experience, motivation, knowledge, attitude, availability of work instruction and worker compliance to work instruction among forklift operator. Questionnaire was used to determine age, job experience, motivation, knowledge, attitude, and availability of work instruction. Observation method was used to measure worker compliance to work instructions. The collected data were analyzed using logistic regression and bootstrap to find which variable had strong relationship with worker compliance to work instructions. The results indicated that motivation had significant correlation with workers compliance to work instruction. It could be concluded that motivation was a significant determinant compared to work instruction among forklift operator. It is therefore recommended that company perform routine inspection and safety training of forklift operation.

**Keywords:** Compliance to work instructions, Motivation, Forklift operators

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### INTRODUCTION

Gyekye and Salminen (2009) stated that the older workers, the more often to work safely [1]. Other study from Gyekye and Salminen (2007) stated that one of major determinant of accident risk is job experience [2]. One of strategies to prevent accident is management of unsafe personal and mechanical conditions, such as attitudes, abilities and knowledge [3]. Study on Nepal welders found that 75% of welders realize hazards at their workplace but only 19.7% aware about earmuffs [4]. A study among Colombian taxi driver found that driver attitude on facing risk is not related to perform safe act [5]. Project owner has obligation to ensure all of workers safety by establishing procedure and penalizing the deviation [6]. Different individual factors in goal orientation may related to variety of workers safety compliance [7]. The safety compliance of workers is one of important aspect to achieve occupational safety and health goal by developing safety and health program [8]. Forklift is one of popular industrial equipment because of its relatively fast-moving and powerful. Forklift operators must operate without any mistakes to keep productivity target, ensure safety operation, and avoid any damage [9]. Local government regulation instructs forklift operator to take responsibility for safe operation and company to apply occupational safety and health management

system to prevent forklift accident [10,11]. Based on this, problem statement that can be stated is "Is there any correlation between age, job experience, motivation, knowledge, attitude, availability of work instruction and compliance to work instruction among forklift operators?"

### MATERIALS AND METHODS

The data of this research was secondary data from previous research by Trisanti (2017) [12]. The research was observational, cross sectional, quantitative, and correlative study. This was conducted at steel industry located in Sidoarjo, East Java, Indonesia from October to November 2017. The samples were 25 out of 26 forklift operators at steel industry in Sidoarjo, Indonesia. The respondents were selected using simple random sampling method from Slovin Formula. Based on previous research data, the collected data were analyzed by binary logistic regression test and bootstrap method to find the relation between variables.

The dependent variable were workers compliance to work instruction on forklift operator. The independent variables were age, job experience, motivation, knowledge, attitude and availability of work instruction. Questionnaires were used to determine age, job experience, motivation, knowledge, attitude and availability of work instruction. Observational method was used for finding worker compliance to work instruction on forklift operator by using Critical Behavior Checklist (CBC) sheets. The sheet was filled by worker with the help of researcher. This research was approved

by The Ethics Committee of the Faculty of Public Health, Airlangga University with an ethical certificate number: 458-KEPK.

**RESULTS**

The results showed that workers with younger age and complying with work instructions were 4 workers (16.0%). The workers with shorter job experience and complying with work instructions were 5 workers (20.0%). The workers with better motivation and complying with work instructions were 6 workers (24.0%). The workers with better knowledge and complying with work instructions were 7 workers (28.0%). The workers with better attitude and complying with work instructions were 7 workers (28.0%). The workers that perceive availability of work instruction and comply with work instructions were 6 workers (24.0%) (Table I).

The results of binary logistic regression analysis with bootstrap because of lack of data. This were presented using 1000 times resampling. It can be seen on table,

there were a huge Exp(B) value on the independent variables. Thus, there was significant relationship between independent variables. An analysis must be performed to find which variables that interrelate and will be eliminated using spearman’s rank correlation.

The results of correlation between age, job experience, motivation, knowledge, attitude and availability of work instruction showed on table II that some variables had significant relationships each other. Age had a significant relationship with job experience, thus one variable can represent another variable and job experience was chosen to represent age. Motivation had significant relationship with attitude and availability of work instruction, thus motivation was chosen to represent attitude and availability of work instruction. Based on this, selected independent variables to be represent all of variables were job experience, motivation, and knowledge.

The results of logistic regression with bootstrap showed on table III indicate that motivation had significant

**Table I: Logistic Regression With Bootstrap Results**

		<b>B</b>	<b>S.E.</b>	<b>Wald</b>	<b>df</b>	<b>Sig.</b>	<b>Exp(B)</b>
Step 1 <sup>a</sup>	Age	-9.749	1879792.737	0	1	1.000	0
	Job Experience	9.749	1879792.737	0	1	1.000	17144.556
	Motivation	19.839	9089.411	0	1	0.998	413096568.900
	Knowledge	-18.133	26805.263	0	1	0.999	0
	Attitude	19.496	9884.625	0	1	0.998	293119463.900
	Availability of Work Instruction	19.839	9089.411	0	1	0.998	413096568.900
	Constant	-60.881	29473.221	0	1	0.998	0

**Table II: Correlation Between Independent Variables With Spearman’s Rank Correlation**

		<b>Age</b>	<b>Job Experience</b>	<b>Motivation</b>	<b>Knowledge</b>	<b>Attitude</b>	<b>Availability of Work Instruction</b>
Age	Correlation Coefficient	1.000	<b>0.846**</b>	0.014	-0.079	0.066	0.066
	Sig. (2-tailed)	.	0.000	0.946	0.706	0.755	0.755
	N	25	25	25	25	25	25
Job Experience	Correlation Coefficient	<b>0.846**</b>	1.000	0.097	-0.021	0.102	0.102
	Sig. (2-tailed)	0.000	.	0.646	0.922	0.627	0.627
	N	25	25	25	25	25	25
Motivation	Correlation Coefficient	0.014	0.097	1.000	0.230	<b>0.764**</b>	<b>0.400*</b>
	Sig. (2-tailed)	0.946	0.646	.	0.268	,000	0.048
	N	25	25	25	25	25	25
Knowledge	Correlation Coefficient	-0.079	-0.021	0.230	1.000	,302	0.302
	Sig. (2-tailed)	0.706	0.922	0.268	.	,143	0.143
	N	25	25	25	25	25	25
Attitude	Correlation Coefficient	0.066	0.102	<b>0.764**</b>	0.302	1,000	<b>0.500*</b>
	Sig. (2-tailed)	0.755	0.627	0.000	0.143	.	0.011
	N	25	25	25	25	25	25
Availability of Work Instruction	Correlation Coefficient	0.066	0.102	<b>0.400*</b>	0.302	<b>0.500*</b>	1,000
	Sig. (2-tailed)	0.755	0.627	0.048	0.143	0.011	.
	N	25	25	25	25	25	25

correlation with workers compliance to work instruction. The significance value (sig.) of motivation was 0.008 and this value is less than 0.05 (5%). Based on this data, the logit model formula for workers compliance to work instruction was :

$$Y = a + b_1X_1 + \dots + b_nX_n$$

Logit P(Compliance) = -25.159 + 4.413 (Motivation)

Note:

- a = constant
- b = variable coefficient
- X = variable value

## DISCUSSION AND CONCLUSION

Based on the results, it can be concluded that motivation has significant determinant to compliant to work instructions among forklift operator. Motivation is related to workers compliance through reward and punishment system. The higher level of motivation, the better productivity of workers [13]. One of aspect to achieve better productivity is workers compliance to safety procedure. Management can increase workers motivation by incentive, recognition and awards. Those can make worker to alter their behavior to be desired outcome such compliance to work instructions [14]. Pordanjani and Ebrahimi study found that safety motivation had significant negative correlation with occupational accident rate [15]. Other relevant study by Rosalita, etc stated that safety management practices have indirect influence to safety performance through safety motivation [16].

Based on Maslow's hierarchy of needs theory, some of esteem needs are incentive, recognition, and awards. This explain how motivation is related to employees achievement [17]. Herzberg's two factors theory state that achievement and recognition are factors that build motivation of workers [18]. Based on McClelland's human motivation theory, need for achievement is one of three needs that useful for workers to reach their best job performance [19]. Motivating workers is not only to make workers comply to work instruction, but also to build safety culture in workplace by internalizing safety value [20]. Motivation relates to safety climate to increase job performance inside organization. Motivation is a mediator to build individual safety behavior [21].

Study from Salminen (1996) stated that the younger workers, the higher accident frequency [22]. Toft (2000)

have reported that accident frequency increase on older workers [23]. Relationship between age and compliance to safety rule vary in some study, so thus there is no significant relationship between age and compliance to work instructions. Study from Butani (1988) stated that there is strong relationship between age and job experience. In the same study, job experience is more varied than age [24]. Thus, this principle was applied to choose job experience to represent age in this statistical test.

Knowledge not related to compliance to work instruction is supported by Budhathoki, etc study. Their finding states that although 90,7% welders aware that wearing goggle/eyeshield is a must, only 18% welders wear standart personal protective equipment (PPE). The others wear sunglasses that is not a standart PPE [4]. Knowledge could be related to compliance to work instruction if there were supporting facilities such as training, work instructions, availability of PPE, etc. Tristanti (2017) stated that attitude of breaking the work instruction may be caused of high production targets, so that a series of procedures are considered as obstacle while working. Other finding stated that company has provided work instruction but there is no work instruction sheet to be located in work station [12]. These finding support results that attitude does not relate to compliance to work instruction, and also available of work instructions. Recommendation to ensure compliance to work instruction is practicing routine inspection by company. Routine inspection is differentiated in daily and monthly. Daily inspection can be carried out by safety officer with walk through survey method. Monthly inspection is carried out by company safety and health committee. All of unsafe action and condition can be discussed in monthly safety meeting to follow up those deviations.

Another recommendation is safety training of forklift operation. Training aims to provide information about tasks, hazards and preventive efforts. And also, training aims to build communication between worker and management. If training is carried out regularly, it can increase motivation of the workers [12]. Training can motivate workers to achieve better job performance [25].

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**Table III: Logistic Regression of 3 Representative Independent Variables With Bootstrap**

	B	Bias	Std. Error	Sig. (2-tailed)	95% Confidence Interval		
					Lower	Upper	
Step 1	Job Experience	0.286	1.818 <sup>b</sup>	13.984 <sup>b</sup>	0.253 <sup>b</sup>	-19.337 <sup>b</sup>	19.820 <sup>b</sup>
	Motivation	4.413	17.839 <sup>b</sup>	17.561 <sup>b</sup>	0.008 <sup>b</sup>	2.015 <sup>b</sup>	41.420 <sup>b</sup>
	Knowledge	18.581	-6.511 <sup>b</sup>	11.860 <sup>b</sup>	0.186 <sup>b</sup>	-17.823 <sup>b</sup>	20.287 <sup>b</sup>
	Constant	-25.159	-22.473 <sup>b</sup>	41.123 <sup>b</sup>	0.275 <sup>b</sup>	-119.998 <sup>b</sup>	-3.996 <sup>b</sup>

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## EXTENDED ABSTRACT

# The Analysis of the Factors Related to Compliance of Personal Protective Equipment Usage at PT X (Steel Companies) Finishing Area-Sidoarjo

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### SUMMARY

The use of Personal Protective Equipment (PPE) was the final stage of the hazards control hierarchy in the workplace. The benefits of using PPE at work was not enough to drive all workers to use it. This study aimed to analyze the factors that are related to compliance use of PPE in PT X. This research was observational research with a quantitative approach, with cross-sectional research design. The data obtained were analyzed using the coefficient contingency and Regression method. Respondents of this study were all of the workers in the finishing of PT. X which was 36 workers. The data were obtained from questionnaires and observation. The results of this study show that leadership style ( $P=0,628$ ) has a strong relationship, the leaders using the transformational style were motivating workers to dutifully use PPE. Attitudes ( $p=0,523$ ) and availability ( $p=0,505$ ) have a moderated relationship with the used of PPE in the finishing workers of PT. X. The conclusion of this research was showed leadership style factor (transformational) has a significant correlation to affect the workers on the compliance of using PPE. The recommendation for SHE officers is that they should provide training to the worker about how to use PPE properly, checking periodically on the availability of PPE stock.

**Keywords:** Compliance, PPE, Worker

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### INTRODUCTION

Technological progress has an impact on increasing the productivity of the company. The increased productivity was done by maximizing the existing resources. Excessive resource exploitation and not offset by control systems such as managing human resources and machinery will impact the safety and health of workers. The unbalanced condition can lead to work scarcity.

Based on the ILO data in 2013, every 15 seconds, there is one worker in the world died due to a work accident, and 160 workers suffered health problems due to work [1]. Indonesian Employment Agency for Social Health Insurance (BPJS) of Manpower noted that in 2014 53,319 workers suffered work accidents, and in 2015, 50,089 workers were employed by work accident [2].

The next effort that can be done to prevent accidents is to use a control hierarchy. The hierarchy begins with hazard control by elimination, substitution, engineering, administrative, and use of Personal Protective Equipment (PPE). The use of PPE for labor is the last option if the

previous four phases were not effective. Each company requires its workforce to obediently use PPE while working. Compliance with the use of PPE is influenced by individual factors of workers which is worker's characteristic. Individual characteristics in question are the employment duration, the level of formal education, and knowledge about PPE. A person's employment duration will affect a worker's behavior.

PT X is one of the largest steel companies in Indonesia. The implementation of Occupational Safety and Health at PT X has been well integrated. PT X has required every worker to use PPE while in the company area or while working. The results of the interview with SHE officer showed that the workers at the finishing section of PT X is the section with the lowest level of PPE compliance. The result of preliminary data observation done in the finishing section showed that 5 out of 10 workers (50%) did not obediently use PPE while working.

### MATERIALS AND METHODS

This study used research data expressed in the form of numbers, it only performed observations without giving treatment to the object of the research. The design of this research was cross-sectional at a certain time or period. The dependent variable was compliance use of PPE and the independent variables were leadership style,

duration of work, education and knowledge, attitude and availability. Based on the analysis, this study was descriptive since it aimed only to see the picture of an event within a particular population [3].

**RESULTS**

The results of this study were obtained from the calculation results using a contingency coefficient test that aimed to determine the closeness of the relationship between dependent variables and independent variables.

It can be seen on table I that leadership style has a strong coefficient relationship with the value of the contingency coefficient is 0,628. Based on the results of cross-tabulation, it was found that obedient workers using PPE gave the supervisor’s assessment with a transformational

**Table I: The Correlation Test Result of Independent and Dependent Variables**

Independent Variable	Value of Contingency Coefficient	Coefficient Relationship
Leadership style	0.628	Strong
Duration of Work	0.283	Low
Knowledge	0.009	Very Low
Attitude	0.523	Medium
Availability	0.505	Medium

**Grade Value of Contingency Coefficient**  
 0.00-0.199= very Low; 0.20-0.399= low; 0.40-0.599= medium; 0.60-0.799= strong; 0.80-1.000= very strong

leadership style (92,6%). Table II shows the distribution leadership style of the supervisor. Transformational style has the highest percentage (75%). Table III shows the leadership style is a variable with p<0.05 value and the independent variable leadership style which dominantly influences workers to use PPE.

**Table II: Distribution Leadership style of supervisor in the finishing area**

Leadership style	Frequency	Percentage (%)
Transformational	27	75
Transactional	6	16.7
Laisses Faire	3	8.3
Total	36	100

**Table III: Variables in the equation**

Variables	P- value
Leadership style	<b>0.016</b>
Duration of work	1.000
Knowledge	0.777
Attitude	0.999
Availability	0.185

**DISCUSSION AND CONCLUSION**

Among the independent variables, the leadership style has a strong coefficient contingency and significant (p<0,05). The dominant leadership style of supervisors

is the transformational leadership. The transformational leadership style is idealized influenced and inspirational motivation. The supervisor always makes the workers feel comfortable, the supervisor always motivated, helping the workers while on a difficult job, always support the workers. When the workers feel comfortable with the supervisor, they can help the company or supervisor to carry out the vision and reduce the accident. This factor has good effect on motivation, to change the attitude of workers about using PPE. Safety knowledge and safety motivation are well-established predictors of safety participation. In a survey of workers, Jiang and Probst find that transformational leadership strengthens the safety knowledge-participation relationship. Transformational Leadership is associated with positive safety outcomes, such as improved safety climate, increased safety behaviors, and decreased accident and injuries [4]. The Duration of work has a low coefficient contingency, in finishing area, the workers were work 5-15 years. Even though they have worked long but not affected them to compliant by using PPE. The knowledge of the workers in the finishing area is good but while they was working they are not compliant with using PPE. This is because the knowledge possessed by the worker is only to know or base knowledge [3]. Attitude of workers has not significant p=0,999 (p>0,05). A research was done by Irene [8] showed that attitude affects not significantly to worker’s pursuance in using safety equipment’s with the value of p=0,114 and p=0,301 (p>0, 05). The occurrence of pursuance in using safety equipment’s as a culture at work is caused by the personal experience of workers themselves in doing their jobs.

The availability of PPE factor has medium coefficient relationship. PPE is tool provided by the company and used by workers in doing particular work in order to cover and minimize the risks in working area including accidents and incidents. The availability of PPE is a standardized procedure that is a must for a company to provide. In fact, the availability of safety equipment does not guarantee the achievement of work safety in a company.

The conclusion of this research is leadership style factor (transformational) has a significant correlation to affect the workers on the compliance of using PPE. Workers perception regarding the availability of PPE was still less than expected. This was caused by the stock of PPE that is often depleted or not available due to lack of routine checks. The majority of workers have adhered to use PPE properly while working, but during the observation, it is still found some workers who are not obedient to use PPE. Non-compliance of the majority of workers because they do not use or wrongly use especially PPE safety goggles and mask.

The strong relationship indicated the supervisor leadership style variable with workers compliance using PPE. Knowledge, duration of work, and level of

workers education have a very low closeness to workers compliance using PPE. The availability factor of PPE has a moderate relationship with compliance with the use of PPE. Based on the conclusions above, the suggestion that can be given to PT X is to provide training to the supervisor about transformational leadership, it is expected to improve supervisor to maintain the leadership style possessed and can influence the increase worker's compliance to work safely.

Performing regular checks on the amount of PPE stock that exists in each workplace, especially in the finishing section, because the checks that were not conducted in routine is one factor of unavailability of PPE so indirectly cause the workforce to be disobedient on using PPE while working because of PPE stock was out. The availability of PPE must be guaranteed by the company. The socialization on regulations regarding workplace safety needs to be improved. These procedures will minimize the risks caused by workplace accidents.

SHE officers hold workshops or toolbox meetings on PPE routinely to the workers. This proves to be effective because although the majority of the finishing workforce has only average education level (high school graduates/ vocational high school) but the majority of the finishing section workers have good knowledge, especially about PPE. In addition to holding workshops, SHE officers should also provide training to the workforce on how to use the correct PPE especially for PPE masks and safety goggles.

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## EXTENDED ABSTRACT

# Analysis of Lymphocyte Cell Proliferation and IFN- $\gamma$ Expression In Saliva of Severe Early Childhood Caries and Caries-Free in Surabaya

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## SUMMARY

Dental caries is a chronic, multifactorial disease and occurs by shifting of biofilm. Shifting of biofilm flora caused by poor oral hygiene, genetic factors, and long-term immune changes lead to an increase in *Streptococcus mutans* which results in decreased pH and demineralization on tooth surfaces. The body's immune system serves to defend from foreign invaders. IFN- $\gamma$  and lymphocytes are innate and adaptive immunity components that are responsible for the occurrence of disease. The role of the immune system becomes important in understanding the mechanisms of disease prevention. The effective function of the body's immune system is to immediately eradicate the infectious agent from the body. The objective of this study was to analyze the expression of IFN- $\gamma$  and salivary cell lymphocyte proliferation as an early detection marker of severe early childhood caries. Saliva taken from preschool-aged children 4 to 6 years was divided into two groups, ie heavy caries group with DMFT > 6 and caries-free with dmft = 0, for lymphocyte cell proliferation test using MTT assay and for expression test of IFN- $\gamma$  using flow cytometry test. There are differences in lymphocyte cell proliferation and IFN- $\gamma$  expression in the saliva of severe early childhood (S-ECC) caries and caries-free. The increase in lymphocyte proliferation and IFN- $\gamma$  expression up to 6 hours incubation can be used as the indicator of early detection marker of severe early childhood caries.

**Keywords:** Lymphocyte Cell, IFN- $\gamma$ , Severe early childhood caries (S-ECC), Early detection marker

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## INTRODUCTION

In Indonesia, the prevalence of caries in children aged 3-5 years continues to increase. In 2001, caries prevalence in children aged 3-5 years in DKI Jakarta was 81.2% [1]. In Surabaya, the prevalence of Early Childhood Caries (ECC) in groups of children 6 months-3 years was 30.8%; while the prevalence of Severe Early Childhood Caries (S-ECC) was 29.2% [2]. The process of caries occurrence is the result of a gradual and consistent shift in the balance of demineralization and remineralization of tooth enamel directly affected by *S.mutans* is one of the most important etiologic agents as the cause of dental caries [3].

Immune system of the body serves to defend the human body from foreign invaders. Immune system can cause various diseases such as infection, aging, allergies, disorders of various organs and other diseases such as cancer and auto immune deficiency syndrome (AIDS)

[4]. The role of the Immune system of the body becomes increasingly important in conceiving the mechanisms of disease prevention. The effective function of the body immune system is to immediately eradicate the infectious agent from the body. This is done by mutually interactive system actions, ie innate (very specific) fast but non-specific and adaptive immune system [5].

In response to pathogenic microbes, the adaptive immune system of the body develops effector cells that function to prevent such threats, ie: CD4+ T cell memory that serves as a protective against bacterial infections [6]. CD4 + cells participate in response to secondary infections that are potentially anti pathogenic [7]. Producing antibodies, and CD8 + T cell cytotoxicity [8].

Immune in the oral cavity is a system that makes the balance by controlling various microbes contained in the oral cavity that fluctuate due to external aggression. Various dental caries prevention has been done, for example by correct brushing, fluoridation with topical application, and vaccine making which has not yet shown the expected results [9]. Therefore this research was aimed to identify the risk factor of dental caries in

the form of immune system both innate and adaptive immunity which one of its function is to eliminate pathogen that attacking the host. It is very importance to analyze the proliferation of lymphocytes and IFN- $\gamma$  expression in saliva and caries-free as early detection marker of severe early childhood caries.

**MATERIALS AND METHODS**

**Lymphocyte Isolation**

Salivary lymphocyte was obtained by instructing the subjects to gargle with 10 ml of 1.5% sterile NaCl solution while gargling for 30 seconds, then exporiated into a sterile glass. This procedure was repeated 4 times. Next amples was centrifuged at 450g for 15 minutes, at 4°C. The centrifugation pellets were then mixed with 2 ml of medium RPMI, and then the samples are then filtered sequentially with 20 and 11  $\mu$ m nylon filters [10]. The resulted in a cell suspension and then was calculated using a hemocytometer.

The same volume of cell suspension and 0.2% blue tripan dye was mixed in Eppendorf tube and vortexed. The same suspension aliquot (20  $\mu$ l) was added to both chamber haemocytometers and observed under a microscope (10X objective). The mixture was drawn digrid with capillary action. The cells were counted in an area of 16 squares which was equal to the number of cells x104 / ml. Only translucent cells are counted in the box. The number of cells per ml was calculated using the following formula:

$$\text{Cell / ml} = \text{average number of cells per primary square} \times 104 \times \text{dilution factor}$$

**Lymphocyte Proliferation Test**

MTT assay is the standard used to measure cell viability. This is colorimetric test that measures cell proliferation. MTT assay is based on the reduction of the yellow tetrazolium compound, 3- (4,5-dimethylthiazol-2) -2,5-diphenyl tetrazolium bromide (MTT) by mitochondria succinic dehydrogenase. MTT entered the cell and entered the mitochondria and was reduced to a color solution (dark purple) formazan crystal. These cells were then dissolved with organic solvents and released, formazane reagents were measured using a spectrophotometer [11]. The optimum wavelength for absorbance was 570 nm. The research results were analyzed by plotting the number of cells against absorbance, followed by changes in quantization of cell proliferation. The tetrazolium reduction rate was proportional to the rate of cell proliferation.

$$\% \text{ Cell Proliferation} = \frac{\text{Average absorbance of treated cells}}{\text{Average absorbance of untreated cells}} \times 100$$

**IFN- $\gamma$  Expression Analysis with Flow Cytometry Principle**

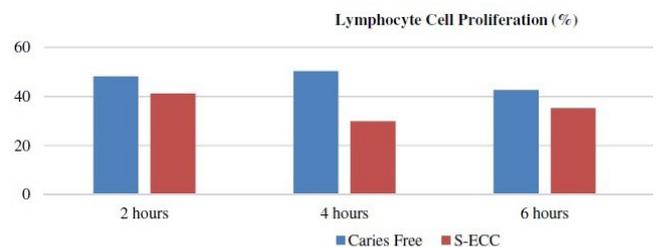
Analysis of IFN- $\gamma$  expression was determined using flow cytometry, according to manufactur

Fluoresceinisothiocyanate (FITC), phycoerythrin (PE), allophycocyanin (APC), Peridinin chlorophyll protein (PerCP), PerCP-Cy5.5-conjugated monoclonal antibodies (mAbs) (Becton Dickinson San Jose, CA, USA). The optimal concentration of mAbs was determined for each mAb by titration. Flow cytometry simultaneously measures and analyzes the physical properties of particles such as cells as they flow through the flow of fluid through a beam of light. The nature of scatter cell light can be used to analyze changes in size, granularity, internal complexity and relative fluorescence intensity. Flow cytometric analysis was performed to directly determine the immunomodulation pattern of lymphocytes, using conjugated monoclonal antibodies (mAbs).

This research was approved by The Ethics Committee of the Faculty of Dental Medicine Universitas Airlangga with an ethical certificate number: 209/HRECC.FODM/IX/2017.

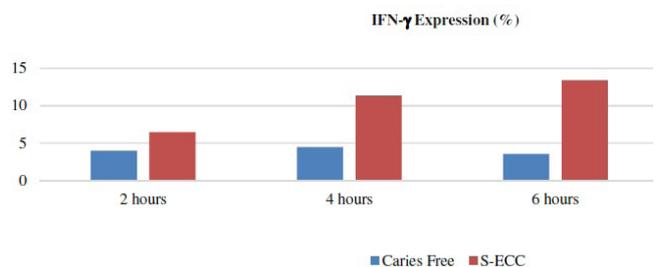
**RESULTS**

The result of the research in caries fresh showed that there was an increase of lymphocyte cell proliferation at incubation until 4 hours then decrease of lymphocyte proliferation at 6 hours incubation, whereas in the S-ECC group the decrease of lymphocyte cell proliferation in 4 hours incubation increased again after 6 hours incubation as seen in Figure 1.



**Figure 1: Lymphocyte proliferation after incubation of 2 hours, 4 hours and 6 hours on caries free and S-ECC (n=8)**

The results of test statistic analysis in the caries-free group showed that there was an increase in IF- $\gamma$  expression in 4 hours incubation but decreased at 6 hours incubation, but in the S-ECC group increased IFN- $\gamma$  expression up to 6 hours incubation as seen in Figure 2.



**Figure 2: The average graph of IFN- $\gamma$  expression on the surface of saliva netrofil after incubation of 2 hours, 4 hours and 6 hours in free caries and S-ECC (n=8)**

## DISCUSSION AND CONCLUSION

Dental caries occur by microbiological shifts in biofilms. Shifting of biofilm flora caused by poor oral hygiene, genetic factors, and long-term immune changes leads to an increase in *Streptococcus mutans* which results in decreased pH and demineralization on tooth surfaces. Immune system of the body serves to defend the human body from foreign invaders.

Soluble mediators of the innate response provide a network of signals to organize molecular and cellular response to infection, including direct and immediate antimicrobial activity. Innate response provides a signal network to regulate molecular and cellular responses immediately close to infection, including direct and immediate antimicrobial activity [12].

IFN- $\gamma$  is a proinflammatory cytokine that supports cellular immunity secreted from innate and adaptive immune cells due to the effects of cytokines such as IL-12 and IL-18. IFN- $\gamma$  was first described for its antiviral activity but is currently known to protect against certain types of microbial infections and mice lacking IFN- $\gamma$  or IFN-receptors can cause infections that easily caused by microbes.

IFN- $\gamma$  causes cytotoxic T cell responses (CD8) and up-regulation of presenting Cell antigen (APC) class II to enhance the activation of TH4-cell CD4 antigens. Furthermore, it encourages naive CD4 + T-cells to commit to the TH1 phenotype. In addition, IFN- $\gamma$  may inhibit cell growth and induce apoptosis to reduce the TH2 population [13]. It is possible that the lymphocyte cell proliferation and IFN- $\gamma$  expression increase in S-ECC up to 6 hours incubation time is compared to free caries. Conclusion, increase in lymphocyte proliferation and IFN- $\gamma$  expression up to 6 hours incubation can be used as the indicator of early detection marker of severe early childhood caries.

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## EXTENDED ABSTRACT

# Analysis of Risk Management At Welding in Gresik Steel Fabrication Company

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### SUMMARY

Gresik steel fabrication company has some complex work processes. Welding was one of the activities with a high risk in the steel fabrication company Gresik. The objective of this study was to analyze the company's risk management of Gresik steel fabrication. This research was combination of observational with cross-sectional study design. The research used observation and interviews with several relevant parties to determine the work steps in welding, hazard analysis, and control that has been done by the company. Variable in this research were the analysis of risk, risk assessment, and risk control recommendations welding. The results indicate there were 17 hazard welding whereas 5 has high hazard risk, 9 have moderate hazard risk, and 3 consider as low hazard risk. The potential risk in this study that has a high risk were noisy, working at height, electricity, and welding sparks. Furthermore, a high-hazard risk welding control recommendations includes engineering controls, administrative controls, and use of PPE. Moderate hazard risk control recommendations on welding were engineering control, and occupational health services.

**Keywords:** Risk management, Welding, Steel fabrication

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### INTRODUCTION

Gresik steel fabrication company offers services to produce design fabrication and installation of tower construction, bridges, and factories. The production process at the company's steel fabrication were drawing, marking-cutting, drilling or punching, assembling, welding, finishing (consisting of grinding, stamp, and sandblasting), painting, quality control and packing. Based on the description above, welding was a job that has a high risk hazard such as noisy, dehydration due to hot environment, electrical shock, injury to the eye, awkward working position, fire, and the explosion [1]. Welding produced effects that can pollute the environment were dust, fume, and gas pollutants. This was because the welding can be done indoors or outdoors [2]. Welding aims to combine metal (steel) in accordance with a predetermined design. Welding is done by using a specific technology needed by almost types of metal construction. Welding technology has developed continuously for example in arc and laser welding. This is done to obtain welds quality with better quality [4]. In 2013, it was reported that there were 250 million cases of accidents in the workplace and more than 160 million workers suffer from pain due to hazards

in the workplace, as well as 1.2 million workers die due to accidents [5]. In 2014, the prevalence of accidents at welding workers in South India was 80% with 24.4% of the total welders have been trained and competent [6].

Based on the results of the initial interview, it is known that welding has a number risk than other activities, with the second highest accident rate after grinding. By 2016, there were 124 accidents in the welding activities and 86 of cases got compensation to the victims. During 2017 (in January-March) there were 41 accidents in the welding that 37 of cases got compensation to the victims, and the rest cases were 3 cases of blisters, and 1 case of scratched. It is important to analyze risk management at welding in Steel Fabrication Company Gresik.

### MATERIALS AND METHODS

This research was an observational research with the cross-sectional design. It was conducted in May to June 2017. We used observation and interviews several stakeholders (such as HSE officer, HSE manager, and workers in the welding) to determine the work steps in welding, hazard analysis, and control who has conducted by the company. The secondary data was the previous studies about risk management analysis at grinding in Gresik steel fabrication company. Variable in this research were the welding parts risk analysis, welding risk assessment and risk control recommendations. The data were processed using the tools of risk analysis form.

1. Sorting the work steps in the process of welding.
2. To identify hazards at every step of the work.
3. Conduct a risk assessment to determine the level of hazard by determining the level of probability (likelihood) and severity (consequence) of such risks. Determination of likelihood and consequence is done by means of semiquantitative based on ISO 31000: 2009.
4. Calculate the level of risk to the formula:  
Risk = Likelihood x Consequence
5. Categorize the level of that risk into risk categories provided by the provision of appropriate color level of risk.
  - a. Score 1-6 = high risk (high risk)
  - b. Score 7-15 = risk (moderate risk)
  - c. Score 16-10 = low risk (acceptable risk)

Based on the results of data processing, it can be seen as the value of the risk of harm and categorization. Further analysis of control that has been done so that it can be determined by the risk control.

**RESULTS**

It is shown in table I that there were 17 hazards in welding consisted of three low-risk hazards, 9 moderate hazard, and 5 high hazard risks.

**Table I: Risk Assessment In Welding in Steel Fabrication Company Gresik**

Hazard risk	likelihood	consequence	Level Risk	Status
Fainting due to electric shock	5	4	20	Low
Minor burns due to electric shock	4	4	16	Low
Died of electro-cution	5	1	5	High
Eye irritation due to welding sparks	2	4	8	Moderate
Fainted from inhaling too much fume	5	4	20	Low
Respiratory tract infections	4	3	12	Moderate
Minor burns due to sparks	3	4	12	Moderate
blister	2	4	8	Moderate
Open wounds as a result of sparks	4	3	12	Moderate
The burns were caused by fires	4	2	8	Moderate
Died because of fire	5	1	5	High
The ability to hear is reduced	3	5	15	Moderate
Fatigue due to awkward posture	2	5	10	Moderate
Muscle pain due to posture awkward	2	5	10	Moderate
Falling from a height	3	2	6	High
falling objects	3	2	6	High
Hearing loss due to noise	3	2	6	High

**DISCUSSION AND CONCLUSION**

**Hazards Identification**

The welding process in Gresik Steel Fabrication Company consists of three main stages, namely the preparation phase, the implementation phase and stage of completion. Potential hazards at the preparation stage are the electricity, scratches, and falling objects. While the potential dangers at the implementation stage that were noisy, gas and fume, heat work climate, metal sparks, awkward posture, working at height, and welding sparks. At the stage of completion, the potential hazards were electricity, and abrasions. A study revealed that the welding work is a process that has a high risk of work followed by several potential hazards such as unique exposure, extreme heat, high radiant emission, high electromagnetic radiation, splatter, and smoke [7].

During the preparation stage, the activities carried out was to prepare the tools that will be used as the condition and availability of welding wire in the work area, the condition of the welding machine, the condition of the work area, and the condition of the O<sub>2</sub> tube, CO<sub>2</sub> tube and LPG. On examination of the welding wire, the potential hazards that can happen are scratched, open sores, whereas at the time of turning on the welding machine can causes electric shock. According to some studies, the incidence of electrical shock was influenced by several factors, such as open electrical conductor, wet environmental and clothes, broken equipment, and ignorance the workers [7].

During the implementation phase, there were several potential hazards due to welding that can be done in a variety of ambient conditions and using a variety of working positions. Fume and gas generated during welding activities take place. Fume is solid particles derived from raw materials welding, base metal, and multiple layers on base metals including manganese (Mn), beryllium (Be), cadmium (Cd), chromium (Cr), cobalt (Co), copper (Cu ), iron (Fe), lead (Pb), mercury (Hg), molybdenum (Mo), nickel (Ni), zinc (Zn), antimony (Sb), and vanadium (V). Welding fume measuring 0.005-20 µm or less than 10-30% of the mass fume more than 1 µm. The nature welding temperature released high intensity, sparks and splatter can cause risk of burning on the welders. The temperature of welding carried outreach 10000 oF. Welding can cause noise, this is caused by several factors such as the work process, stages of labor, and work area condition [7].

At the stage of completion of the activities carried out werere welding shut off the engine, smoothing tools, and cleaning work area. Electric shock can occur when turning off the welding machine, while blisters or sores can occur when cleaning the work area and smoothing tools.

**Risk Assessment**

Welding have 3 low hazard risk (17.5%), 9 hazard

moderate (53%), and 5 high hazard risk (29.5%), High hazard risk consists of died of electric shock and fire, falling from a height, the fall of the material, and hearing loss. Value severity died of electric shock and fire is one that is catastrophic because it resulted in fatalities. While the value of the possibility of death is 5, that almost never happens in the first year. Based on the probability and severity died of electric shock and fire, then the value of risk is 5. Moreover, the severity of falls from height, falling objects, and hearing loss is 2, namely major can lead to defects in the welder. While the value of the probability of occurrence is the proficiency level 3, which sometimes occurs in welding. The potential hazards that have a high hazard risk were electric shock, noise, welding sparks, and working at heights.

The moderate hazard risk consist of eye irritation due to welding sparks, respiratory tract infections, minor burns due to sparks, blister, open wounds as a result of sparks, burns were caused by fires, reduced hear ability, fatigue due to awkward posture, and muscle pain due to awkward posture. The potential hazards that have a moderate hazard risk were welding sparks, awkward posture, gas and fume, and noise.

### Risk Control

Based on Table I, it is known that there are 5 high hazard risks in welding. So that high-priority hazard in determining control. International Loss Causation Model (ILCI) theory revealed that the factors causing the accident consisted of direct causes (immediate causes), the basic causes (basic causes), and lack of supervision (lack of control). Direct causes the welding is the unsafe act and unsafe condition.

Risk control in the Gresik company of a steel fabrication were safety talk, safety induction, safety inspection (at workshop, distribution LPG gas, CO<sub>2</sub>, and O<sub>2</sub>), safety work permit, the use of PPE (work clothing, safety shoes, helmets, earplugs, face shield, mask, and gloves), and competent workers.

Risk management can be used by hierarchical control approach (hierarchy of controls). Hierarchy of risk control was a sequence in the prevention and control of risks that may arise which consists of several levels consecutively starting from control by technical means (elimination, substitution, engineering), control of the administrative to control through PPE (Personal Protective Equipment)<sup>8</sup>, High hazard risk control recommendations on welding such as:

#### 1. Engineering Control

Engineering control is controlling performed by engineering the tools, machines, infrastructure, and building [8]. engineering that can be performed on a welding among others by performing maintenance on working equipment, inspections on electrical installations, the use of a tool with low voltage safety

devices (LVSD), do insulation work processes noisy (separating the work area noisy from all the work activities so not a lot of workers exposed to noise), install noise-canceling on tools such as shot blasting, fettling and plasma spraying, the installation of barriers in the workplace, installation of ventilation in the workplace, the arrangement work is good and useful work tool for the work at height [10].

#### 2. Administrative control

Administrative control is done by making the control procedures, rules, installation of signs, and training<sup>8</sup>. Administrative control to do the welding, among others put a warning on the work area, do a refresh training on safety in welding, supervision on safety work permit, safety talk, safety induction [9,10].

#### 3. The use of PPE

The use of PPE in the form of welding special gloves that are not flammable, safety shoes, ear plugs or ear muff, face shield, helmet safety, overall which is not flammable, and a full body harness to the welding at height [9,10].

The moderate hazard risk control recommendation such as:

#### 1. Engineering control

Engineering control for moderate hazard risk was the use of ventilation in work area, use welding barrier in work area, and maintenance work area, tools, and machines.

#### 2. Occupational health services in work area

Occupational health services was the infrastructure-based service working as close as possible to the workplaces and communities. The occupational services can be performed on welding as surveillance of work environment (measurement hazard of work environment), surveillance of workers health regularly, refresh first aid training, safety on welding training, risk assessment on health of welding, record the document of activities (hygienic measurements and outcomes such as occupational diseases and injuries) [11].

The conclusion of this research that there are 17 hazards in welding in steel fabrication Gresik with high hazard risks as much as 5. The potential hazards that have a high risk of were noisy, working at height, electricity, and sparks. High hazard risk control recommendations on welding are to implement engineering controls, administrative controls, and use of PPE. Moderate hazard risk control recommendations on welding were engineering control, and occupational health services.

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## EXTENDED ABSTRACT

# Respiratory Symptoms and Associated Factors Among Building Construction Workers in Surabaya

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## SUMMARY

Dust is the most important hazard in the building construction work. It is potentially inhaled by the workers and may lead to respiratory symptoms. The purpose of this study was to analyze the factors related to respiratory symptoms among building construction workers. The method of this research was cross-sectional design with sample size of 86 people. The data were obtained from the Material Data Sheet, the questionnaire from the American Thoracic Society (ATS-DLD-78-A), and dust measurement using Low Volume Dust Sampler (LVDS). Data were analyzed by using logistic regression test ( $\alpha=0.05$ ). The results showed that the material contained high silica on the fly ash (42.19%). The level of dust exceeded threshold limit values ( $10 \text{ mg/m}^3$ ), that was on concrete grinding work ( $12.1539 \text{ mg/m}^3$ ) and ceramic cutting work ( $10.2224 \text{ mg/m}^3$ ). As many as 65.1% of workers have respiratory symptoms with the most symptoms of a cough and intake dose  $>0.03 \text{ mg/kg.day}$  (81%). Logistic regression test showed that the working period ( $p=0.003$ ) and the intake dose ( $p=0.006$ ) was the most influential factors for the respiratory symptoms. It is recommended for companies to measure respirable dust fraction and silica content, carry out spirometry and x-ray checks, provide appropriate local exhaust ventilation and dust masks, perform a work rotation system to limit the duration of dust exposure.

**Keywords:** Dust, Building construction, Respiratory symptoms

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## INTRODUCTION

Air pollution is a crucial problem in the industrial world. The significant hazards of dust are generated during construction projects, which are contributors to air pollution [1,2]. Dust materials in construction work are very diverse; namely concrete, cement, sand, wood, fly ash and Hebel, which produce some types of dust i.e. silica dust, wood dust and dust with low toxicity. Most sources of the dust come from concrete grinding. As in Korea, concrete work is one type of work targeted by fugitive dust pollution control [3]. Continuous exposure to dust can cause lung disease. The main diseases caused by dust associated with construction workers are silicosis, Chronic Obstructive Pulmonary Disease (COPD) to lung cancer [4]. A Swedish study showed that occupational exposure caused by dust pollution increases the risk of COPD and death for construction workers, especially among nonsmokers [5]. The results of research in India on construction workers exposed to dust showed that pulmonary function values, i.e. FVC, FEV1%, FEV1/FVC, PEF, FEF25-75% continued to decline along with the duration of exposure [6]. Other research on construction

workers in India mentioned respiratory symptoms due to dust including sinusitis (40%), sneezing (30%), shortness of breath (15%), nasal congestion (10%), and asthma (5%). The high incidence is influenced by continuous exposure to dust in the workplace [7]. Other research in the United States showed that 18% of construction workers have COPD, with an increased risk due to smoking habits [8]. Meanwhile in Semarang, the most occupational lung diseases result in serious disruption of pulmonary function decline, with the main symptom of shortness of breath [9]. Based on the observation, the dust in the construction work is very visible, especially in the finishing work. In the finishing process that contains some materials such as cement, fly-ash, admixtures, copper slag, Hebel concrete and ceramics are alleged to have high quartz silica ( $\text{SiO}_2$ ) content. Exposure to silica dust is always associated with silicosis in construction workers. The dust also caused symptoms from workers such as coughing, sneezing, and eye irritation. Measurement of dust levels in the workplace has never been done. In addition, personal protective equipment such as masks is also not used properly as has been required in Law no. 1 of 1970 on Occupational Safety [10]. So, it was also necessary measured the intake dose of dust that inhaled by the worker which was possibly related to occurrence of respiratory symptoms. The purpose of this study was to analyze the factors that influence respiratory symptoms of workers affected by

dust in building construction work.

**MATERIALS AND METHODS**

The research was observational and used a cross-sectional study design. The research was conducted September 2017. The sample was the entire population of 86 finishing workers. The selection of respondents was based on criteria which include: workers willing to become respondents, at least 18 years of age, minimum 1 year work period and active work. The data were analyzed by using logistic regression ( $\alpha=0.05$ ). The independent variables in this study were working period, smoking habit, dust concentration and intake dose, while the dependent variable was respiratory symptoms. The data collection was by identifying Material Safety Data Sheets (MSDS), measuring dust levels and filling in questionnaires. Filling out the questionnaire using the question sheets given to workers, including the characteristics of respondents and respiratory symptoms by using a questionnaire from the American Thoracic Society (ATS-DLD-78-A) [11]. Measurement of dust levels was using Low Volume Dust Sampler (LVDS) for 30 minutes on the concrete grinding process, ceramic cutting process and cleaning activities [11]. The measurements were made at the beginning of work (morning), rest, and the end of work (afternoon). MSDS sheets were used to identify the chemical content of the materials used [11]. Intake dose (Ink) measurement was using formula based on the dust concentration(C), respiratory rate (R), exposure time (tE), frequency of exposure (fE), duration of exposure (Dt), then divided by body weight (Wb) and average time period (tavg) as follows [12] :

$$Ink = \frac{C \times R \times tE \times fE \times Dt}{Wb \times tavg}$$

**RESULTS**

Based on the chemical content, of the material used in finishing work has a high content of silica, especially on fly ash (42.19 %). Like other materials such as cement, ceramics, Hebel and copper slag can also produce silica dust which can expose workers. The individual characteristics in this study mostly had a working period of  $\leq 3$  years (62%), and most of them smoked (93%). The measurement of dust concentration was carried out in the finishing area which was the work of grinding concrete, ceramic cutting and cleaning activities. The results of the measurement of dust concentration in the work area is shown in the table I.

Table I indicated the existence of fluctuation for 3 times which performed in the morning, rest and afternoon were intended to calculate the time-weighted average of 8 hours of work a day, with the highest time-weighted average in the work area was on concrete grinding work (12.159 mg/m<sup>3</sup>) which was exceeded of threshold values

**Table I: Measurement Results of Dust Concentration**

	Time (hours)	Dust Level (mg/m <sup>3</sup> )
Concrete Grinding	08.50-09.20	14.5891
	12.00-12.30	4.6572
	15.00-15.30	13.4481
	<b>Average</b>	<b>12.1539</b>
Ceramic Cutting	09.30-10.00	12.2235
	12.40-13.10	3.0558
	15.40-16.10	11.0956
	<b>Average</b>	<b>10.2224</b>
Cleaning Activities	10.10-10.40	9.0801
	13.10-13.40	2.4934
	16.10-16.40	10.4092
	<b>Average</b>	<b>8.4208</b>

(NAB=10 mg/m<sup>3</sup>). After identifying the characteristics of the worker and the concentration of dust, the intake dose measurement can be carried out. For example, worker number 1 with dust exposure concentration (C) 8.4208 mg/m<sup>3</sup>, inhalation rate (R) 0.65 m<sup>3</sup>/hour, time exposure in a day (tE) 7 hours/day, frequency of exposure in a year (fE) 312 days/year, duration of exposure or working day (Dt) 1 year, with weight (Wb) 71 kg and an average exposure time period (tavg) 10950 days (for non-carcinogenic toxins), the following calculation was obtained:

$$Ink = \frac{C \times R \times tE \times fE \times Dt}{Wb \times tavg} = \frac{8.4208 \frac{mg}{m^3} \times 0.65 \frac{m^3}{hours} \times 7 \frac{hours}{day} \times 312 \frac{days}{year} \times 1 year}{71 kg \times 10950 days} = 0.02 \frac{mg}{kg \cdot day}$$

So, the dust intake dose for respondent number 1 is 0.02 mg/kg.day. Most of respondent have intake dose >0.03 mg/kg.day (81%). Intake dose of dust that enters the body has the potential cause for respiratory symptoms. Based on the results of this study, most of the workers in the finishing area experienced symptoms related to their respiratory (65.1%). The number of respiratory symptoms experienced by the worker was varied. Most workers have 2 respiratory symptoms. Types of workers respiratory symptoms can be seen in Table II.

**Table II: Distribution Type of Respiratory Symptoms**

	Yes		No		Total	
	n	%	n	%	n	%
Cough	56	100	0	0	86	100
Sputum	34	60.7	22	39.3	86	100
Wheezing	6	10.7	50	89.3	86	100
Dyspnea	3	5.4	53	94.6	86	100

The presence of respiratory symptoms experienced by the workers is possible due to dust exposure concentration at work, workers characteristic and intake dose. To find the most influential factors on respiratory symptoms, a logistic regression test was performed. Based on Table III it is known that the most influential factors on respiratory symptoms are working period (p= 0.003) and intake dose (p= 0.006).

**Table III: The Distribution of Factors Related to Respiratory Symptoms**

Variable	Respiratory Symptoms				Total		p-value
	Yes		No		n	%	
	n	%	n	%			
<b>Working Period</b>							0.003
>3 years	29	87.9	4	12.1	33	100	
≤3 years	27	50.9	26	49.1	53	100	
<b>Smoking Habit</b>							0.254
Yes	54	66.7	27	33.3	81	100	
No	2	40.0	3	60.0	5	100	
<b>Dust Concentration</b>							0.090
>NAB (>10 mg/m <sup>3</sup> )	48	64.9	26	35.1	74	100	
≤NAB (≤10 mg/m <sup>3</sup> )	8	66.7	4	33.3	12	100	
<b>Intake Dose</b>							0.006
>0,03 mg/kg.day	51	72.9	19	27.1	70	100	
≤0,03 mg/kg.day	5	31.3	11	68.8	16	100	

## DISCUSSION AND CONCLUSION

Based on observations in this study, it was known that a lot of dust was produced from finishing work, especially on concrete grinding work, with the materials used in the concrete compiler include cement, fly ash, copper slag and Hebel which contain high silica, especially on flyash component. Silica dust which exposes workers continuously has been potentially caused silicosis, which based on the International Agency for Research on Cancer (IARC) silica dust is included in group 1 which is carcinogenic to humans (human lung carcinogen) [13]. Other research in the building demolition workers in Tehran, showed that the risk of mortality caused by silicosis was higher than 1/1000 (unacceptable level of risk) [14]. The highest dust concentration produced by concrete grinding work and ceramic cutting work, that was exceeded of the threshold limit value which set by the Minister of Manpower and Transmigration Regulation no. PER.13/MEN/X/2011 Year 2011 About Threshold Limits Physical And Chemical Factors In The Workplace (10 mg/m<sup>3</sup>) [15]. This was in line with research on several construction activities in America, that the level of respirable dust in surface grinding was the highest (6.17 mg/m<sup>3</sup>), exceeding the limit determined by ACGIH for silica respirable dust [16]. Most of the workers had respiratory symptoms of 56 people (65.1%) with the most common type of symptoms was a cough. The results of the study on construction workers in India showed that the most common respiratory symptoms were productive cough (23.9%) and dry cough (16.9%). Workers experience respiratory symptoms after working in construction (94.6%) [17]. Coughing is a defense reaction due to trachea bronchial irritation from exposure to respirable particles. As with chronic bronchitis which is always characterized by excessive mucus formation and manifests as a chronic cough at least 3 months a year [18]. It could not be ignored because it also very possible workers experience to silicosis which has the initial symptoms of shortness of breath and coughing.

The results showed that the most influential factors for respiratory symptoms were working period ( $p = 0.003$ ) and intake dose ( $p = 0.006$ ). Work period is the length of time the respondent works and exposed to dust in the finishing area. In theory, the longer people work, the more dust is inhaled and potentially a health risk. The dust effect received by workers is proportional to the intake dose received where the intake dose is influenced by the concentration of dust and the length of work. The higher of intake dose, the more at risk of experiencing respiratory symptoms[19].

The level of dust exceeded threshold limit values that was on concrete grinding work and ceramic cutting work. Most of workers have respiratory symptoms with the most symptoms of a cough. Logistic regression test showed that the working period and the intake dose was the most influential factors for the respiratory symptoms. The suggestions that can be given are the need to carry out risk management by calculating the concentration of dust and the duration of exposure that is safe for workers as well as carrying out a rotation system of workers. While the technical effort that can be done is to install a Local Exhaust Vent or use a wet method and provide the appropriate respirator. Other prevention efforts that need to be done are the measurement of respirable dust fraction and silica content to see the risk of exposure. Evaluation of the workers also needs to be done that is checking x-rays, lung physiology and sputum examination to distinguish it from other diseases such as chronic bronchitis, asthma, tuberculosis, and pneumonia.

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## EXTENDED ABSTRACT

# The Influence Work Periods and Knowledge of 5S to the 5S Implementation at Logistic Section in Heavy Equipment Fabrication Company Gresik

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### SUMMARY

Applying the proper 5S (sort, set, shine, standardize and sustain) is essential to maximize the level of occupational safety and health that can be associated with the increasing of productivity. This research aims to analyze the influence of work periods and knowledge of 5S to the 5S implementation at the logistics section in heavy equipment fabrication company Gresik. This study used secondary data from a previous study in heavy equipment fabrication company in the logistics section. The research is an analytical study which has a purpose to evaluate the influence between work periods and knowledge of 5S to the 5S implementation. Statistical analysis uses linear regression with 1000 replication bootstrap with small sample size (24 samples). The most distribution of employee according to the work period in the logistics section in heavy equipment fabrication company Gresik is <6 years, knowledge of 5S as 100% included in the good category, and 5S implementation as many as 100% included in the good category. There was no effect of work periods on the implementation of 5S and there was an influence of the knowledge of 5S on the implementation of 5S.

**Keywords:** Work periods, Knowledge, 5S implementation

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### INTRODUCTION

Since 2016 of the free trade period, or better known as the ASEAN Economic Community (AEC), all manufacturing or service companies are faced with a very tight competition. Many companies are content to have as much market share as possible so that they can gain the optimal benefit. The intense competition is forcing companies to improve their quality. This means that companies must be able to follow and implement the development of Science and Technology (Science and Technology) and be able to apply the supervisory or control such that, in all aspects in order to achieve effective results and efficiency in order to ensure the survival of the company [1].

Application of Occupational Health and Safety has a goal to protect and ensure the safety of all workers and ensure that every production resource can be used safely and efficiently to improve the well-being and national productivity. The issues of safety and health cannot be separated from the overall activity, the patterns must be developed within the handling of HSE (in Indonesia we called "Kesehatan dan Keselamatan Kerja or K3") and

control potential hazards should follow the systems approach by implementing System Management K3 (SMK3). The objectives and targets SMK3 are to create a system of occupational safety and health in the workplace by involving members of management, labor, working conditions and environment that are integrated in order to prevent and reduce accidents and occupational diseases as well as the creation of a workplace that is safe, convenient, efficient and productive. One way to improve the quality and productivity is to implement the 5S method which can not only improve the quality of the company but also improve the quality of the workplace environment.

5S program is derived from the Japanese words Seiri, Seiton, Seiso, Seiketsu, and Shitsuke that was otherwise known as 5S (sort, set, shine, standardize and sustain) and in Indonesia known as 5R (Ringkas, Rapi, Resik, Rawat and Rajin). The program represents the culture of how people treat their work properly. The implementation of 5S to Facilitate production, to provide comfort while working, to keep the work environment clean, to characterize the workforce, and to work discipline [2]. When the workplace in order, then the ease of working individuals can be created, and thus the efficiency, productivity, quality, and safety and health will be more easily achieved.

Implementing a 5S in ceramics manufacturing company

has been carried out in the storage department and insulator department. After implementing 5S in the storage department obtained space saving of 12.91% and wastes from certain processes are reduced while insulator department became efficient and effective [3]. The object of this program cannot be separated from elements of management, labor, and the environment. The application of 5S in Sphoorti Machine Tools improves work productivity, corporate profits, enthusiasm, and timeliness between labor and safer workplace conditions [4]. Hence, the implementation of 5S should be maintained continuously so that get good productivity. The results of the research on 5S simulations are that 5S is good to be implemented to improve system performance [5]. The results of the research in Wan Cheng Manufacturing Company show that the application of 5S can Decrease the time to find the needed goods so as to increase of work productivity and work efficiency [6]. Contrariwise, the lack of efficiency and organization at the workplace leads to waste of time and resources, low-quality products, disorganization, safety problems, delivery delays and so on [7].

The company for this research is a heavy equipment fabrication company in Gresik which has had its policy on 5S and has been apply. In an effort to increase productivity and maintain the efficiency and effectiveness of cultural work, it is not enough to stop at the point of good, because the acquisition must be maintained continuously. For that reason, the purpose of this study was to understand the influence of work periods and 5S knowledge to the 5S implementation at the logistics section in heavy equipment fabrication company Gresik.

**MATERIALS AND METHODS**

This research used secondary data from the study in heavy equipment fabrication company in the logistics section. The research is the analytical study of the which have the purpose to evaluate influence between work period, knowledge of 5S to 5S implementation. Data obtained from studies conducted in the logistics department heavy equipment fabrication company in Gresik. The total of workforce of 25 workers were sampled and analyzed as many as 24 workers with statistical analytic bootstrap uses linear regression with 1000 replication to cause the sample is small (24 samples). Work period was the amount of time the labors work on the logistics section and was classified as less than 6 years, between 6 to 10 years, and more than 10 years. Knowledge of 5S was the level of understanding about 5S. This data was obtained from questionnaires distributed to the workers into the sample. The Question consists of eight items that represent the knowledge and attitudes of 8 items represent about 5S. each item has the highest score and the lowest score was rated 3 rated 1. it can be used as a benchmark in understanding

and action of 5S. This variable was classified as less, enough, and good category. The 5S implementation was all activities carried out within the framework of labor 5S. this variable was classified as less (score 0-8), enough (score 9-16), good (score 17-24). This research was approved by The Ethics Committee of the Faculty of Public Health Airlangga University with an ethical certificate number :170-KEPK.

**RESULTS**

Based on the secondary data, heavy equipment fabrication company Gresik has set implementation of 5S as technical guidelines and SOPs must be implemented. This rule refers to the policy document number SD / X-01 on the control of 5S. This document describes the control procedure, the commitment of management, organizational structure 5S, 5S area, a work program 5S, 5S program implementation, evaluation of 5S, 5S follow-up program, and a basic explanation 5S[8].

**Work Period**

Based on Table 1 the most distribution of employee According to the work period in the logistics section in heavy equipment fabrication company Gresik is <6 years with the number of 15 employees (62.5%). This is because there is the new incoming employee who has the tenure of less than one year and most having work periods of 4-5 years.

**Table I: Employee Distribution According to Work Period at the Logistic Section in heavy equipment fabrication company Gresik**

Work Period (years)	Logistic Section	
	N	%
<6	15	62.5
6-10	4	16.7
> 10	5	20.8
Total	24	100

**Knowledge of 5S**

Based on Table II knowledge of 5S in the logistics section in heavy equipment fabrication company Gresik as many as 24 employees (100%) included in the good category of 5S knowledge. This is because there are promote about the 5S in the workplace so that the knowledge of workers about 5S is still good.

**Table II: Employee Distribution According to Knowledge of 5S at the Logistic section in heavy equipment fabrication company Gresik.**

5R Knowledge	Logistic Section	
	N	%
Good	24	100
Total	24	100

Source: Secondary Data<sup>(8)</sup>

**5S Implementation**

Based on Table 3 the distribution of 5S implementation at the logistics section in heavy equipment fabrication company Gresik as many as 24 employees (100%) included in the good category. This category has

a value that varies from numbers 17-24, although having a different value but all are still included in the good category. This is due to the supervision of the management are related to the implementation of 5S if the worker violates it will receive a warning from the Management or even sanctions.

Analysis of the influence between Work Period, Knowledge of 5S to 5S implementation at the logistic section. Regression analysis is used here to test the effect of knowledge and years of service. In regression analysis variables used in knowledge using the total score is not category. Results of regression analysis of 1000 bootstrap samples are show that there is no effects of work period on the implementation of 5S at the logistic section. As for the value of the variable sig knowledge of 5S, The conclusions that can be drawn that there is the influence of the level of knowledge on the implementation of 5S at logistic section in the heavy equipment fabrication company Gresik.

**Table III: Employee Distribution According to 5S Implementation at the Logistics Section heavy equipment fabrication company in Gresik.**

Attitudes towards 5R	Logistic Section	
	N	%
Good	24	100
Total	24	100

Source: Secondary Data<sup>(8)</sup>

## DISCUSSION AND CONCLUSION

It can be concluded that working time has no effect in the implementation of 5S on the logistics section in heavy equipment fabrication company Gresik. It can be caused by the long working lives (this can be seen from the table) that most of the workforce has a working period of fewer than 6 years. A relatively short working period is a period of adaptation for a workers, so sometimes he is still not used to the work culture in everyday activities. While workers who have experienced it will be easier to recognize the work environment so that more careful in work[9]. These results agree with the results of research conducted on a motorcycle mechanic in Semarang which states that there is no relationship between tenure with 5S practices [10]. This is in contrast with the results of research that says there is a relationship between the length of service and employee attitudes toward the implementation of 5S in the logistics department in the company of heavy equipment fabrication [8].

The knowledge level has an influence on the implementation of 5S in the workplace. This shows the importance of knowledge of the implementation of 5S can run well. In accordance with the theory of behavior by Lawrence Green, there are three factors that predispose people to behave: predisposing factors, enabling factors and reinforcing factors. Included in the predisposing factor is knowledge, attitudes, beliefs, values and demographic factors such as age, gender, economic status, and others [11]. With good knowledge about

5S it is expected that 5S behavior can be applied and became a habit so that it becomes a good culture in the workplace. These results agree with research that says that there is a low correlation between knowledge and attitude of employees towards the implementation of 5S at the logistics company's fabrication[8]. But, these results differ from the statement that there is no relationship between the level of knowledge in the practice of 5S [10].

The main purpose of the 5S implementation is to maximize the level of occupational safety and health associated with Increased productivity [12]. 5S understanding should be improved because there is no influence of working life in this analysis. Procurement update the science or knowledge of 5S as a refresher step should be done regularly to recall the importance of 5S. In addition to the need for monitoring the implementation of day-to-day activities. Although there has been an SOP on 5S but in the daily activities it is necessary to monitor whether these activities already underway in accordance with standard operating procedures that have been made.

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## EXTENDED ABSTRACT

# The Relation Between Job Tenure and Social Support Period of Coworkers and Superiors With Work Stress On Aircraft Maintenance Officer At Airlines Company

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### SUMMARY

Aircraft Maintenance Officer is one of the jobs that can leads to work stress, because it required individuals who were competent in knowledge and skills. This job also required speed and accuracy in completing the task. The purpose of this study was to identified the correlation between job tenure and social support of coworkers and superiors with workstress on aircraft maintenance officer in airlines company. This study was a descriptive observational study with cross-sectional design. The total of 41 subjects were used as the respondent in this study. The primary the data was collected by questionnaires such as age, job tenure and social support of coworkers and superiors by Berlin Social Support Scale questionnaire and the brief job stress questionnaire used to measure work stress among aircraft maintenance officer airlines company. The result of this study shows that most of the workers who have high social support of coworkers and superiors have medium work stress. The analyzed data with Chi-Square test showed that there were correlation of job tenure with work stress ( $r = 0.000$ ) showing the longer job tenure having lower work stress. Social support of coworkers and superiors was also correlated with work stress ( $r = 0.160$ ), with more social support of coworkers and superiors resulted in less work stress. The better the social support received the lower the risk of job stress. The experience and capability will helped workers to overcome the problem in order to prevent stress. Workers should be able to maintain good communication between colleagues and superiors to reduce burden and stress experienced.

**Keywords:** Job tenure, Social support period of coworkers and superiors, Work stress, Airlines company

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### INTRODUCTION

Aircraft technicians have an important role in the repair industry and aircraft maintenance. Therefore, the health of aircraft engineers are very noteworthy. One of the health problems experienced by aircraft engineers are work stress, this is because aircraft technicians have high job demands in terms of speed and accuracy in completing the task, followed by a short turnaround time task [1].

The factors that affect the stress include: (a) the workplace, such as environments with extreme temperatures, less lighting, noisy; (b) the content of the work, such as time limits, workload, complexity of the work; (c) requirements for the job as a career and employment status is unclear, (d) interpersonal relationships in the work as not fit with co-workers, less open attitude, and the boss is too much demand [2].

Basically, the company not only expects employees who are competence, capable and skilled, but most importantly, they work hard and willing to achieve optimal results. Ability, aptitude and skills of employees are meaningless for the company without work hard with ability, competency and skill he had. The working period was important for employees who have worked for decades have high productivity [3].

Social support factor related to work stress. The results of the study shows that respondents who experience many work stress complaints are respondents with poor social support with the largest proportion experienced very heavy work stress. This shows that social support is bad will be able to influence the emergence of work stress. This is reinforced by the research of The Relationship Between Social Support and Job Stress in Solopos Employees, which concludes that there is a negative relationship describing the higher social support, the lower the work stress on Solopos employees [4].

Airlines company was a company engaged in the field of aircraft maintenance and repair. worker activity of airlines company focuses on maintaining and ensuring

equipment and aircraft systems to work in accordance with the functions and operations according to standard so that aircraft in airworthy condition. The aircraft maintenance jobs require individuals who are competent in the knowledge, skills, and behaviors because it involves the safety of many people. Job tenure of workers and social support coworkers and employers in completing the task allows the emergence of job stress on the workforce concerned. Less friendly working environment such as exposure to noise, vibration, and high heat also allows the emergence of job stress.

Based on the results of the preliminary studies that have been carried out on 16 workers, obtained information that more than 90% workers have experienced job stress. The work stress experienced by the majority is related to work and work environment. Job stress factors include the demands of high work, accuracy and speed in completing tasks, as well as non-working environments comfortable like extreme noise and temperature. In addition, there also other factors namely the existence of family problems and personal relationships between workers and superiors are low.

The purpose of this study is to determine the relationship between job tenure and social support of coworkers and superiors with work stress on aircraft maintenance at airlines company.

**MATERIALS AND METHODS**

The type of this research is an observational study using questionnaire with interview method to the labor of aircraft maintenance department at airlines company. This study was descriptive-cross sectional to identify and analyze the relationship between job tenure and social support of coworkers and superiors with work stress. It was conducted in May 2018. Primary data obtained by observation and filling questionnaire. The secondary data consist of company profile and amount of labor from company record.

The population of this study was the entire workforce of aircraft maintenance at airlines company, and the sample used in this study is 40 workers, with exclusion in this study was worker that cannot issue financial problems and family problems, unpleasant workforce because of unclear roles, and not requires career development. No samples were issued because of this exclusion criteria.. The process of data collection used a Berlin Social Support Scale questionnaire to measure the social support of coworkers and Superiors, there were 31 Questions, and the measurements with Likert scale: 1 = Strongly Disagree 2 = Disagree 3 = Agree 4 = Strongly Agree . The Job Stress Questionnaire to measured the level of work stress, there were 57 questions, and the measurements with Likert scale: 1 = Strongly Agree 2 = Agree 3 = Disagree 4 = Strongly Disagree. Then data will analyzed by chi-square test because the data was

ordinal scale. This research was approved by The Ethics Commite of the Faculty of Public Health Airlangga University with an ethical certificate number : 241-KEPK.

**RESULTS**

**Distribution of Individual Characteristics**

Table I shows that there were three working groups of aircraft maintenance period officer at airlines company. The results of the study found that as many as 31 people or 75.6% of workers have a working period of less than five years.

**Table I:** Distribution of Job tenure on Aircraft Maintenance Workers of PT.X in 2017

Job tenure	Frequency (n)	Percentage (%)
<5 Years	31	75.6
5-10 Years	6	14.6
> 10 Years	4	9.8
<b>Total</b>	<b>41</b>	<b>100</b>

Based on the resulted of social support coworkers and superiors as shown in table II, it was found that as many as 35 people or 85.4% of the workforce was a level of sosial support level coworkers and superiors in a high category.

**Table III:** Identification of Work Stress Level on Aircraft Maintenance Workers of airlines company in 2017

Work Stress	Frequency (n)	Percentage (%)
Low	16	39
Medium	25	61
High	0	0
<b>Total</b>	<b>41</b>	<b>100</b>

**Identification of Work Stress Level**

Based on table III, 25 people or 61% of workers have work stress levels which was included in the medium category.

**Table III:** Identification of Work Stress Level on Aircraft Maintenance Workers of airlines company in 2017

Work Stress	Frequency (n)	Percentage (%)
Low	16	39
Medium	25	61
High	0	0
<b>Total</b>	<b>41</b>	<b>100</b>

**The Relation Between Job Tenure with Work stress**

The result of the statistical test with chi-square between job tenure and work stress on table IV indicated that there were correlation (0.000). This means that the longer job tenure got lower work stress. The resulted showed correlation between job tenure with work stress, this was due to the possibility of workers with longer job tenure tend to have the ability and better understanding in doing his job compared to workers with job tenure shorted work so that it can triggered work stress. This was consistended with research in 2017 with title relationship between job tenure with work stress on

**Table IV.** The Relation Between Job Tenure with Work Stress on Aircraft Maintenance Workers of Airlines Company

Job Tenure	Work Stress						Total	
	low		Medium		High		n	%
	n	%	N	%	n	%		
<5 th	12	38.7	19	61.3	0	0	31	100
5-10 th	2	33.3	4	66.7	0	0	6	100
> 10 th	2	50.0	2	50.0	0	0	4	100
Total	16	39.0	25	61.0	0	0	41	100
<b>Correlation coefficient</b>				<b>0.000</b>				

labor part winding in PT Iskandar Indah Printing Textile Surakarta which indicated there is correlation between job tenure with workstress (0,012) [5].

**The Relation Between Social Support of Coworkers And Superiors with Work Stress**

The result shown in table V are correlation coefficient of 0,160. This means that the higher the social support, the lower the stress of work. This was consistent with research in 2018 with title the relationship between social support and work stress on Port employees which indicated there is correlation between social support with work stress [6].

**Table V:** The relation between Social Support of Coworkers and Superiors with Work Stress on Aircraft Maintenance Workers of Airlines Company

Social Support	Work Stress						Total	
	low		Medium		High		N	%
	n	%	N	%	n	%		
Low	0	0	0	0	0	0	0	0
Medium	1	16.7	5	83.3	0	0	6	100
heavy	15	42.9	20	57.1	0	0	35	100
Total	16	39.0	25	61.0	0	0	41	100
<b>Correlation coefficient</b>				<b>0.160</b>				

**DISCUSSION AND CONCLUSION**

It was found that the majority of workers experienced medium job stress, it was because of a fairly heavy workload perceived labor. There were also factors related to the worked duration, work shift with worked hours that still exceeded the limit specified by the law, and worked environment where workers work on environmental condition included physical hazards such as noise, vibration, and heat caused by exposure to the sun can provide pressured and triggered to stress.

The result of research conducted on the worker of aircraft maintenance section airlines company there were correlation of job tenure with work stress (r = 0,000) it means the longer job tenure got lower work stress. Job tenure had an important influence in triggering the emergence of occupational stress. Workers with longer service life tend to had the capacity and a better

capability of its work compared to workers who had shorted worked live. This was because the experienced of the workers with longer worked lived had more experience on the job he did [7]. Longer worked lived was closely related to the experience and capability of the job [8] The experience and capability of this will helped workers to overcome the problem in order to prevented stress.

Then there were correlation of social support of coworkers and superiors with work stress (r = 0,160), it means more social support of coworkers and Superiors resulting in less work stress. Cooper theory states that one of the factors that cause job stress was bad social support. The better the social support received the lower the risk of job stress that would arise [9].

Suggestions on this research were, the labor should be able to maintain good communication between colleagues and superiors so that when experiencing trouble in his work does not make a burden and can alleviate the stress experienced. In addition, it was expected the company to constantly monitor and provide counseling facilities to the workers to know the problems experienced anything both at work and outside of work in order to reduce stress, so as to improve the quality and productivity of work as well as the company's target can be achieved.

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## EXTENDED ABSTRACT

# The Risk Factors Analysis of Menstrual Disorders in Women Workers of Shoes Industry, Sidoarjo

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### SUMMARY

Menstrual disorders is an important indicator to shows the function of the reproductive system disorders. Menstrual disorders may be associated with an increased risk of various diseases such as cervical cancer, breast cancer, infertility and diabetes mellitus. Menstrual disorders is caused by various factors. This study was conducted to analyze the risk of menstrual disorders in women workers in the area of Finishing Factory 1, Shoes Industry, Sidoarjo. This study was an observational study with cross sectional design. Samples were 199 respondents taken from 396 populations that calculated with proportional random sampling with proportion based on work shift (Shift A: 68 workers, Shift B: 65 workers, Shift C: 66 workers). The sample exclusion criteria for this study was pregnant. Data was analyzed by Chi-Square Test and Binary Logistic Regression. There were relationship between nutritional status, age of menarche, usage of contraception, type of contraception and duration of usage contraception with menstrual disorders. Variabel such as job stress was not related with menstrual disorders. The risk factors of menstrual disorders were progesterin type contraception (risk: 5.2 times), duration of contraception usage for 12-24 monts (risk: 4.5 times), abnormal nutritional status (risk: 3.8 times),contraception usage (risk: 2.8 times) and abnormal in age at menarche (risk: 1.8 times). Based on overall test, nutritional status, age of menarche, usage of contraception, type of contraception and duration of contraception usage) together affects the occurrence of menstrual disorders but based on partial test, factors of nutritional status, age of menarche, type of contraception and duration of contraception usage were not partialy affects the occurrence of menstrual disorders. Menstrual disorders could occured due to the independent factors that affected together, not partially. It is recommended for women workers at Shoes Industry, Sidoarjo should drink more water, consume foods high in calcium, fruits and vegetables and choose contraceptives which cause menstrual disorders such as non hormonal contraception.

**Keywords:** Mentrual disorders, Shoes industry, Women workers

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### INTRODUCTION

The emergence of industrialization opens opportunities for women to be able to work in various industrial sectors so that the women workers participation rate increases. Women can participate economically to work to support the quality of life of women and their families towards a better life.

According to data released by the Center for Employment Data and Information of the Indonesian Ministry of Manpower and Transmigration's Development and Information Research Agency in February 2017, the number of workers in Indonesia is 120,887,937 people with 46,229,159 women workers. The number of workers in East Java Province was 20,034,229 people with 11,627,833 of men workers and 8,406,466 of women workers. This shows that women who work as

laborers are quite high in Indonesia, especially in East Java [1].

Data released by Indonesian Ministry of Health in 2017, the fertility rate or Indonesia's Total Fertility Rate (TFR) of 2.4, which means there will be 2 children per woman in out of city. The number women of childbearing age in Indonesia is 70,250,528 women and in East Java is 10,435,722 women. The number of couples of childbearing age in Indonesia is 37,338,265 couples who use family planning actively as much as 23,606,218 couples (63,22%). In East Java 6,316,634 couples who use family planning actively as much as 4,150,437 couples (65,71%) with 61,70% progesterin injection [2].

About 50% of women in the world suffer from menstrual disorders such as dysmenorrhea. The prevalence of menstrual disorders in Indonesia is 55% with 64,25% dysmenorrhea [3]. Many studies show the factors that cause menstrual disorders to occur are nutritional status [4-6], age of menarche [4,7], usage of contraception [6,8], type of contraception [6,8], duration of usage

contraception [6,8], and job stress [4,9].

Menstrual disorders experienced by women workers can lead to high absentee and decrease in performance so will reduce the productivity which costs become inefficient. Therefore, it is necessary to analyze the incidence of menstrual disorders in women workers. One of the biggest shoes industry in Indonesia is a foreign company that produces shoes in Sidoarjo City. Human resources in the shoes industry are quite high that are 5,000 women workers who works mostly in the cutting, upper and finishing area.

In the area of Finishing Factory 1, there are many factors that can cause menstrual disorders such as high temperature and high noise level because it is close to the injection machine so that it can trigger the onset of menstrual disorders in the woman worker in shoes industry, Sidoarjo. The purpose of this study was to analyze the risk factors of menstrual disorders in women workers in the area of Finishing Factory 1, Shoes Industry, Sidoarjo.

**MATERIALS AND METHODS**

This study was an observational study with cross sectional design. Samples were 199 respondents taken from 396 populations that calculated with proportional random sampling with proportion based on work shift. The sample exclusion was pregnant. Dependent variable is menstrual disorders experienced by woman workers of shoes industry, Sidoarjo. Independent variabel were nutritional status, age of menarche, usage of contraception, type of contraception, duration of usage contraception, temperature, noise and job stress. Nutritional status was obtained by MCU results, temperature and noise measured by using Thermo-Higrometer and Sound Level Meter, and the others were obtained by menstrual disorders questionnaire, Pictorial Blood Loss Assessment and Job Stress Survey (JSS). This study was conducted in the area of Finishing Factory 1, Shoes Industry, Sidoarjo in September 3-19 2015. The data collected was done by editing process. Data was analyzed by Chi-Square Test and Binary Logistic Regression. If the Chi-Square Test was not fulfilled, then the Fisher Exact Test was used.

**RESULTS**

The majority of women workers respondents in the area of Finishing Factory 1, Shoes Industry, Sidoarjo experienced menstrual disorders is 170 workers (85.4%) (Table I).

**Table I: Distribution of Menstrual Disorders in Women Workers in Area of Finishing Factory 1, Shoes Industry, Sidoarjo**

Menstrual Disorders	n	%
Yes	170	85.4
No	29	14.6
Total	199	100.0

Most of the women workers in the area of Finishing Factory 1, Shoes Industry, Sidoarjo such as 109 workers had abnormal nutritional status, 106 workers had abnormal of age of menarche, 87 workers (91.6%) used contraception, 37 workers (97.4%) used progestin injection (every 3 months), 34 people (97.1%) used contraception for 12-24 months and 89 people (80.9%) had a mild job stress index (JSS score: 0.5- 13.5) experienced menstrual disorders (Table II).

The results of statistical tests for nutritional status (9,105 of Fisher Fisher’s Exact Test with 0,044 of p value), age of menarche (19.205 of Pearson Chi-Square with 0.000 of p value), usage of contraception (4.621 of Continuity Correction value with 0.032 of p value), type of contraception (7.716 of Fisher’s Exact Test with 0.038 of p value), duration of contraception usage (0.023 of p value) were smaller than  $\alpha$  (0.05) so it could be seen that there were relationship between nutritional status, age of menarche, type contraception, duration of contraception usage with menstrual disorders in women workers in the area of Finishing Factory 1, Shoes Industry, Sidoarjo. However, job stress index (0.074 of Fisher’s Exact Test) was higher than  $\alpha$  (0.05) so there was not relationship between job stress index with menstrual disorders in women workers in the area of Finishing Factory 1, Shoes Industry, Sidoarjo. The risk factors of menstrual disorders were progestin (risk: 5.2 times), duration of contraception usage for 12-24 months (risk: 4.5 times), abnormal nutritional status (risk: 3.8 times),contraception usage (risk: 2.8 times) and abnormal in age at menarche (risk: 1.8 times).

Based on the table of model significance test, the Sig. Model value was 0.000, smaller than  $\alpha$  (0.05) so that the independent variable (nutritional status, age of menarche, usage of contraception, type of contraception and duration of contraception usage) together or minimum there was at least one independent affects the occurrence of menstrual disorders of women workers in the area of Finishing Factory 1, Shoes Industry, Sidoarjo. Based on the Summary Model table (Table III), the value of Nagelkerke’s R Square was 0.886 so 88.6% of menstrual disorders that could be explained by the variability of the independent variable, while 11.4 % of the rest was explained by the variability of other variables outside the independent variables studied. Based on partial test, factors of nutritional status, age of menarche, type of contraception and duration of contraception usage were not partialy affects the occurrence of menstrual disorders (Table IV).

**DISCUSSION AND CONCLUSION**

Most of respondents experienced menstrual disorders. There were relationship between menstrual disorders with nutritional status, age of menarche, usage of contraception, type of contraception and duration of usage contraception, except job stress. The risk factors of

**Table II: Relationship between Risk Factors and Menstrual Disorders of Women Workers in the Area of Finishing Factory 1, Shoes Industry, Sidoarjo**

Risk Factors	Categories	Menstrual Disorders				p	Relationship	CI (95%)	
		Yes		No					
		n	%	n	%				
Nutritional Status	Underweight	13	92.9	1	7.1	0.044	Yes	3.84	
	Normal	69	76.7	21	23.3				
	Overweight :								
	1.Risky	51	92.7	4	7.3				
	2.Obese I	29	93.5	2	6.5				
Age of Menarche	3.Obese II	8	88.9	1	11.1	0.000	Yes	1.77	
	Precocious Puberty	74	98.7	1	1.3				
	Menarche Normal	64	81.0	15	19.0				
Usage of Contraception	Menarche Tarda	32	71.1	13	28.9	0.032	Yes	2.75	
	Use	87	91.6	8	8.4				
Type of Contraception	Not Use	83	79.8	21	20.2	0.038	Yes	5.18	
	Pill	5	62.5	3	37.5				
	Comb. Injection	25	92.6	2	7.4				
	Progestin Injection	37	97.4	1	2.6				
	Implant	6	85.7	1	14.3				
Duration of Contraception Usage	AKDR/IUD AKD	14	93.3	1	6.7	0.020	Yes	4.49	
	<1 Month	2	50.0	2	50.0				
	1-3 Months	4	80.0	1	20.0				
	3-6 Months	22	88.0	3	12.0				
	6-12 Months	25	96.2	1	3.8				
Job Stress Index	12-24 Months	34	97.1	1	2.9	0.074	No		
	Low	89	80.9	21	19.1				
	Medium	52	88.1	7	11.9				
	High	29	96.7	1	3.3				

**Table III: Overall Test of Binary Logistic Regression of Risk Factors and Menstrual Disorders of Women Workers in The Area of Finishing Factory 1, Shoes Industry, Sidoarjo**

Omnibus Test of Model Coefficients					Summary Model		
	Chi-Square	df	Sig.	-2 Log likelihood	Cox & Snell R Square	Nagelkerke's R Square	
Step 1	Step	45.728	4	0.000			
	Block	45.728	4	0.000	8.077	0.402	0.886
	Model	45.728	4	0.000			

menstrual disorders were progestin type contraception (risk: 5.2 times), duration of contraception usage for 12-24 months (risk: 4.5 times), abnormal nutritional status (risk: 3.8 times), contraception usage (risk: 2.8 times), and abnormal in age at menarche (risk: 1.8 times). These risk factors (nutritional status, age of menarche, usage of contraception, type of contraception and duration of contraception usage) together affects the occurrence of menstrual disorders but not partially affects the occurrence of menstrual disorders.

The causes of physiological menstrual disorders are related to hormonal system disorders that caused by the use of hormonal contraception, stress, age, over nutrition, marital status, age at menarche, number of parturition, exposure to chemicals, work shift, period of work and environment [10-12]. A woman who has a deficiency or excess nutrition will have an impact

on the decline of hypothalamic function which does not provide stimulation to the anterior pituitary to produce FSH and LH so the menstrual cycle will also be disrupted [13]. Age at early menarche related to the incidence of primary dysmenorrhea [14]. Menarche tarda is generally caused by hereditary factors, health problems and malnutrition which can cause a decrease in gonadotropin levels so that the secretion of estrogen and progesterone hormone will decrease [15].

Menstrual pain or dysmenorrhea is caused by contraceptive usage. According to WHO [16], hormonal contraception causes heavy bleeding during menstruation, menstrual decreases and disruption of the menstrual cycle. Therefore, people who use contraception, especially hormonal contraception, are more prone to menstrual disorders than those who use non-hormonal contraception. Progestin/3-month injections have more menstrual complaints than other types of contraception because a higher progesterone content compared to other contraceptives so it easily causes reproductive hormone imbalances and results in frequent menstrual disorders, amenorrhea and more bleeding compared to other contraceptives [17].

Job stress not related to menstrual disorders in this study is not in accordance with the theory stated that menstrual disorders are caused by stress that induce hypothalamus

**Table IV: Partial Test of Binary Logistic Regression of Risk Factors and Menstrual Disorders of Women Workers in The Area of Finishing Factory 1, Shoes Industry, Sidoarjo**

Step 1 <sup>a</sup>	B	S.E.	Wald	df	Sig.	Exp (B)	95%CI	
							Lower	Upper
Type of Contraception	-3.777	2.652	2.029	1	0.154	0.023	0.000	4.140
Duration of Contraception Usage	-4.628	2.739	2.856	1	0.091	0.010	0.000	2.095
Nutritional Status	-1.213	0.639	3.603	1	0.058	0.297	0.085	1.040
Age of Menarche	3.522	2.778	1.607	1	0.205	33.845	0.145	7835.895
Constant	42.109	22.274	3.574	1	0.059	1.939E+18		

to secretes CRH so GnRH causes unequal expenditure of LH and FSH [18-21]. However, another study showed similar result with thus study [22]. This is probably due to job stress experienced by respondents were light, so the stress might not be able to trigger the hypothalamus to secrete LH and FSH hormone inbalanced that causes menstrual disorders.

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## EXTENDED ABSTRACT

# The Correlation between Individual, Occupational, and Work Environment Factors to Reproductive Health of Female Workers in the Beverage and Plastic Industries in Sidoarjo, Indonesia

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### SUMMARY

PT.X and PT.Y are two companies that is located at Taman district, Sidoarjo Regency in East Java and engaged in the beverage manufacturing and plastic manufacturing industries respectively. As many as 109 respondents were selected using simple random sampling method. Data collection techniques was done by using questionnaires to find out individual factors, work, and psychological factors (work stress) and direct measurement of the work environment (measurement of temperature and noise). Work stress was measured using Job Stress Survey (JSS) by Vagg and Spielberger. Temperature measured using Thermal Environment Monitor, while noise was measured using Sound Level Meter device. Correlation analysis in this study was using contingency coefficient method. The results shows that a total of 63.3% (69 respondents out of total 109) of female workers experienced reproductive health problems. The result of the correlation test showed that the independent variable of parity numbers, work stress, work environment temperature, and work shift has significant effect on reproductive health ( $p$ -value  $< 0.05$ ). This can be seen from the probability value ( $p$ -value) of the correlation test. The  $p$ -value for parity number variable is 0.000, work stress is 0.000, temperature is 0.044 and work shift is 0.006. The contingency coefficient test indicate that parity number, workshift, work station temperature, and work stress are as significant contributor on reproductive health disorders, in this case menstrual disorders and pregnancy disorders in female workers. Therefore it is important for the company to address the issues of work shift arrangement, heat exposure and stress management in the work environment

**Keywords:** Reproductive health, Female workers, Individual factors, Occupational factors, Work environment factors

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### INTRODUCTION

In East Java, 40.6% of total workers are female [1]. Female workers have different reproductive phases i.e. menstruation, pregnancy and menopause which make them more vulnerable to reproductive problem when they are exposed to occupational and non-occupational risk [1]. In this study, 12 risk factors are observed and evaluated. Those 12 risk factors are categorized into three categories: individual factor (age, marital status, nutritional status, age of menarche, number of parity, and parity distance), occupational factors (working period, work shift, work position) and work environment factor (temperature, noise, and work stress).

From observation at PT X and PT Y shows that workers are mainly involved in three different activities which were office, product packing, and cleaning service. Working process at both companies requires workers to

do monotonous movements and prolonged sitting for 8 hours a day, with one hour break midday. The working room temperature at PT. X and PT Y were not optimal [1]. This could trigger the brain to work slower and often caused work stress because female workers would feel less comfortable with the workplace and weaken their control over emotions. High temperatures could also cause dehydration in pregnant women, menstrual disorders, miscarriage and fetus stress. The influence of psychological stress were found in 30% of women who visited infertility clinics [2]. Fertility problems may also be caused by increased bodily effort to counteract the effects of stress, so that the reproductive system is deprioritized by the body's resources [3]. Psychological stress could affect the level of the cortisol hormone, causing a decrease in estradiol production that could affect the function of granulosa cells in the follicle, resulting in decreased oocyte quality [4]. Theoretically the influence of work shifts, especially work shifts with a rotation system for female workers could cause disturbance in sleep quality, decreased work capacity, fatigue, decreased appetite, indigestion, menstrual disorders in the form of menstrual cycles and abnormal menstrual periods, less opportunity to interact with

others, and declined performance [1]. It is very important to find the correlation between individual, occupational, and work environment factors on reproductive health disorders in female workers.

### MATERIALS AND METHODS

The study was a cross sectional study. The population of this research are all female workers at the beverage company PT X and plastic company PT Y in Sidoarjo Regency (110 workers) which then selected using simple random sampling method and using Lemeshow formula calculated as many as 109 respondents. The dependent variable was the reproductive health of female workers. The independent variables of this research are individual factor (age, marital status, nutritional status, age of menarche, number of parity, and parity distance), occupational factors (working period, work shift, work position) and work environment factor (temperature, noise, and work stress). Data collection techniques was done by using questionnaires to find out individual factors, work, and psychological factors (work stress) and direct measurement of the work environment (measurement of temperature and noise). Work stress was measured using Job Stress Survey (JSS) by Vagg and Spielberger. Temperature measured using Thermal Environment Monitor from 3M, while noise was measured using Sound Level Meter device. Data analysis was done using statistical software SPSS. Correlation analysis in this study was using contingency coefficient method. This test was being used to learn the correlation between independent and dependent variables. This research was approved by The Ethics Committee of the Faculty of Public Health Airlangga University with an ethical certificate number: 546-KEPK.

### RESULTS

The results shows that a total of 63.3% (69 respondents out of total 109) of female workers experienced reproductive health problems. Most of the respondents were in the 21-35 years age group, have normal nutritional status, married status, had normal menarche age, had given birth (parity) once, and did not have parity distance since most of them have not married yet or only been gave birth once (Table I)

Table II shows that most respondents were working for less than 5 years at PT X and PT Y (47.7%), work in shift (70.6%), and engaged in monotonous activities that require them to sit or stand for more than 4 hours during work (78%). The temperature of respondents work stations are 79.8% optimum, while 56.9 % respondents were experiencing high noise level at work (>85 dB). Most of the respondents Work Stress Index are low (58.7%).

Table III showed that most of reproductive problem in

**Table I: Respondents Sociodemographic Factors Distribution**

Variable	n	%
<b>Age</b>		
< 20 years	15	13.8
20-35 years	75	68.8
>35 years	19	17.4
<b>Nutritional Status</b>		
Underweight	6	5.5
Normal	68	62.4
Overweight	35	32.1
<b>Marriage Status</b>		
Have Not Married	20	18.3
Married	89	81.7
<b>Menarche Age</b>		
Precocious Puberty	4	3.7
Normal	86	78.9
Menarche Tarda	19	17.4
<b>Parity Number</b>		
Never Partus	43	39.4
<b>Have not Married</b>	<b>20</b>	<b>18.3</b>
<b>Have not give birth</b>	<b>23</b>	<b>21.1</b>
Partus 1 time	47	43.1
Partus > 1 time	19	17.4
<b>Parity Distance</b>		
No Parity Distance	90	82.6
<b>Have not Married</b>	<b>20</b>	<b>18.3</b>
<b>Married with no child</b>	<b>23</b>	<b>21.1</b>
Parity distance ≤ 2 years	12	11.0
Parity distance > 2 years	7	6.4

**Table II: Resodents Work Factors Distribution**

Variable	n	%
<b>Employment Period</b>		
< 5 years	52	47.7
6-10 years	36	33.0
> 10 years	21	19.3
<b>Work Shift</b>		
No Shift	32	29.4
Shift	77	70.6
<b>Work Activities</b>		
Not Monotonous	24	22.0
Monotonous	85	78.0
<b>Temperature</b>		
Optimum (18-28°C)	87	79.8
Hot (>28°C)	22	20.2
<b>Noise Level</b>		
Low (≤ 85 dB)	47	43.1
High (>85 dB)	62	56.9
<b>Work Stress Index</b>		
Low (0.5-13.5)	64	58.7
Average (13.6-24.5)	38	34.9
High (24.6-40.5)	7	6.4

**Table III: Distribution of Reproductive Problem among Respondents**

Reproductive Problem	No Disorder		Disorder Present		Total	
	n	%	n	%	n	%
Menstruation	43	39.4	66	60.6	109	100
Pregnancy	87	79.8	22	20.2	109	100

female workers are menstruation problem, 60.6% of the female sample or 66 respondent reporting menstruation problem. Pregnancy problem occupies second place, with 20.2% or 22 respondents reporting pregnancy problem.

Table IV shows that for Work Stress Index, the highest reproductive problem is in respondents that work on high stress category (range 24.6-40.5 in Work Stress Index). All respondents with high work stress index are reporting a reproductive problem. Average stress work occupied second place, with 89.5% of respondents reporting a reproductive problem. The higher work stress index is proportional with percentage of reproductive problem in the female workers.

The same pattern is occurred in the temperature variable. Most of the reproductive problem is occurred in the workers that work at high temperature, more than 280 C. As many as 89.5% of the respondents who work on high working temperature are reporting a reproductive problem compare to only 58.6% in normal working temperature. High working temperature may contribute to reproductive problem.

As many as 71.4% of workers that work in shift regime

**Table IV: Results of Cross Tabulation between Independent Variables with Reproductive Health among Respondents**

Variables	Reproductive Health				Total		
	No Disorder		Disorder Present		n	%	
	n	%	n	%			
<b>Work Stress Index</b>	High = 24.6-40.5	0	0,0	7	100,0	7	100
	Average = 13.6-24.5	4	10,5	34	89,5	38	100
	Low = 0.5-13.5	36	56,3	28	43,8	64	100
	Total	40	36,7	69	63,3	109	100
<b>Temperature</b>	> 28 C	4	18,2	18	81,8	22	100
	<= 28 C	36	41,4	51	58,6	87	100
	Total	40	36,7	69	63,3	109	100
<b>Work Shift</b>	Shift	22	28,6	55	71,4	77	100
	No Shift	18	56,3	14	43,8	32	100
	Total	40	36,7	69	63,3	109	100
<b>Parity number</b>	> 1 time	4	21,1	15	78,9	19	100
	1 time	9	19,1	38	80,9	47	100
	never	27	62,8	16	37,2	43	100
	Total	40	36,7	69	63,3	109	100

are reporting a reproductive problem while in regular work regime, only 43.8% of respondent are reporting a problem. Working in shift regime is contributed to reproductive problem in female workers. Female workers with one or more partus have higher reproductive problem. 78.9% respondent that have more than 1 partus and 80.9% respondent that have 1 partus are reporting a reproductive problem.

The result of the correlation test in Table V showed that the independent variable of parity numbers, work stress, work environment temperature, and work shift has significant effect on reproductive health (p-value < 0.05). This can be seen from the probability value (p-value) of the correlation test. The p-value for parity number variable is 0.000, work stress is 0.000, temperature is 0.044 and work shift is 0.006.

**Table V: Contingency Coefficient Test Result of the Independent Variables on Reproductive Health among Respondents**

Free Variable Category	p-value
Parity distance	0.096
<b>Parity number</b>	<b>0.000</b>
<b>Work Stress</b>	<b>0.000</b>
<b>Temperature</b>	<b>0.044</b>
Age	0.329
Nutritional status	0.424
Menarche Age	0.768
Marital Status	0.172
Duration of employment	0.478
<b>Work Shift</b>	<b>0.006</b>
Working position	0.567
Noise	0.763

**DISCUSSION AND CONCLUSION**

The significant p-value result for parity number was in accordance with the research which stated that work stress, age, smoking habit, and parity number could increase the risk of spontaneous abortion [5]. While for occupational factors, most respondents have worked for <5 years and had a work shift pattern, as well as a monotonous working position. The work environment indicated that most respondents work in cool temperature workstations (<28°C), work in noisy workstations (> 85 dB), and had low job stress index. Female workers could be exposed to hazards such as high temperature, irregular working time, and psychological stress. The hazard of high temperature could cause emotional stress as well as disruption in pregnant female workers. A cumulative high temperature working environment and acute exposure could cause disruption in pregnancy[6]. Such exposure to heat can cause disorders in pregnancy. Stress could also lead to increased suicide rates [7], and various emotional disturbances [8].

The result from this research shows that work stress is correlated with reproductive health. In a case where the

work stress was classified as severe stress, it could cause irregular menstruation or pain during menstruation, also women who experienced severe stress would give birth to low birth weight or premature, high levels of stress could also increase the risk of miscarriage [9-11]. Stress would also affect the occurrence of obesogenic effects, especially in pregnant women with high-sucrose diet [12]. Maternal stress was very important to avoid. Children born to mothers with stressful conditions could experience growth delay especially in the first three years of life [13]. Most of these delays occurred in mothers with a high risk of stress. Thus, pregnant women with low stress could still avoid the growth delay in their children.

Exposure to heat and stress that occurred during pregnancy could cause various reproductive health problems [1,14]. The result of contingency tests showed that there were a significant influence between individual factor (number of parity), occupational factor (work shift) and work environment factor (temperature and work stress) to reproductive health disorder such as menstruation and pregnancy disorder in female workers. Therefore it is important to address the issues of work shift, heat exposure and stress management in the work environment. Company may conduct regular rotation between shift workers and non-shift workers. A good ventilation system is recommended to be installed to reduce heat exposure to workers. Work stress can be reduced with training on stress management (e.g. meditation class, skill enhancement program, etc), play relaxing music on speakers, or refreshing outdoor program. It may be followed by counseling about reproductive health knowledge for female workers, and also supporting program and adequate health facilities.

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## EXTENDED ABSTRACT

# The Difference of Work Fatigue on Operator Based on Shift Pattern in PT. X

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### SUMMARY

Fatigue is one of the problems often experienced by workers which can lead to fatal events. Workers with longer working hours tend to be experience fatigue. An operator has a duty to operate a machine and standby for 8 hours in order to always supervise the production of which if it is not given any enough rest time, it will be at risk of fatigue. The aims of the study is to find out the difference in work fatigue between workers in Division A who work on 5-days – 2-day off (40 hours per week) shift pattern with division B who work on 6-days – 1-day off (48 hours per week) shift pattern. This research was analytic observational methods of data collection and cross sectional design. The sample in this study was operators in division A and B taken from the population using stratified random sampling technique. Variable testing performed using statistical test of mann-whitney test for ordinal data. Different test show that there is a difference in work fatigue between the workers in division A and B who have different shift patterns. Both of division are exposed to noise and work climate that are not up to standard, but division B was exposed longer each week, indicating that division B workers are more likely to experience work fatigue with more severe categories.

**Keywords:** Fatigue, Shift pattern, Operator

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### INTRODUCTION

Work fatigue is one of the fatal problems often experienced by the workers. Almost every year, as many as two million workers died due to work accidents caused by the fatigue factor [1]. Work fatigue itself is caused by several factors including individual factor, work factor, environmental factor and psychological factor [2]. Technological advance such as the creation of certain tool or machine, facilitates the workers' duty. Therefore, they can work only as an operator and can minimize manual handling activities which have high risk of causing muscle injury. The availability of equipment or machinery in a workplace which is not supported by good corporate health and safety commitment will lead to other health problems such as work-related fatigue resulting from a lack of rest time or longer work time than the standard [3]. Such problems occur since the company does not consider any over physical workload. PT.X has several divisions and all divisions already use machine to assist the workers as an operator only. Operators at PT.X have a duty to operate a machine, ensuring that the production is in

accordance with the standards, and cleaning the work area every time before working. Despite having the same task of operating a machine, what distinguishes between division A and B is the shift pattern. Division A works for 40 hours per week with 5 working days or 8 hours per day, while division B works for 48 hours per day with 6 working days or 8 hours per day. Meanwhile, the standard working hours in Indonesia for 6 working days should contain only 7 hours per day [4]. Workers with longer working hours than the standard tend to have poor work performance of which one of the causes is due to fatigue [5]. In addition, it also causes increased work stress [6], death [7], and work-related accidents [8].

Based on the secondary data obtained from the company, precisely the work incident in division A is higher than workers in division B [9]. It occurs mostly because division A workers are mostly female with an average age (> 35 years old) that allows them to experience fatigue more easily when working [10]. Based on workers in division B who have been working hours outside the standard, the high prevalence of work incident experienced by workers in divisions with working hours that are standard, then this study aims to find out whether there is a difference in work fatigue between division A working with 5-days - 2-day off shift pattern (40 hours per week) and division B working with

6-days – 1-day off shift pattern (48 hours per week).

**MATERIALS AND METHODS**

The population in this research is all operators of division A as many as 67 workers and operators of division B as many as 40 groups in PT.X. The sample size in this research is calculated using stratified random sampling technique through Sample Size 2.0 software by S.K. Lwangadan S. Lemeshow because there are 2 divisions with different numbers of working hours. The worker’s population in divisions A and B are heterogeneous or different, so they have different strata and each division must have a representative to be the research sample. Each number of population in each division will be divided into 2 strata (L = 2), those are division A and B. The error value used is 5% (d = 0.05) with a confidence level of 95% (1 - α = 0.95), while the proportion that shows the characteristic on the strata is 50% (PH = 0.5). The number of samples in Division A is 53 workers, while in division B is 31 workers. The instrument in this study is questionnaire which was distributed to the respondents in division A and B. There are 3 sections in the questionnaire, those are questionnaire for individual data including age and gender, questionnaire for subjective complaints data at work environment (noise, work climate, lighting), and a fatigue questionnaire using a subjective feeling of fatigue containing 30 questions which are divided into several categories: questions 1-10 asking weakness in the head, questions 11-20 asking the weakening of motivation, questions 21-30 showing a picture of physical fatigue which is then categorized in Likert scale. The data analysis used is SPSS 21.0. Descriptive analysis was used to determine the frequency and percentage of age, gender, subjective complaints on noise, work climate, lighting, and work fatigue. The difference analysis is also used to find out the difference of work fatigue of both divisions using statistical test of mann-whitney test for ordinal data.

**RESULTS**

The age of all workers are divided into 2 categories, those are young and old. In division A, 94.3% of the respondents belongs to the old category, while in division B 71% of the respondents belongs to the old age category. This shows that both divisions are mostly in the old age category (Table 1). For the gender in division A, 22.7% of the respondents is male, while 77.3% is female. Meanwhile, in Division B, 54.8% of the respondents is male and 45.2% is female. There is a difference for the gender in both divisions, in which division A has more female operators, while division B has more male operators (Table I.).

As shown in table I, there is 52.8% of the respondents in division A who admitted feeling disturbed due to the noise at work. Meanwhile, in division B, there is 83.9% of the respondents who claimed to be disturbed for the

**Table I: Distribution of Individual Worker Factors in Divisions A and Division B of PT.X**

Variable	Category	Division A		Division B	
		N	%	N	%
Age	Young (≤35 years old)	3	5.7	9	29
	Old (>35 years old)	50	94.3	22	71
Gender	Male	12	22.6	17	54.8
	Female	41	77.4	14	45.2

noise (Table II). Based on the subjective complaints for the working climate felt by the respondents, there is 71.7% of the respondents in division A who claimed to be disturbed at work, while in division B, 67.7% of the respondents claimed to be disturbed. As shown on table II, both in division A and the highest experienced work stress in the medium category. However, it can be seen that Division A experienced high category work stress (20.8%) and was very high (11.3%) greater than Division B.

**Table II: Subjective Complaints on the Working Environment of Workers in Divisions A and Division B of PT.X**

Variable	Category	Division A		Division B	
		N	%	N	%
Noise	Feeling Disturbed	28	52.8	26	83.9
	Not Feeling Disturbed	25	47.2	5	16.1
Working Climate	Feeling Disturbed	38	71.7	21	67.7
	Not Feeling Disturbed	15	28.3	10	32.3

Table III shown that there are 3 categories of work fatigue, those are mild, moderate, and severe, both in division A and B. In division A, as much as 13.2% of the respondents experience work fatigue in severe category. Meanwhile, in division B, as much as 83.9% of the respondents experience work fatigue in the category of severe as well. It can be seen that in division B, most workers experience severe work fatigue category as shown in table IV.

**Table III: Distribution of Work Stress in Divisions A and Division B of PT.X**

Work Stress	Division A		Division B	
	N	%	N	%
Low	11	20.8	5	16
Medium	25	47.1	17	54.8
High	11	20.8	8	25.8
Very High	6	11.3	1	3.4

Based on table V, the p-value obtained is 0.037, which means that p < α (0.05). Hypothesis is accepted in which there is a difference between the work fatigue experienced by the workers in division A who work for 40 hours per week and the workers of division B who work for 48 hours per week.

**Table IV: Distribution of Workers' Fatigue in Division A and Division B of PT.X**

Work Fatigue	Division A		Division B	
	N	%	N	%
Mild	21	39.6	10	32.2
Moderate	25	47.2	7	22.6
Severe	7	13.2	14	45.2

**Table V: Difference Test Result of Workers Fatigue in Division A and Division B of PT.X**

Work Fatigue	Division	N	Mean Rank	p-value
	A	53	38.52	0.037
	B	31	49.31	

## DISCUSSION AND CONCLUSION

Based on the results of the difference test analysis, the result shows that there is a difference between the work fatigue in division A and B. This is because division B has longer working hours in each week due to different shift pattern. The working hours in division B exceeds the standard working hours normally applied in Indonesia [4]. However, even though Division B has longer working hours than Division A workers, based on work stress distribution, it can be seen that division A workers actually experience higher and very high category work stress. For the physical workload, it is not too high since respondents in both divisions only serve as machine operators. However, the monotonous and individual factors such as age, gender and occupational exposure can also affect the work fatigue experienced by the respondents in both divisions [2]. The lack of rest time experienced by the workers leads to their increasingly heavy work pressures that affect their behavior to be more likely insecure because of the lack of concentration [11].

The individual factor of age indicating that both divisions mostly belongs to old category. The older the age of a person, the more likely they experience fatigue because their body cannot work with a heavy physical workload [12]. In addition, the respondents in division B work longer than the respondents in division A, making the respondents in division B more likely to be exhausted. Then, for the gender, the distribution in both divisions is different. In division B whose workers are mostly male have a habit of staying up late, which makes their break time is interrupted. Moreover, they are given only one day off in 1 week of which rest is needed to restore power used during work [13]. For the working environment factors, it can be seen that in both divisions, most workers claim to be disturbed by the noise, and work climate. After measuring the noise using a sound level meter, the noise exposure in division A is 95 dBA, while in division B is 92 dBA. In fact, for workers with 8 working hours per day, they should not be exposed to noise for more than 85dBA [14]. Both divisions have similar NAB exposure, but the workers of division B are

exposed for a longer period in each week. Therefore, it is worse for the workers in division B. The assumption is that the higher the noise in a workplace, the more difficult it will be for the workers to concentrate. In addition, they will also easily get stress so that it can trigger the emergence of fatigue [12]. In addition, noise is indeed one of the major occupational environmental hazard that cause work fatigue [15]. For the working climate measured using heat stress apparatus, it is 30°C in division A and 35°C in division B. In the category of medium physical workload with 75% -100% working time, the maximum working climate should be 28° [14]. Moreover, the workers in division B are exposed longer than the workers of division A in each week due to the different shift pattern. Such hot condition will cause fatigue, drowsiness, and heat exhaustion which can reduce the workers' stability and increase the number of work errors. The comfortable temperature for Indonesians is between 24-26°C [12]. The hot working temperature tends to make worker experience mild to moderate work fatigue [16].

Both of division are exposed to noise and work climate that are not up to standard, but division B was exposed longer each week, indicating that division B workers are more likely to experience work fatigue with more severe categories. Suggestions for this study are that workers with working hours that exceed standards need to be given food or supplements that can increase their energy so that they are not prone to fatigue. Then for the two divisions, considering the work is quite monotonous, it needs to be held light exercise in the middle of their work will reduce stiff muscles so that the body is also not easy to experience signs of work exhaustion.

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## EXTENDED ABSTRACT

# Analyze of Utilization of Occupational Health Unit to Control Occupational Disease Among Informal Workers in Medokan Ayu

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### SUMMARY

Puskesmas (Indonesian: Pusat Kesehatan Masyarakat, English: Primary Health care) Medokan Ayu is appointed by the government health centers to be the industrial health care in Surabaya. OHU (English: Occupational Health Unit, Indonesian: Unit Kesehatan Kerja) is a form of health efforts come from, and to the people who provide basic health services (primary health care) for the working people, particularly informal workers. This study aim to analyze the utilization of the OHU to control of occupational diseases among informal workers in Medokan Ayu. This study was a qualitative research with type of research was case study design. Sample research were all of informal workers (home industry workers) who visited the post OHU. The data collection were conducted by interviews and observations. Interview was conducted to determine the characteristics of workers and the utilization of OHU. Observation was conducted to determine the environmental factors that can cause acute respiratory infections in the workplace. The result showed that the utilization of OHU are still lacking possibly cause of some factors such as limited of implementation program (OHU only held twice a month) and limited number of health workers. The disease mostly occurred of informal workers were respiratory diseases caused by environmental factors such as indoor air pollution, lack of ventilation, density residential houses, and lack of lighting. OHU as a healthcare for informal workers can't handle all of occupational disease. Therefore, OHU can provide referral effort to Puskesmas to hold an environmental health program to handle the occupational disease.

**Keywords:** Utilization, Occupational health unit, Occupational disease, Informal workers

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### INTRODUCTION

In Indonesia, industry sector divided into formal sector and informal sector. Formal sectors are business that get permission and registered from government. While informal sectors are business that do not have permission and not registered from government. The examples of informal sector such as coffee seller, peddler, home industry like tempeh seller, bakery. In Act No. 36 of 2009 on the health, it states that occupational health efforts aimed to protect the workers to live healthy and be free of health problems [1]. Occupational disease are a diseases caused by work and / or work environment [2]. OHU post is required to provide public health services for workers at risk of exposure to works and the working environment. On the Regulation of the Ministry of Health of the Republic of Indonesia Number

13 of 2015 on the Implementation of Health Services, Environmental Health Center states that every health care must give service delivery in the form of counseling, environmental health inspections, and environmental health interventions [3]. In fact, the attention to health care for the informal sector, especially related to the environmental health aspects are still lacking in Indonesia. Many people are busy to work so they forget about their health [4]. Health system constantly seek better ways to make health services accessible, affordable, equitable and responsive [5]. The accessibility to health care is a multidimensional concept and a prerequisite for active participant in community activities [6]. Access to health care is an important public health issue [7]. Currently some countries are reforming their health systems to improve service delivery and cost efficiency of primary health care [8]. Based on data about disease trends in health care Medokan Ayu in 2017, the most common disease is respiratory acute infection. This study was conducted to analyze the utilization of the OHU to control of occupational diseases among informal workers in Medokan Ayu.

**MATERIALS AND METHODS**

Puskesmas Medokan Ayu was built in 1994/1995 and was inaugurated on 29 November 1995. Puskesmas Medokan Ayu is located at Jl. North Asri Medokan IV / 31. Puskesmas Medokan Ayu is one of the health centers design as industrial health centers in Surabaya. This study was a qualitative research with type of research was case study design. The sampling method of respondents was using purposive sampling. Sample research were all of informal workers (home industry workers) who visited the post OHU such as tailor, vegetable seller, coffee seller, grocer, tempeh seller, food seller, gallon seller, and laborers. OHU was a part of the health care system used to facilitate the informal sector workers. The primary data collection were conducted in January-February 2018 by interviews and observations. Interview was conducted to determine the characteristics of workers and the utilization of OHU. Observation was conducted to determine the environmental factors that can cause acute respiratory infections in the workplace. The secondary data collection were from Public Health Service of Surabaya and Social Insurance Administration Organization of Employment to find out which one of health care that had an OHU and the most frequent disease had been known by Medokan Ayu Health Care’s Profile. The research variables were utilization of occupational health unit and occupational disease such as acute respiratory infections (Indonesian: Infeksi Saluran Pernapasan Akut or ISPA). This research was approved by The Ethics Committee of the Faculty of Public Health Airlangga University with an ethical certificate number: 580-KEPK.

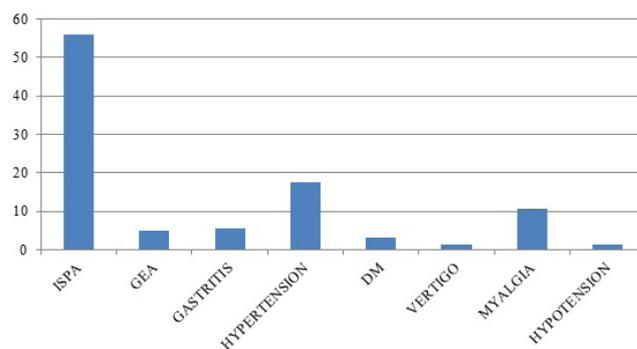
**RESULTS**

Based on table I, all of sixteen (16) informal workers who visited the post OHU were women. The most age characteristics were in the age of 41-50 years (7 people) with their last education were mostly middle and high school (each was six (6) people).

**Table I: Individual Characteristic**

	Characteristic	Number (n)
<b>Gender</b>	Man	0
	Women	16
<b>Age (years)</b>	21-30	1
	31-40	6
	41-50	7
	51-60	0
	61-70	2
	Primary school	3
<b>Education</b>	Middle school	6
	High school	6
	Vocational high school	1

From the data, it was found that the most frequent diseases of informal workers (56%) were acute respiratory infection (ISPA) (Figure 1). There are thirteen basic task and functions of OHU such as worker’s meeting, self-surveillance survey, community of work meeting, forming OHU post, planning of OHU, conseling of OHU, medical check, reference effort, intersectoral collaboration, managing OHU financial, assisting worker’s economic empowerment, and build up self-ability. OHU as a healthcare for informal workers can’t handle all of occupational disease cause of limited number of health workers. Therefore, OHU can provide referral effort to Puskesmas to handle the occupational disease.



**Figure 1: The Most Frequent Diseases of Informal Workers at Puskesmas Medokan Ayu in 2017**

**DISCUSSION AND CONCLUSION**

Puskesmas Medokan Ayu has implemented several environmental health services such as monitoring and control of water quality, control of public places, supervision, and control of sanitation and environmental health training institutions. Puskesmas Medokan Ayu has occupational health unit held every Saturday or Sunday first in Rusun Penjaringan. The OHU Medokan Ayu as a healthcare for informal workers has carried out various activities such as medical check (blood pressure) and conseling education.

Based on the results above, the most frequent diseases of informal workers were acute respiratory infection (ISPA). The environmental factors that may affect ISPA include[9]:First, it was indoor air pollution. In addition to the workload of the job, female workers are also doing the cooking activity, so that every day women workers are always in contact with the smoke in the kitchen, based on studies in developing countries, itcshows a relationship between exposure to pollution in the home and pneumonia, upper respiratory tract infection, as well as middle ear infections. Four major drivers of global lung disease are tobacco, indoor air pollution, external air pollution, and occupational exposure[10].Second it was house ventilation. Ventilation is very helpful to force air circulation inside the house to maintain the balance of oxygen for the people in the house. In addition, ventilation affects the humidity, the greater the amount of ventilation, the humidity in the house can

be reduced. Ventilation also affects the process of air dilution to dilute the concentration of germs carried in the house and die due to ultraviolet rays. The third factor is residence density, based on demographic conditions in local communities, Medokan Ayu belongs to dense populated area, most of the social levels of society in Medokan Ayu are at medium level. The density also effects on oxygen consumption and the airflow velocity in the respiratory system that affects the amount of dust exposure received by the residents of the house. In addition, the denser the residence, it will facilitate disease transfer, especially diseases through the air on fellow residents. The fourth factor is lighting, a healthy home requires adequate lighting from the sunlight containing ultraviolet light to kill germs in the home. Sunlight into the house should be at least 60 lux and should not be dazzling.

Based on the discussions, health centers as health care facilities should optimize the work program related to environmental health as the promotive and preventive efforts on the spread of respiratory diseases. The OHU Medokan Ayu as a healthcare for informal workers has carried out various activities such as medical check (blood pressure) and counseling education. However, environmental health programs are still not carried out because of many activities that carried out by puskesmas. This condition causes a lack of utilization of the OHU Medokan Ayu. Lack of utilization of OHU is possibly the cause of some of the factors such as limited of implementation programs (only held twice a month) and limited number of health workers.

The OHU Medokan Ayu can collaborate with Puskesmas Medokan Ayu to hold an environmental health program. Environmental health efforts that can be done in environmental health poly include public places control, this can be done through the provision of green open space and planting trees to absorb air pollutants in ambient air. Other than that, supervision and control of sanitation can be done by conducting counseling activities such as counseling about healthy home with sufficient ventilation to ensure air circulation in the home, the importance of applying good housekeeping and maintenance. In addition, regular monitoring of air quality around settlement is needed for prevention against air pollution.

Based on the analysis of the results and discussion in this study, it can be concluded that: First, occupational Health Unit is one of the OHU health centers of Medokan Ayu which one of the health services is poly environmental health. Second, lack of utilization of OHU Medokan Ayu possibly cause of some factors such as limited

of implementation program (OHU only held twice a month) and limited number of health workers. Third, from the data of diseases in health care Medokan Ayu region in 2017, it is found that the most frequent diseases is acute respiratory infection (ISPA). Fourth, environmental health services as the promotive and preventive efforts that have been implemented by Puskesmas Medokan Ayu include supervision and control of water quality, control of public places, supervision, and control of sanitation and environmental health training institutions. Promotive and preventive activities aimed first aid at work accidents and occupational diseases to reduce or eliminate the risk of accidents and occupational diseases as well as to improve workers health. Last, the environmental factors that affect ISPA include indoor air pollution, lack of ventilation, density residential houses, and lack of lighting.

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## EXTENDED ABSTRACT

# Analysis of the Unsafe Actions Inter Work Shift on Harbor Mobile Crane Operations in PT Berlian Jasa Terminal Indonesia (PT. BJTI), Surabaya

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### SUMMARY

Berlian Jasa Terminal Indonesia PT (PT. BJTI) Surabaya is one of the companies which handles the activities of loading containers. These activities are done in 24 hours every day which bears the dangerous risk that cause unsafe actions and accidents. This study analyzed the differences between the unsafe actions and accidents between each shift over the harbor mobile crane (HMC)'s operation in the PT. BJTI, Surabaya. The design of this study was observational along with the approaches of cross-sectional. This study was conducted among 34 operators of HMC's. The data used in this study were primary data which were drawn by the results of observation, interview, and secondary data from the company. The results of the study indicated that most of HMC's operators had been working for more than 3-years long. The highest number of the unsafe actions had occurred when they did not used Personal Protective Equipment (PPE). There were some differences between unsafe actions in each shift with a low category. Most of the medium unsafe actions had occurred during the night shift. There were also some differences between accidents in each shift with an intense category. Mainly, the HMC's operators experienced an accident by bumped into an objected. The highest frequency of accidents happened during the night shift. The differences between unsafe actions and accidents were induced by the lack of controlled on every shifts and disturbed Circadian Rhythm. The company was expected to be able to adopt a reward and punishment system related to the used of PPE. The company needs to improve the controlled system so that the control could be done on every shift. The company needs to provide first aid officers on every shift.

**Keywords:** Unsafe actions, Working shift, Harbour mobile crane, Operator

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### INTRODUCTION

Sea transportation is an important role in the process of future economic development in Indonesia. Transportation facilities and systems are needed to meet the aspects of security, speed to support the distribution of goods through sea. One of the alternatives to achieve that goal is through the use of containers. The speed of loading and unloading processes of using containers are influenced by a supporting tool, known as Harbor Mobile Crane (HMC).

Cargo handling activities ranked as one of the highest potential accident risks in container port, as reported by some port safety authorities such as Hong Kong Marine Department [1]. In 2015 from 98 recorded accidents that occurred at the largest and busiest container port in Tanjung Priok, Indonesia, according to the Social

Insurance Administration Organization BPJS (administers the Indonesian national health insurance), there have been 105.182 cases of work accidents. 38% of them were cases of work accidents involving falling from height and occurrence of work accidents due to cranes [2].

Work accident is affected by two direct causes (unsafe action and unsafe conditions) [3]. One of the control measures to overcome the high rate of work accident is to apply the work shift system. Workplace accidents may increase if the workload is excessive [4]. The application of the work shift system aims to reduce one's workload and prevent overtime. However, work in shift can affect the safety and health of the workers. This is due to Circadian Rhythm that associated with workplace accidents (Circadian Rhythms are physical, mental and behavioral changes that follow a daily cycle. They respond primarily to light and darkness in an organism's environment. Sleeping at night and being awake during the day are the examples of a light-related circadian rhythm) [5]. Workers who work during the night shift have 28% higher risk for injury or accident than any

other shifts [6].

According to McKinnon in Fadhillah [7], unsafe actions referred to someone who were deviated from safety procedures that can triggered work accidents. This was in accordance with Heinrich’s opinion, which stated that 88% of industrial accident cases were caused by unsafe actions. Unsafe actions in this study were dangerous actions that carried out by HMC operators in the operation of HMC at PT.BJTI Surabaya. This study aimed to analyze the differences of unsafe actions between work shifts on the operation of HMC in PT.BJTI Surabaya.

**MATERIALS AND METHODS**

This study was conducted among 34 HMC’s operators. This study was conducted on October-November 2017. The variables studied in this research included unsafe action level undertaken by workers and work shift on HMC operation. Primary data which was obtained through observations was made during work shifts among workers for unsafe action. secondary data which included a general description of the company, its location, organizational structure, employment, employment, working hours and workplace accidents were obtained from the management of the company.

The data were analyzed by using univariate for the frequency distribution and the percentage of each variable such as unsafe action. Meanwhile, bivariate analysis was used to determine the relationship between two variables. The differences between unsafe action working shifts were analyzed descriptively by looking at the unsafe action frequency distribution, and then compared to work shifts. The information obtained were presented in table form and narrated.

**RESULTS**

The classification of unsafe actions in this study was divided into 4 categories: safe, low, medium and high. The assessment of unsafe actions on HMC operators were classified into 8 criteria. Unsafe actions were considered as ‘safe’ if HMC operators do not performed unsafe actions, ‘low’ if they performed 1-3 types of unsafe actions, ‘medium’ if performed 4-6 types of unsafe actions and ‘high’ if there were 7-8 types of unsafe actions. Based on the results presented in Table O, it showed that most operators conducted unsafe actions with a medium category (4-6 types of unsafe actions) which equal to 61.8%.

Meanwhile, based on the observations during morning and night shifts, the unsafe action that mostly done by HMC operators every shifts was by not using Personal Protective Equipment (PPE) as listed in Table OO and Table III. Other unsafe actions that occurred quite frequently in every shifts were operating tools with

**Table I: Distribution of Unsafe Actions at HMC Operator in PT.BJTI Surabaya 2017**

Unsafe Actions	Frequency (n)	Percentage (%)
Safe	0	0
Low	13	38,2
Medium	21	61,8
High	0	0
Total	34	100

**Table II: Distribution of Unsafe Actions at HMC Operator at morning Shift in PT.BJTI Surabaya 2017**

No	Unsafe Actions	Safe		Unsafe		Total	
		Σ	%	Σ	%	Σ	%
1	Failed to safe	34	100	0	0	34	100
2	Operate tool with wrong/ not proper speed	30	88.2	4	11.8	34	100
3	Not using PPE	0	0	34	100	34	100
4	Use wrong equipment or not according to procedure	34	100	0	0	34	100
5	Incorrect loading	34	100	0	0	34	100
6	Incorrect lifting	31	91.1	1	2.9	34	100
7	Incorrect placement	30	88.2	4	11.8	34	100
8	repairing machine when operating	30	88.2	4	11.8	34	100

**Table III: Distribution of Unsafe Actions at HMC Operator at afternoon Shift in PT.BJTI Surabaya 2017**

No	Unsafe Actions	safe		Unsafe		Total	
		Σ	%	Σ	%	Σ	%
1	Failed to safe	31	91.2	3	8,8	34	100
2	Operate tool with wrong/ not proper speed	24	70,6	10	29,4	34	100
3	Not using PPE	0	0	34	100	34	100
4	Use wrong equipment or not according to procedure	34	100	0	0	34	100
5	Incorrect loading	33	97.1	1	2.9	34	100
6	Incorrect lifting	32	94.1	2	5.9	34	100
7	Incorrect placement	24	70.6	10	29.4	34	100
8	repairing machine when operating	34	100	0	0	34	100

improper speed, incorrect placement, and repair of the engine while operating. The difference between unsafe actions and work shifts was done by comparing the 4 categories of unsafe actions. The results showed that there were no unsafe actions in a safe and high categories. However, it can be seen that the percentage of HMC operators doing unsafe actions with moderate category often occurred at night shift at 44.1% as shown in Table IV. Medium category on the night shift has the highest occurrence of unsafe actions, which at 44.1%. Whereas unsafe actions with the lowest category most occurred during morning shift at 85.3%.

**DISCUSSION**

Based on the results on the observations, every working shifts indicated that the workers were doing an unsafe action during their working time, by not using

**Table IV: Tabulate Crosses Shift Work and Unsafe Actions in HMC Operators at PT.BJTI Surabaya 2017**

Shift work	Unsafe Actions								Total	
	Safe		Low		Medium		High		$\Sigma$	%
	$\Sigma$	%	$\Sigma$	%	$\Sigma$	%	$\Sigma$	%		
Morning shift	0	0	29	85,3	5	14,7	0	0	34	100
Night shift	0	0	19	55,9	15	44,1	0	0	34	100

PPE. This was not in accordance with the provisions of Permenakertrans No.PER.08/MEN/VII/2010 [8] concerning PPE Article 6 which stated that all workers and other people in the work area were required to use PPE in accordance with potential hazards and risks.

There were two factors that deal directly with unsafe actions, which related to the act of not using PPE, namely personal factor and job factor. The personal factor in question was a lack of knowledge about the importance of using PPE. This was consistent with the results of research conducted by Raodah [9] which stated that knowledge was one of the factors associated with the use of PPE. If the workforce had insufficient knowledge on the potential or sources of danger in the workplace, then the individual will tend to make the wrong decisions in the case of the use of PPE.

The job factor, namely lack of supervision. If the supervision has been done well, then this can encourage the workforce to always using PPE. This was consistent with the results of research conducted by Yustrianita [11] which stated that supervision was one of the factors associated with the use of PPE. Other job factor was the convenience of using PPE. This was consistent with the results by Sumarna [12] where most employees have used PPE even if only once during work. But because they feel uncomfortable, disturbed and can slow down the work process, the workforce becomes reluctant to use PPE again while working. According to Tanko and N.A. Anigbogu [13], most workers felt that the PPE was uncomfortable. This was because of the size of the equipment which were oversized, not designed for hot weather, weight when used, slowing down work and limiting their movement. Thus, the comfort factor of using PPE became one of the factors that caused HMC operators to be reluctant to use PPE when operating HMC.

Other unsafe action that was also often found in each work shifts was improper container placement. when containers were placed in the head truck and on land during the loading process that might endangers the workers, namely TKBM (loading and unloading workers) and mechanics who were repairing the engine around the area. An appropriate speed was another problem that frequently occurred when loading and offloading the containers to and from ships which may cause danger to operators and the area.

Meanwhile, based on the results obtained in this study,

the decline in unsafe actions with low category during evening shift, as well as the increase of unsafe actions with the medium category on the night shift can be influenced by several factors. According to International Loss Control Institute (ILCI) theory, unsafe actions were caused by two factors: personal factors and job factors. Personal factors that can affected the unsafe actions in workplace were due to the lack of physical and mental abilities of the workforce [14]. The reduced in physical ability of labor can affected the difference in unsafe actions between shifts of work. According to Winasunu in Kirana [15] every human being has Circadian Rhythm. The 2005 International Classification of Sleep Disorders estimated that a shift work sleep disorder can be found in 2-5% of workers [16]. This disorder was characterized by excessive sleepiness and/or sleep disruption for at least one month in relation with the atypical work schedule. Individual tolerance to shift work remains a complex problem that was affected by the number of consecutive work hours and shifts, the rest periods, and the predictability of work schedules. Sleepiness usually occurs during night shifts and was maximal at the end of the night. Impaired vigilance and performance occurred around times of increased sleepiness and can seriously compromised workers' health and safety. Indeed, workers suffering from a shift work sleep-wake disorder can fall asleep involuntarily at work or while driving back home after a night shift. Working on atypical shifts has important socioeconomic impacts as it leads to an increased risk of accidents, workers' impairment and danger to public safety, especially at night [17].

## CONCLUSION

In conclusion, unsafe actions were mostly occurred among the operators of HMC in PT. BJTI Surabaya in all work shifts and were related to the act of not using PPE (100%). Other unsafe actions also happened in every working shifts such as operating tools with improper speed, incorrect placement, and repair of the engine while operating.

As recommendations, the company needs to reduce the occurrence of unsafe actions on HMC operators by providing a good knowledge that related to the importance of the use of PPE through safety talk before work. The company also may apply a reward system for HMC operators who routinely use PPE while working and punishment of HMC operators who do not use PPE while working. The management should improve the supervision system on the HMC operator which can be

done on every work shift. Lastly, HMC operators who are working on night shifts should utilize their time optimally to rest before the start of the shift.

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## EXTENDED ABSTRACT

# Determinant Factors Affecting the Compliance With the Use of Personal Protective Equipment (PPE) in Gas Plant

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### SUMMARY

PT Samator Gas is an industry that produces a wide variety of gases, such as O<sub>2</sub>, N<sub>2</sub>, acetylene, oxican, and CO<sub>2</sub>. Workers in the production department are at a great risk of exposure to harmful chemicals that may cause skin irritation or respiratory disorders. Personal protective equipment (PPE) is one of five hierarchies of hazard controls. The study aimed to analyze some factors affecting the compliance with the use of PPE. This study was descriptive and observational research with a cross sectional design. 36 workers in the production department were randomly selected. Independent variables of this study were predisposing factors (age, working period, knowledge and attitude) and enabling factors (availability of PPE, training and promotion). Meanwhile, dependent variable was the compliance of the use of PPE. The collected data then were analyzed by using Statistical Package for Social Science (SPSS). The results showed that 69.4% of the workforces did not use PPE accordingly, and 30.6% of them used PPE based on the standart operational procedure (SOP). The independent variable affecting the compliance with the used of PPE was the availability of PPE (significant p value at 0.018 < 0.05). While age, working period, knowledge, attitudes and promotions do not influenced workers' compliance in using PPE. Some factors that influenced the used of PPE were the enabling factors which included the availability of the equipment. Therefore, the management department must plan the needs of the equipment according to the number of workers and reserve a part of it in case some of PPE were damaged. Management department also should conduct regular checks on the availability of PPE in warehouses and identify what causes the unavailability of PPE. Besides that, they also need to hold training about the appropriate use and treatment of the equipment by workers.

**Keywords:** determinant factors, personal protective equipment, compliance, gas plant

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### INTRODUCTION

Nowadays, Occupational and Safety Health (OSH) problems in Indonesia commonly can be seen through the high number of work accidents. Data from the Social Insurance Administration Organization of Employment showed an increase in the work accident rates. In 2016, 101.367 work accidents occurred and increased to 123.000 in 2017, while from January to March 2018 there were 5318 work accidents [1]. The high number of work accidents can cause some disadvantages for workers and companies. According to the International Labour Organization (ILO) there were more than 250 million accidents in the workplace every year, and more than 160 million workers became sick because of hazards at work [2]. The National Health Survey in 2016 in Indonesia reported that there were 21.80% of workers experiencing health problems in the electricity and gas industries [3]. According to Domino Model

of Bird and Germain, losses were caused by five interconnected factors including control, basic causes (knowledge, attitude, availability of PPE, training, skills, standard of work), direct causes (not using PPE and unsafe environment) due to contact with hazardous materials [4]. Mortality can be in the form of a work accident if the illness process occurs quickly or suddenly (acute). Also, it can be in the form of a work-related disease if the illness process is slow (chronic). According to Rachmansyah (2016), the biggest cause of accidents in the industries was human factor for about 80-85%, including the workforce characteristics. The characteristics included insufficient knowledge of the use of PPE, unawareness of the use of the equipment that causing disobedience [5]. In addition, the interpersonal factor is a substantial factor in estimating the compliance with PPE on Chinese migrant workers who got exposed to organic solvents [6]. The use of the equipment increased with negative attitudes of farmers towards pesticides, high levels of knowledge about pesticide hazards, frequent contact with information sources, and past poisoning experience during pesticide handling [7]. Some internal factors determined the relationship between gender, skill and intention to

perform safety behavior when they inspect a ship at the harbour. Besides, some external factors included the availability of PPE, tools and materials that influenced safety behavior when the workers inspect the ship [8]. PT Samator Industrial Gas is one of the largest gas industries in Indonesia. There were various types of gases produced by PT Samator, namely N<sub>2</sub> and liquid gas, O<sub>2</sub> and liquid gases, acetylene gas, Oxican, liquid CO<sub>2</sub>. In the production department, workers get a high risk of exposure to chemicals. One of the chemicals is rock carbide (Calcium carbide) which can cause respiratory problems, skin burning and eyes mucosa. To protect the workers, the company must provide PPE, as one of the labor obligations is to use PPE properly (OSHA, 2013). Based on the company's medical check-up data, it was found that 49.5% workers experienced mild retention and obstructive pulmonary disease. There were 63.6% of workers rarely used PPE. According to Lawrence Green's theory, behavior in response to the use of PPE is affected by three factors including predisposing factors, enabling factors, and reinforcing factors [9]. Currently, there are still some workers who are reluctant to use the equipment provided by PT Samator. Moreover, there are some others who use PPE improperly. The objective of this study was to identify the determinant factors affecting the compliance with the use of PPE by workers.

**MATERIALS AND METHODS**

This study was a cross-sectional research with simple random sampling. The samples in this study were 36 workers out of 39 total woekers in the production department. Primary data were collected from October to November 2017 by interview and observation. Independent variables of this study were predisposing factors such as age, working period, knowledge, and attitude. Meanwhile, the independent variables were included enabling factors such as the availability of PPE, training and promotion. Whereas, dependent variable of this study was the compliance with the use of PPE. Secondary data were obtained from PT Samator, including occupational health and safety policy and company regulations. The collected data then were analyzed by using Statistical Package for Social Science (SPSS).

**RESULTS**

Based on Table I, there were 69.4% workers who did not comply the work standard in using PPE, and 30.6% of the workers had complied to use them. The results of logistic regression showed that enabling factors have a significant influenced on the compliance with the utilization of PPE (Table II). This enabling factor was the availability of PPE (significant p value of 0.018 < 0.05).

**DISCUSSION AND CONCLUSION**

The results of this study were in line with the research

**Table I: The Distribution Frequency of Perdisposing, Enabling Factors and PPE Compliance**

Variables	n	Percentage
<b>Predisposing Factors</b>		
Age (years)		
<30	12	33.3
>30	24	66.7
Working Periode (years)		
<10	14	38.9
>10	22	61.1
Knowledge		
Good	19	52.8
Less	17	47.2
Attitude		
Good	13	36.1
Less	23	63.9
<b>Enabling Factors</b>		
Stock		
Enough	16	44.4
Less	20	55.6
Training		
Good	17	47.2
Less	19	52.8
Promotion		
Enough	35	97.2
Less	1	2.8
<b>Compliance of PPE</b>		
Obedient	11	30.6
Not obey	25	69.4

conducted by Arcury et al. (2002); Halfacre-Hitchcock et al. (2006); Perry et al. (2002) who reported that training to increase the knowledge might not be a factor that encourages someone to use PPE [10][11][12]. An increase in knowledge is required, but it is not enough to influence the workers' behavior [13]. Workers' attitude do not affected the compliance with the utilization of PPE. This is contrary to the research conducted by Federico Andrade et al. (2015) which stated that the ability to work fast and comfortably determined whether or not workers who use PPE [14]. Meanwhile, age has no influenced on the compliance with the use of the equipment. According to the previous study about the compliance of welders in PT PAL Indonesia, there were no correlation between age, working period, or education with compliance with the use of PPE based on the Standard Operating Procedure (SOP). The results of the research showed that there was a significant correlation between knowledge and the compliance with the use of PPE based on the SOP [15]. Meanwhile, another study pointed out that there was a correlation between age and the compliance with the use of PPE. However, there was no influence between knowledge and the compliance with the use of PPE [16]. Factor that significantly influenced the compliance in this study was the availability of the equipment. Mac Farlane (2013) reported that the compliance with the utilization of PPE

**Table II: The Results of Logistic Regression That Determinant to The Use of PPE by Using Bootsrap Method**

Variable	B	Bias	Std Error	Sig.(2-tailed)	95% Confidence Interval	
					Lower	Upper
Age	0.951	7.121 <sup>b</sup>	24.798 <sup>b</sup>	0.110 <sup>b</sup>	-54.380 <sup>b</sup>	61.468 <sup>b</sup>
Working P	-0.324	-2.856 <sup>b</sup>	18.568 <sup>b</sup>	0.298 <sup>b</sup>	-51.337 <sup>b</sup>	35.753 <sup>b</sup>
Knowledge	-0.106	-0.950 <sup>b</sup>	21.389 <sup>b</sup>	0.562 <sup>b</sup>	-55.937 <sup>b</sup>	36.846 <sup>b</sup>
Attitude	1.353	8.698 <sup>b</sup>	19.978 <sup>b</sup>	0.093 <sup>b</sup>	-24.837 <sup>b</sup>	55.967 <sup>b</sup>
Availability PPE	2.889	21.500 <sup>b</sup>	31.040 <sup>b</sup>	0.018 <sup>b</sup>	-1.433 <sup>b</sup>	105.989 <sup>b</sup>
Training	0.925	7.704 <sup>b</sup>	21.550 <sup>b</sup>	0.176 <sup>b</sup>	-33.902 <sup>b</sup>	57.868 <sup>b</sup>
Promotion	-19.099	14.023 <sup>b</sup>	21.363 <sup>b</sup>	0.418 <sup>b</sup>	-40.694 <sup>b</sup>	47.980 <sup>b</sup>

was influenced by the access to the equipment [17]. This report was correlated to the research conducted by Sharifzadeh et al. (2017) who stated that the availability of PPE was a prominent constraint [18]. The more complete the equipment is, the more obedient workers will be in using it [19]. An increase in available PPE will enhance the frequency of its uses. There was a relationship between the availability of personal protective equipment and safety behavior [8]. Based on the observation, it was found that there was no stock of PPE in the warehouse. PPE was budgeted annually based on the request of OSH division and will be given by request through the reporting mechanism. The equipment used in this company included safety helmets, masks, gloves, ear plugs, ear muffs, eye goggles, work clothes and safety shoes. For work clothes, they were given only once per year. According to International Loss Control Institute (ILCI) Model explained in Bird (1992), inadequate facilities can lead to sub-standard conditions which was the direct cause of unsafe behavior among workers [20]. If the organization do not provide the facilities, it will be difficult for the workers to carry out activities according to the SOP.

In summary, PT Samator has zero accident program. The management department of the company have demonstrated their commitment to ensure the availability of important resources in the form of human resources (experts), Occupational Health safety (OHS) organizational structure, and financial resources. These financial resources included the availability of PPE. This company has provided PPE in accordance to the Regulation of The Minister of Labor and Transmigration (No.8/MEN/X/2011) about PPE [21] and RI Regulation No. 1 of 1970 about Work Safety [22]. The company also has applied the Regulation of the Ministry of Labor No. 5 of 2018 about OHS Environment. The regulation stated that employers must control hazards by using appropriate PPE [23]. Moreover, the company also made a documented SOP for PPE. Advisory Committee of OHS have been formed, yet the supervision program is still lacking. An optimal identification on the needs for the stockpile of the equipment has not yet been performed as well. The managerial department needs to provide PPE according to the number of workers and reserve some extras in case of emergency. They also need to conduct regular check on the availability of the

equipment in warehouses and identify what causes the unavailability of the PPE. Besides that, they also need to hold training about the proper use and treatment of PPE by workers.

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## EXTENDED ABSTRACT

# Management of Solid Medical Waste in Hospital a Logic Model Approach: A Literature Review

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## SUMMARY

Medical waste solid has potentially raised the risk of occupational accidents and disease transmission for the doctors, nurses, technicians, and all related to the management of the hospital or of patient care and hospital visitors. The purpose of research conduct and management of solid medical waste in hospital. Method of collecting secondary data is literature study. Furthermore, the conducted literature review, performed a survey paper on a research topic, Then analyze and deeply synthesize the paper with logic model approach. The data was analyzed using descriptive analysis. The results of the research reveal that the situation of medical waste solid have the potential risk of the occurrence of the accident. The inputs was the availability of trash according to type of garbage, the availability of sufficient power, the system is developed well, the technology support and the existence of the partnership to third parties. Reduce the number of medical waste solid is priority. decreasing the amount of waste solid medical in hospital. The medium-term with the reduced risk of accidents, of transmission of diseases such as nosocomial infections will be reduced and ambient air quality will be better, decreased the number of medical waste solid due to the presence of recycling. Categorizing the trash according to type of garbage, the availability of sufficient power, the system is developed well, the technology support and the existence of the partnership to third parties. The outputs were the activities supported with resources and the existing infrastructure to achieve the minimization of medical waste solid in the hospital. The outcomes are reducing the number of accidents, nosocomial infections and environmental pollution.

**Keywords:** Management, Solid Medical Waste, Logic Model

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## INTRODUCTION

Medical waste solid had potentially large in raises the risk of occupational accidents and disease transmission for the doctors, nurses, technicians, and all related to the management of the hospital or of patient care and hospital visitors. The amount of generation of medical waste solid per year in RSUD Dr Soetomo Surabaya [1] with the measurement period for 5 years i.e. year 2013 s/d in 2017 as shown in Figure 1.

## MATERIALS AND METHODS

Research methods used are secondary data which is literature study. Library studies collect information relevant to the topic under study. That information can be obtained from scholarly books, research reports,



**Figure 1: The amount of Generation of Medical Waste Solid per Year in RSUD Dr Soetomo Surabaya 2013 until 2017**

articles, scientific thesis and dissertation, regulations, statutes, yearbooks, encyclopedias and written sources both printed and electronic, as well as other research journals. Furthermore, the conducted literature review, performed a survey paper on a research topic then make analyze and deeply synthesize the paper that is reviewed with logic model. Logic model is a method

or systematic way and the visual in the present and give an understanding of the relationships between the resources, plan the activities of a program, change as well as the results to be achieved (Figure 2). Logic model is a tool that serves for planning, management, and evaluation of a program [2]. The data was analyzed using descriptive analysis.

**RESULTS AND DISCUSSION**

Controlling waste is an important part of public health where improperly managed waste can create conditions that may have severe adverse effects on public health and the environment [3].

Solid waste medical includes nine types of waste i.e. infectious waste, pathology, sharp objects, pharmaceutical, sitotoksis, chemical, radioactive, the container is pressurized and is constituted of a heavy metal [4]. Controlling waste is an important part of public health where improperly managed waste can create conditions that may have severe adverse effects on public health and the environment [3].

**Situation**

Solid waste medical includes nine types of waste i.e. infectious waste, pathology, sharp objects, pharmaceutical, sitotoksis, chemical, radioactive, the container is pressurized and is constituted of a heavy metal [3]. Controlling waste is an important part of public health where improperly managed waste can create conditions that may have severe adverse effects on public health and the environment [4].

Solid waste of the hospital such as needles are disposed together with household waste, harm to the janitor while enhancing the transmission of HIV (99%) via syringe used [5]. Factors supporting the occurrence of infections nosocomial is environmental factors. water, air, and materials that must be disposed of or waste is a group of environmental factors. Clerk waste collector is a person which most at risk for infection with nosocomial due to direct contact.

**Priority**

Reducing the amount of medical waste solid waste management implemented according to the procedure in the Environmental management System can help minimize the environmental impact, as well as the cost needed to manage waste [6]. The reduction of waste amount and sorting waste is a top priority to go Green Hospital. Reduction activities also reduce the adverse effects to the environment and society.

**Inputs**

The availability of bins, personnel, systems, technology and partnership. The efforts of good management with the adequacy of the financial and management organization, tools and means. The availability of human resources who received training in penanganan medical waste will reduce the occurrence of number of accidents [7].

**Outputs**

Activities supported with resources and the existing infrastructure to achieve the minimization of medical waste solid in the hospital. The goals should be done by performing the recycling of medical waste solid, 13

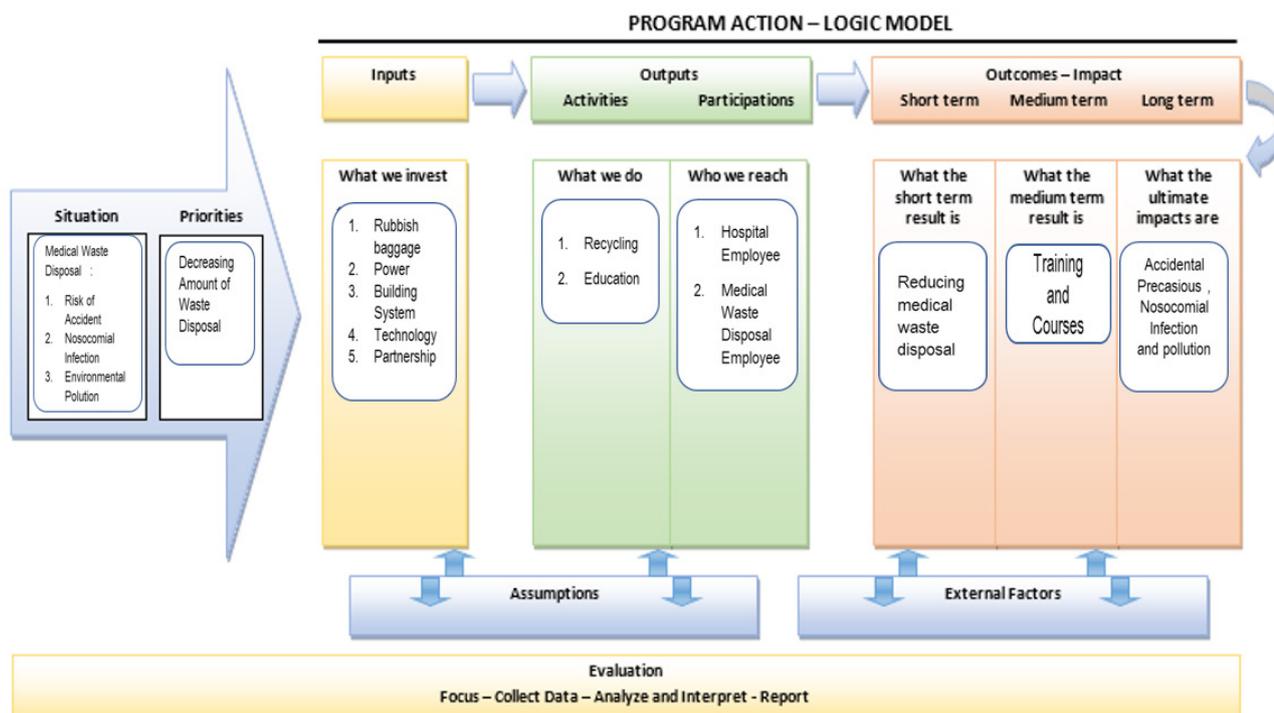


Figure 2: The implementation of the Logic Model in the Management of Medical Waste Solid in the Hospital based on Powell, 2008 [2]

doctors (68,4%) at one Hospital in Bandung said that recycling is one of the efforts to reduce waste [8]. It takes discipline health personnel in disposing of garbage according to type of garbage . The knowledge abouts very important to established in every officer in the disposal of medical waste [9]. Cooperation with third parties needs to be improved.

### Outcomes-Impact

Outcomes short-term with decreasing the amount of medical waste solid in the hospital. The medium-term with the reduced risk of accidents, of transmission of diseases such as nosocomial infections will be reduced and ambient air quality will be better, decreased the number of medical waste solid due to the presence of recycling. The short term recycling and combustion with skillfully to reduce the amount of waste solid medical hospital [10]. The Long term will reduce the number of accidents, nosocomial infections and environmental pollution.

### The Assumption

Program leaders who supported the availability of power and adequate infrastructure and discipline awakened in the system including the third party will be able to achieve the goals that have been defined.

### External Factors

The success of a program in managing medical waste solid this need to be supported by the various relevant agencies. Sanitarians also need to make a recording of the reporting of medical waste management solid based Guidelines for Management of Medical Waste Sharp at the Center for Public Health [11]. Hospital Policies Jogja by performing the contract system to facilitate the supervision of officers. The contract system makes the process of solid waste management to be more effective, because if the officer did a fatal mistake it can be terminated at any time by agreement is a contract [12].

### CONCLUSION

Waste management medical solid at the hospital with the approach logic model shows that the situation of medical waste solid are risky, with priority decline in the number of medical waste solid, the inputs with the conditions of labor and technologies that exist, outputs the minimization of waste by recycling medical waste solid so that the outcomes will reduce the number of accidents, nosocomial infections and environmental pollution.

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## EXTENDED ABSTRACT

# Improving Professional Development of Public Health Professionals Through Informal Learning

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### SUMMARY

Continuing Professional Education (CPE) is entering the third era in which education and learning occur in a workplace. The concept of learning in the profession is believed to lead on the improvement of job performance of public health professionals. However, little research has been done to understand the informal learning participation for professional development of public health professionals. All data were collected using online survey. The final sample used for analysis consisted of 172 public health professionals in the database of The Georgia of Public Health Training Center (GPHTC). The results from this study suggested that most public health professionals participated in available informal learning opportunities to advance in their professions.

**Keywords:** Continuing professional education, Informal learning, Professional development

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### INTRODUCTION

Public health professionals need to keep on learning in the profession. However, studies show most public health professionals do not engage in activities that can enhance their professional development. There are many opportunities for public health professionals to engage in learning in the profession. These learning opportunities may be conducted formally by particular organization, but some may be experienced as informal or incidental learning in the workplace. Formal, informal and incidental learning are distinguish based on the degree of control by the learner[1]. Informal learning can be encouraged by organization but mostly occur in daily life where individual learn from and through experience in particular situation [1]. The heavy workload, cost to participate, lack of administrative support, child care and home responsibilities are some of the barriers that resulted in low participation in formal learning activities [2,3]. The idea of informal learning may be a significant aspect of continuous learning for public health professionals that complement the formal learning in CPE.

This informal learning community, members appeared to be supportive to enhance each other's learning [4]. Informal learning also encourages members to freely give opinions to agree or disagree rather than focuses

on the "right" answer or achieve a consensus [4]. The informal learning transform the knowledge, beliefs and behaviors of public health professionals in their professional practices. Through the interactions in the workplace, these changes of knowledge, beliefs and behaviors affect the learning at group or team level that eventually influence the learning at organizational level. Literatures showed that professionals need to continue learn in the profession and organization need the learning culture to foster professional development of professionals. However, there are only few studies that have been conducted to understand the role of the informal learning in professional development of public health professionals.

### MATERIALS AND METHODS

This study used a cross-sectional and exploratory study design to survey members of the Georgia Public Health Training Center (GPHTC) at the University of Georgia (UGA). All data were collected for an approximately 10-week period of study through Qualtrics survey site as the medium for data collection. The online survey was developed by the researchers based on Watkins's formal, informal, and incidental learning Questionnaires and the short version of the Dimensions of the Learning Organization Questionnaire (DLOQ). All of the data in this study were gathered using Qualtrics and analyzed using statistical software.

### RESULTS AND DISCUSSION

Formal, informal and incidental learning are distinguished based on the degree of control by the learner [1]. In

regards to informal learning opportunities, the instrument assessed (1) the availability of these informal learning opportunities and (2) their participation in the following opportunities in the last six months: 1) A library with professional journals and books; 2) Membership dues to professional associations or networks; 3) Formal mentoring from supervisors on professional and career development; 4) Performance planning—getting performance expectations from supervisors based on organizational goals; 5) Performance planning—getting performance expectations from clients or customers; 6) Performance planning—setting performance objectives for personal development needs; 7) Computerized information bases available to support your work; 8) Job aids, checklists, tools, etc. from peers, supervisor; 9) Structured critiquing sessions on one’s work with peers or supervisors.

Informal learning can be encouraged by organization but mostly occur in daily life where individual learn from and through experience in particular situation [1]. According to the analysis, the most common informal learning opportunities identified by the participants were receiving performance expectations from their supervisors based on the organizational goals, and setting performance objectives for personal development needs. These participants who identified the availability of informal learning opportunities in their organization may not always participated in these learning activities. Table 1 describes the frequencies and related percentage of the availability and the actual participation of participants in the informal learning opportunities.

Mentoring and coaching, setting goals, meetings, and various professional development activities were those categories that participants in this study used to learn informally. Most participants in this study (66.1%) stated that they did not have informal group learning, and only 33.9% of the participants are member to an informal learning group. Participants who answered that they are part of informal learning group then were asked to compare their experience in learning in formal and informal learning group. More than half of participants in this study (52.5%) prefer to learn informally rather than learning formally provided by their formal professional association (47.5%). They were then asked to give their personal reason of their choices. The reasons of their preference are unique to each individual for those who prefer learning formally and those who prefer to learn informally.

Therefore communities of practice are also unrecognized by the organization and only take form as informal lunch discussions or can be institutionalized as the official structure of the organization and when well managed can offer legitimacy and useful resources for members [8]. As for participants who prefer to learn informally, the answers of the participants were categorized as follow: 1) Ability to discuss issues with fewer

distractions; 2) Dialogue and brainstorming; 3) More open to engage in discussion, ask questions and get an understanding; 4) More honest/direct about failures whereas formal organization tend to discuss success only; 5) More relaxed environment to express ideas/solutions/questions; 6) Insights on “what works here” and how people will respond to a change; 7) Provide more confidentiality; 8) More practical and oriented to a specific task and intended outcome; 9) More time for discussion from personal experiences; 10) Real life and pertinent experience rather than book-learning experience; and 11) More enthusiasm, commitment, energy.

**Table 1: Informal Learning Opportunities and Actual Participation in Learning**

Informal Learning Opportunities In the Last Six Months	Available*		Participated**	
	Frequency	%	Frequency	%
Performance planning—getting performance expectations from supervisors based on organizational goals	78	45.3	57	73.1
Performance planning—setting performance objectives for personal development needs	66	38.4	48	72.7
Computerized information bases available to support your work	62	36.0	47	75.8
Job aids, checklists, tools, etc. from peers, supervisor	55	32.0	38	69.1
Membership dues to professional associations or networks	49	28.5	33	67.3
A library with professional journals and books	47	27.3	22	46.8
Structured critiquing sessions on one’s work with peers or supervisors	46	26.7	25	54.3
Performance planning—getting performance expectations from clients or customers	41	23.8	28	68.3
Formal mentoring from supervisors on professional and career development	32	18.6	16	50.0

\* Total sample: All Participants in the study (172 participants)

\*\*Total Sample: Participants who identified the availability of each learning activity in their organization (different total number of sample for each activity depending on the number shown in the available (\*) column)

**CONCLUSION**

In regards to the informal learning opportunities, this particular study assessed the participants of their experience in learning informally in their workplace. The following situations in which the unintentional learning take place among the individuals in a learning organization: Job rotation, stories and myths, task forces, and informal networks [10].

The majority of participants in this study acknowledge that they learn informally through receiving performance expectations from their supervisors based on the organizational goals (45.3%), and followed by setting performance objectives for personal development needs (38.4%). The role of supervisors in giving positive

feedback to these professionals is crucial in providing reflection for areas of improvement. This evaluation process, either from the supervisor or from personal reflection, provides informal learning opportunities for a public health professional to advance in their profession. Previous study revealed that there were three interrelated themes that emerged from their study about the informal learning activities among health professionals [5]. These three themes were engagement in authentic work activities, learning from mentors, and the use of physical and social resources and tools [5]. These health professionals primarily learn from their daily work related activities [5]. In order to support the informal learning in the organization, the role of the supervisor in the organization is to give continuous support and provide positive feedback for their public health professionals.

In regard to the type of interaction, a previous study found that 11 out of 32 studies revealed that health professionals commonly used face-to-face interaction in the workplace and only few of them use technology as medium [9]. The study suggested that geographical distribution of members and objective of communities of practice influenced the type of interaction between members. These interactions in communities of practice that resulted in the informal learning of professionals are encouraged to create changes in job performance of public health professionals.

However, the availability of these informal learning opportunities was not always ensure that the learning process was experienced by health professionals in this study. These professionals need to have the following skills to be able to learn informally: 1. How to analyze experiences; 2. The ability to learn from others; 3. The ability to act without all the facts available; 4. Choosing among multiple courses of action; 5. Learning about organizational culture; 6. Using a wide range of resources and activities as learning opportunities; and 7. Understanding the competing and varied interests in the shaping of one's work or professional identity [6].

We also asked the participants about their informal learning groups. We asked this question in order to be able to identify their preference between learning in formal and informal group. Most participants in this study stated that they did not have informal group learning (66.1%), and only 31.9% of the participants are member of an informal learning group. Participants who answered that they are part of informal learning group were then asked their preference between learning in a formal group and learning in an informal learning group. Most of participants in this study (52.2%) prefer to learn informally and another 47.5% prefer to participate in learning activities provided by their formal professional association. They were then asked to give their personal reason of their choices. The reasons of their preference are unique to each individual for those who prefer learning formally and those who prefer to

learn informally. According to the participants, the formal learning activities are more well-organized, focused, and offered credits for those who have the professional credentials. The participants also said that the formal learning activities are more credible and professional because they are led by experts in the field. As for participants who prefer learning informally, some of these reasons are because informal learning activities provide the opportunity to have honest, open discussion with their peers, supervisors and/or other similar organizations. This informal learning also gives the participants equal opportunities, increases engagement, increases confidentiality and can be geared toward their personal need in a more relaxed environment. CPE with adequate content, experienced instructors and effective methods of delivery support the professional development of the public health professionals to better human life and service in a profession [7].

### LIMITATION

As any other study, there are limitations in this study that need to be acknowledged. Despite the advantages offered by online survey, online surveys may have the following challenges: 1) Technology can fail because online survey relies on the capability of computer and the technical capabilities of researcher and participants; 2) Lack of control of the data collection environment because there are no face-to face interaction with participants that also make it difficult to calculate the response estimation; 3) Limited generalizability because the participants without access to the internet and who do not have the ability to complete an online survey will not respond [11]. The researcher acknowledged these challenges of using online survey.

### ACKNOWLEDGMENTS

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## EXTENDED ABSTRACT

# Implementation of Hazard Analysis Critical Control Point (HACCP) in Nutrition Department of Hospital “X”, Batu City, Indonesia

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### SUMMARY

Hazard Analysis Critical Control Point (HACCP) is a proven food safety management system based on preventive measures which aim to identify possible hazard in each stage of the food supply chain. The food management in hospital institutions is more complex and requires special handling. The purpose of this research is to evaluate the application of HACCP principle in the provision of food in Nutrition Installation of Hospital X in Batu City. The research design used is descriptive qualitative which was conducted in the Nutrition Installation of Hospital X in July 2015. Total information sources of this research are 9 informants who were selected by the universal sampling which is the whole employees in Nutrition Installation of Hospital X, Batu City. The data collection was done through interview and observation. The results that HACCP Principle has not been implemented maximally because it is not supported by the policy that should be owned by X Hospital of Batu City. It can be concluded that Hospital X has not applied the principle of HACCP maximally because the Hospital does not have a standard implementation of HACCP Principle.

**Keywords:** HACCP, Nutrition Installation, Hospital

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### INTRODUCTION

Food and beverage are one of the basic human needs. Food and beverage contain nutrients needed by the human. In addition to having important benefit, food and beverage are also highly susceptible to harmful substances or microbiology that can harm human health. Generally, diseases which are always closely related to the provision of unhygienic foods are diarrhea, gastritis, and food poisoning. These diseases occur when the food consumed is contaminated by chemicals, physical, and biological substance [1].

In 2016, Indonesia has 1068 food poisoning cases [2]. In order to minimize the risk of food hazard which is contaminated by substances that can endanger health, a good and standardized sanitation system is needed. System which is able to minimize the hazard contamination in food and ensure the quality of food is Hazard Analysis and Critical Control Points (HACCP). HACPP is a quality assurance system based on awareness or appreciation that hazard can arise at certain production point or stage, but control can be

implemented to control those hazards [3].

The food management in a hospital institution is more complex and requires a special handling. In the hospital, food is served directly to the patient at his place treated or in the ward of care. In addition, the provision of food to the patients requires special handling as it relates to the healing process of the patient. Thus, the cleanliness and quality of food are very important because the food served also plays a role in the patients healing process. In order to provide a quality food that is contamination-free of hazardous substances, HACCP becomes an important system in minimizing the risk of harm that can arise from food management.

Several studies have shown that hospital patients tend to have a decrease in their nutritional status during their hospitalization period. Patient satisfactions to the food service in the hospital will influence the food intake and this food intake will have an effect on the nutritional status [16].

As one of the referral hospitals in Batu City, the “X” Hospital should have attention to the quality of service to the patient because the main target of the food management in the hospital is the patient of the hospital. In the food management, the nutrition section is faced with a potential danger such as from bacteriological

food, water, equipment, staff and food handlers or contamination of the surrounding environment. Therefore, the researchers are interested to examine the implementation of the 7 principles of HACCP in Nutrition Installation of Hospital X in Batu City of 2015.

## MATERIALS AND METHODS

The research design used in this research is qualitative descriptive method. This study aims to gather detailed information by describing all existing facts, identifying problems, making comparisons or evaluating the information or data obtained [5]. Sources of research in this study are 9 informants selected by the universal sampling which is the whole employees in the Nutrition Installation of Hospital X in Batu City. Data collection is done through interview and observation. The tool used in this research is observation sheet and interview guide, while the data analysis used is triangulation. Should include the QA/QC for the research tools used.

## RESULTS

Hazard Analysis Critical Control Point (HACCP) is a proven food safety management system based on preventive measures which aim to identify possible hazard in each stage of the food supply chain. Hazard Analysis Critical Control Point (HACCP consists of 7 principles. First, Identifying the Hazard, Second, Determining the Critical Control Point, Third, During the supervision of the critical limits, Fourth, The determination and implementation of a monitoring system, Fifth, Corrective action, Sixth, System verification, Seventh, Documentation.

Among the 7 principles of HACCP, 4 principles have been applied well, those are the principle of determining critical control points, determining critical boundaries for each CCP, establishing and implementing the monitoring system, and corrective actions. Meanwhile, the HACCP Principles that have not been applied consist of 3 principles, those are Hazard Identification, System Verification, and Documentation. That principle cannot be applied because there is no written policy on HACCP Principles.

## DISCUSSION AND CONCLUSION

Hazard Analysis Critical Control Point (HACCP) In Nutrition Departement Of Hospital "X", Batu City, Indonesia consists of 7 principles.

1. Identifying the Hazard Based on SNI ISO 22000: 2009 [5] the flowchart should be prepared for the product or process categories covered by the food safety management system. Flowchart should provide a basis for evaluating the likely occurrence, increase, or inclusion of food safety hazard. Hazard is identified by considering the biological, chemical and physical

hazard. A team identifies a physical hazard of foodstuff starting from the receipt of foodstuff, to some chemical hazard examined such as borax, formalin, and also food coloring. Each food receipt is immediately tested for new items. food that has been checked is not tested every day, but the chemical and physical hazard should be controlled. Meanwhile, laboratory examination for food contamination is never conducted because of the limitation of equipment owned by the Hospital. In this case, the Nutrition Installation of X Hospital continues to propose to the equipment supplier to provide the equipment needed by the Nutrition Installation.

2. Determining the Critical Control Point. This stage is a key in reducing or eliminating the identified hazard. CCP or critical control point is defined as any stage where if it is not properly monitored, it may lead to unsafe food as well as economic damage and loss. In the process of food production, many stages can enable the occurrence of hazard contamination. However, not all stages can be used as CCP, only certain stages can be used as CCP [6].

The measurement that CCP is well established in the hospital's nutritional installations is by looking at the quality of the food produced so far and the absence of any problems arising from the food produced. Information sources used derived from the study of scientific literature and also research on contamination of food hazards.

Recording activities in the supervision of critical borders should be done to show that the critical limits have been well supervised. However, the nutrient installations have not carried out the act of recording the critical limits monitoring.

3. During the supervision of the critical limits. There has never been a problem that has ever happened. If there is any problem, the nutritional installation has planned to do food withdrawal action even if the food has been presented to the patient. However, if the food not been presented to the patient yet, an evaluation will be performed.

4. The determination and implementation of a monitoring system. Monitoring activities are carried out daily by the quality control section. It is performed daily to monitor food processing by a series of visual observations, sensory tests, chemical tests, and physical hazards observations.

Nutrition head office think that the food contamination equipment not complete yet. It also does not have any metal detector and some equipment for the necessary chemical test. However, the nutrition installation will propose the equipment needed to the hospital so that all monitoring activities can be done well. The result of the monitoring activities is that no event

has passed the predetermined parameters and all food processing activities are in accordance with the flowchart. The monitoring frequency should be considered as a part of the control system. Monitoring frequency depends on the type of critical control point specified. Monitoring frequency is sufficient because monitoring is done daily to prove that the food products produced have no problem and complaints made by the patients in the hospital.

5. Corrective action. Corrective action is very important to be performed if the critical limit parameter is exceeded. So far, no corrective action has been taken yet, since there is no problem occur during the monitoring. In addition, there has never been a problem with manufactured food products. Thus, there are no reported or documented corrective action.

6. System verification. Verification must be performed to ensure that HACCP design is properly implemented. For this purpose the verification activities shall include all the specified critical control points [3].

The activity of the verification procedure has not been clearly defined since there is no validation activities have been performed on the specified CCP. However, a team of nutritionists has been convinced that CCP determination has been able to ensure food safety because CCP determination comes from scientific literature.

An audit of the HACCP system has not been done. The food testing in case of microbiology has never been done as well. The verification activities performed so far include reviewing the implementation of food processing whether it is in accordance with the existing provisions or not, so that it ensures the compliance with the program.

7. Documentation. The HACCP system should be documented and its record should also be maintained to show that the system is properly organized and functioning properly. The HACCP documentation system must have a good standard, for example, it can be read clearly and there is no scrawl or eraser. All documents must be signed and dated. Notes are essential for analyzing trends, which will later be needed when reviewing and improving the system [7].

Documentation is also useful to indicate whether there is a change in HACCP design at the time of its adoption. Nutrition installation itself has never made any changes to the HACCP design so there is no documentation of it. The HACCP principle in X Hospital of Batu City has been implemented, but so has not been applied as a whole. Among the 7 principles of HACCP, 4 principles have been applied well, those are the principle of determining critical control points, determining critical boundaries for each CCP, establishing and implementing the

monitoring system, and corrective actions. Meanwhile, the HACCP Principles that have not been applied consist of 3 principles, those are Hazard Identification, System Verification, and Documentation. That principle cannot be applied because there is no written policy on HACCP Principles. Hospital management should prepare and apply the HACCP Principle as a whole. It can be started by preparing policies and Standard Operating Procedures of HACCP System Implementation as a means of minimizing hazard contamination on food and ensuring the food quality. Cleanliness and quality of food are very important to note because the food served to the patient also plays a role in the healing process of the patient.

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## EXTENDED ABSTRACT

# Analysis of Decreasing Hemoglobin Level at Vegetable Farmers in Exposure of Organophosphate Pesticide, Torongrejo Village, Junrejo Subdistrict, Batu City, Indonesia

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### SUMMARY

Pesticide is all chemical substances or other materials and microorganisms and virus. Pesticides can cause negative effects to human health and environment. One of the impact of pesticides exposure is changing levels of hemoglobin (Hb). This study aimed to analyze The Decreasing Of Hemoglobin Level at Farmers in Exposure Of Organophosphate Pesticides at Torongrejo Village Junrejo Subdistrict Batu City Indonesia. This study method was observational analytic with cross sectional design. The sampling technique used simple random sampling. The population were farmers of Torongrejo Village Junrejo Subdistrict Batu City with total sample about 32 respondents. The data obtained by hemoglobin examination, interview and observation. The result of Hemoglobin examination showed that normal Hemoglobin were 17 respondents (53.1%) and abnormal Hemoglobin were 15 respondents (46,9 %). The study result of the variables, completeness of personal protective equipment, length of spraying, pesticides toxicity and pesticides dosage, have no relationship with levels of hemoglobin (hb) changing. It can be concluded that there was no relationship Decreasing Hemoglobin Level at Vegetable Farmers in Exposure of Organophosphate Pesticide, Torongrejo Village, Junrejo Subdistrict, Batu City, Indonesia. It is suggested to conduct training or counseling about pesticide usage, poisoning signs of pesticide, and personal protective equipment usage.

**Keywords:** Pesticide organofosfat, levels of hemoglobin (Hb)

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### INTRODUCTION

World Health Organization (2008) stated that the use of pesticides are affected by the level of toxicity, volume, and exposure significantly affects health. The higher the toxicity of pesticide used, the more signs of poisoning symptom experienced by the farmers. From the data collected, there are about 500,000-1,000,000 people per year in the world who are poisoned by pesticides and about 500-1000 people per year suffered a very fatal impact such as cancer, disability, infertility with a liver disorder. Uncontrolled use of pesticides creates various health problems and environmental pollution. Rangan (2014) states that pesticide exposure affects the human body components, one of them is blood. Pesticide can cause abnormality in the blood profile because pesticide can interfere with the organs that form the blood cells, the formation process of blood cells and the immune system. Blood consists of 2 main components, those are blood plasma and blood cell. Blood cell consists of 3 components: red blood cell, white

blood cell, and platelets. Red blood cell has a major protein that is hemoglobin. Former research conducted by (Ramsingh, 2009) found that there is an influence on the use of pesticide in hemoglobin levels, where this pesticide causes decreased the production or increased the red blood cell destruction. This makes the formation of methemoglobin in red blood cells, causing abnormal hemoglobin and disability in performing its function to deliver oxygen. The presence of methemoglobin in the blood will cause a decrease of Hb levels in red blood cell.

### MATERIALS AND METHODS

The type of this research is observational analytic research. The data obtained through observation, interview, and questionnaire. This research design uses cross sectional through chi-square test with contingency coefficient reading. There are 32 respondents of pesticide sprayer farmers.

### RESULTS

The research showed that from 32 respondents, 12 respondents (37,5%) respondents aged between 47 years until 57 years (Table I).

**Table I: Respondent age**

	Age				
	25-35	36-46	47-57	58-68	69-79
<b>Total</b>	3	9	12	6	2
<b>%</b>	9.4%	28.1%	37.5%	18.8%	6.3%

The results of the research are intended to know that the majority of farmers in Torongrejo do not use complete personal protective equipment (28 respondents/ 87.5%), and while there is 4 respondents (12.5%) that use complete personal protective equipment. On the length of work, none of the respondents had less than 5 years and 100% had more than 5 years experience as farmers who used spray of Organofosfat pesticides. More than half (59%) of the farmers used organofosfat pesticides less than 3 hours each day and about 41% more than 3 hours each day. Three respondents (9.4%) used pesticide more than recommended dosage while 29 respondents (90.6%) used pesticides based on recommended dosage. It is known that 3 respondents (9.4%) used moderate toxicity pesticides, 29 respondents (90.6%) used pesticides with high toxicity (Table II).

**Table II: Respondent characteristic**

	n (%)
<b>Personal Protective Equipment</b>	
Complete	4 (12.5)
Incomplete	28 (87.5)
<b>Length of Work</b>	
< 5 years	0
> 5 years	32 (100)
<b>Length of Spraying</b>	
< 3 hours (good)	19 (59.4)
> 3 hours (bad)	13 (40.6)
<b>Pesticide Dose</b>	
As recommended	29 (90.6)
Not recommended	3 (9.4)
<b>Pesticide Toxicity</b>	
Medium Toxicity	3 (9.4)
High Toxicity	29 (90.6)

Respondents who use incomplete PPE are 28 respondents (87,5%), while those who use complete PPE are only 4 respondents (12,5%). For the length of the sprayer using organophosphate pesticide, 19 respondents (59,4%) are good (less than 3 hours per day) and 13 respondents (40,6%) are not good (more than 3 hours per day). In addition, 3 respondents (9,4%) use pesticide with medium toxicity, while the other 29 respondents (90,6%) use pesticide with high toxicity. Furthermore, 3 respondents (9,4%) use pesticide whose dose is not recommended, while the other 29 respondents (90,6%)

use pesticide with dose as recommended. Lastly, the hemoglobin concentration of 17 (53,1%) farmers are in the normal category, but the other 15 (46,9%) farmers are in the abnormal category (Table III)

**Table III: The Decrease of Hemoglobin Levels on Farmers After the Exposure of Organophosphorus Pesticide**

	p-value
Length of Work	0.513
PPE	0.349
Length of Spraying	0.513
Pesticide Toxicity	0.053
Pesticide Dose	0.471
Decrease of Hemoglobin Level	0.050

The analysis result using chi-square test of protective personal equipment completeness on the decrease of hemoglobin (Hb) level as shown in table III no significant correlation between the protective personal equipment completeness and the decrease of hemoglobin level with the significant value of 0.349. This is contrary to a research conducted by Afriyanto (2008) who states that there is a significant relationship between the completeness of personal protective equipment and the decrease of Hemoglobin (Hb) level [1].

## DISCUSSION AND CONCLUSION

Discharging self protection complete there are 7 parts which are: it be that his long sleeves, trousers, a mask, a hat, eyes of glass, t shirt on a your hands and of a shoeboot. Discharging self protecting devices apd provided able to prevent and reduce the cost of the occurrence of poisoning using pesticides it could,they are full ofarrogance self protecting devices apd provided the possibility of direct contact with using pesticides it could can be reduced so that the risk of using pesticides it could give them bitter and poisonous gets into a through parts of the breathing response of, gastrointestinal tract and the skin can be be done away with

The analysis result by using chi-square obtains that there is no relationship between the spraying length and the change of hemoglobin (Hb) level with a significant result of 0.513. Former research in India conducted by Reddy and Jegdish (2012), obtains a result that there is a relationship between the length of work and the changes in hemoglobin levels. The difference in this study is the intensity of the spraying length time in the study conducted by Reddy and Jegdish (2012) of which farmers who act as the respondents spray pesticide for more than 3 hours per day, while in this research which is conducted in Torongrejo Village, Junrejo Subdistrict, among 32 respondents, 19 (59,4%) respondents spray the pesticide for less than 3 hours per day.

Theoretically according to prihadi in 2007 , in spraying should not may more than 3 hours if than 3 hour then risk poisoning will be bigger .If still need to finish his job

letrest for some time to give opportunity to the body to be rid of exposure pesticides. In long spraying condition, an alarm bell should be rung because the longer the farmers are in contact with pesticide the more likely the farmers would experienced poisoning [9].

The pesticide toxicity on the changes in hemoglobin yield a significance of 0.053. This is not in accordance with Purba (2008) study on environmental factors related to pesticide poisoning which explains that there is no significant relationship between pesticide toxicity and changes in hemoglobin (Hb) levels [5]. Djojsumarto (2008). The use of high toxicity pesticide is because the farmers think that such pesticide is very powerful to prevent pests in plants and do not pay attention to the active ingredients of the pesticide. Farmers suggest maintaining the use of a pesticide which is considered more effective than the other types of pesticide. Said that the risk contamination pesticide influenced by  $LD_{50}$  pesticides. The lower the  $LD_{50}$  pesticide will be more dangerous. Many farmers in Indonesia who do not know the level of its toxicity pesticides they use and often they use it without meet rules given. Besides toxicity pesticides, konsetrasi pesticide also must be considered, it darkens pesticide (means concentration the higher) the worse.

It was also indicated that there is no relationship between the pesticide dose and the change of hemoglobin (Hb) level with the significant result of 0.471. This is in accordance with a research conducted by Fikri (2012) which results that there is no significant relationship between the dose of pesticides and changes in hemoglobin (Hb) levels. However, a research conducted by Afriyanto (2008), obtains that there is a relationship between the dose of pesticides and changes in hemoglobin (Hb). Research is obtainable based on the questionnaire and an interview from 32 respondents, 29 (90,6 %) is located in the in accordance suggestion and 3 (9.4 %) of respondents to a category not in accordance with suggestion. It in accordance suggestion farmers not see rules use is in label, farmers was use measure themselves because measure own is believed will faster kill pests that is the ditanaman. The also diperhatian is broad of land that will sprayed and determine takarannya use tablespoons.

The research was conducted in Torongrejo Village, Junrejo Sub-District, Batu City, with 32 respondents.

Among those respondents, 17 respondents of them have abnormal Hb level, while the other 15 respondents have normal Hb. It can be concluded that there is no significant relationship between the use of organophosphate pesticide and the decreased hemoglobin level.

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## EXTENDED ABSTRACT

# Environmental Risk Factor of Tuberculosis among Children and Household Contact with Adults Having Active TB: A Review

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### SUMMARY

An estimated 1.3 million children under 5 years old had the household contact of pulmonary tuberculosis cases and tuberculosis death rate in children by 15% of all deaths due to TB. The purpose of this review is to study the potential environmental risk factors of tuberculosis in children with smear positive adults in the household. A review search using science direct, PubMed and google search of articles, journals, books to discover risk factor tuberculosis in children. The Potential risk TB infection in children is household contact with adults having active Tuberculosis. Environmental risk factors are ventilation, temperature of room, natural lighting, humidity and overcrowding was significantly associated increased TB infection. Environmental factors are significantly increasing TB infection among children and household contact with adults having active TB.

**Keywords:** Environmental, Risk factor, Tuberculosis, Children

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### INTRODUCTION

Tuberculosis (TB) is a global health problem that has existed for thousands of years and includes the top ten causes of death worldwide. A country's burden of TB can be described by saying how many cases of TB they have in a year. It can also be described by saying how many people in the country die of TB each year. The burden of TB is also sometimes related to the population size. The five countries that stood out as having the largest number of incident cases in 2016 were (in descending order) India, Indonesia, China, the Philippines and Pakistan [1]. Tuberculosis infection in children occurs at any age, but the highest rate of child tuberculosis cases in TB endemic countries is between the ages of 1 and 4 years. In infants, the time between infection and illness can be shorter than in older children, and the presentation may be more acute (1). Globally, according to the WHO (World Health Organization) report, children (aged <15 years) accounted for 6.9% of new TB cases by 2016 [1].

### MATERIALS AND METHODS

We searched from PubMed and Google search, searched terms around environmental risk factor of tuberculosis infection in children. Publications in English and Indonesian, journals, reviews, books were included. We identified 40 titles for examination using the search

terms. After removing duplicates and irrelevant studies, this review was supported 16 papers.

### RESULTS

Tuberculosis is an airborne infectious disease caused by bacterial infection of *Mycobacterium tuberculosis* (Mtb). Mtb in the air, called the droplet core, 1 - 5 microns in diameter. The core droplet infections occurs when people who have tuberculosis disease of the lung or larynx are coughing, sneezing, yelling, or singing. Depending on the environment, these droplets can stay alive in the air for several hours. Mtb is transmitted through the air, not by surface contact [2].

The characteristic of Mtb germ in general is: red rod-shaped with a length of 1-10 microns, width of 0.2-0.6 microns and is acid-resistant in staining with Ziehl-Neelsen method. Mtb is resistant to low temperatures and is very sensitive to heat, sunlight and ultraviolet light. Direct exposure by ultraviolet light causes most germs to die within minutes. Mtb in sputum at temperatures between 30-37°C will die within approximately 1 week of germs can be dormant ("sleep" I does not develop) [3].

Transmission occurs when a person inhales a droplet, and a droplet passes through the mouth or nose, upper respiratory tract, and lungs to reach in the alveoli of the lung [4]. Overall, a relatively small proportion (5-15%) estimated 1.7 billion people infected with Mtb will develop TB disease during their lifetime. Transmission Infections of lung disease in positive-spaced smear positive / sputum cases are at very high risk. The

proximity and frequency of contact is one of the major determinants of the risk of transmission of infection, and people living in homes have a higher risk than regular contact [5,6]. In a large study of household contacts in Peru, smear-positive index cases were associated with a higher risk of infection among household contacts, compared with smear-negative index cases, regardless of the age of the household contacts [6]. In secondary cases, patients with smear-negative culture-positive tuberculosis appear responsible for about 17% of tuberculosis transmission [7].

The potential risk factors for infected Mycobacterium tuberculosis in child are contact with adults TB with smear positive, environmental factors of home include ventilation, [4,5,8,9,10], natural light [4,11], humidity [4,9,11] and occupancy density [5,10,12,13] were associated with an increased risk of TB infection in children [9,14,10].

Risk factors for TB disease in child are influenced by internal, human factors including malnutrition, young age, immunity and HIV immunodeficiency virus [6]. External factors play a great role in Mtb infection process including MTb in sputum, physical environment of home, socioeconomic, knowledge and indoor air pollution [8, 9, 14,15].

In studies undertaken in Indonesia, India, Pakistan, Vietnam, Malawi, Brazil, Kenya and Thailand showed that the proportion of TB infections among children in household contact with adults with active TB (smear positive) had a higher proportion of TB infected [4, 5,6, 8, 10]. Children who live in a house with adult TB patients with positive smear give frequency of contact more often and are exposed to Mtb have a greater risk of MTb infection at age <1 year by 58%, 48% in children > 10 years and 44% in children > 15 years) [16].

Study in India founded that TST positivity in children was associated with lower socioeconomic status (p=0.011), overcrowding (0.008) and duration of symptoms before treatment (p<0.001) significantly associated TB infection among children [5]. In Pakistan founded that environmental and socio economic significantly associated with factors TB was found to be associated with adult crowding, increased family size, poor ventilation and use of biofuels (OR: 4.60,1.75, 3.29 and

3.90) [8].

Study in Thailand result that the risk of tuberculosis infection was significantly associated with close contact (adjusted OR = 3.31, 95% CI = 1.46-7.45), exposure to mother with tuberculosis (adjusted OR = 3.82, 95% CI = 1.44-10.14), exposure to father with tuberculosis (adjusted OR = 2.55, 95% CI = 1.19-5.46), and living in crowded household (adjusted OR = 2.63, 95% CI = 1.18-5.85) [12]. Similarly, in Indonesia has results are associated with incidence population density with children’s pulmonary tuberculosis (p = <0.001), ventilation (p = 0.004), temperature of room (p = 0.036), density occupancy (p = <0.001) , natural lighting (p = 0.016) and humidity (p = 0.025) [10]. The factors which were found to have significant association were included. Base on research conducted in several country found that risk factors associated of tuberculosis infection in children are shown table I.

**DISCUSSION AND CONCLUSION**

The children had household contact with adults having active TB was potential risk TB infection in children. The presence of Mycobacterium tuberculosis is a major factor causing tuberculosis. Poor environmental factors such as poor ventilation, high humidity, poor natural lighting cause the presence of Mycobacterium tuberculosis in the air longer and have a greater risk of Mycobacterium tuberculosis infection. Moreover, a high occupancy density in a house and a large number of household members causes more frequently contact and increased risk infected Mycobacterium tuberculosis.

In conclusion that environmental factors of home include ventilation, natural light , humidity, occupancy density are significantly associated TB infection among children and household contact with adults having active TB. They are potential increased risk of TB infection in children in poor environmental. Break the chain of transmission of Mycobacterium tuberculosis by minimizing and even killing the presence of Mycobacterium tuberculosis in the air through ventilation and natural lighting.

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**Table I: The risk faktor of children tuberculosis infection based on research in several country**

Country	Indonesia	India	Pakistan	Kenya	Thailand	Malawi	Brazil	Vietnam
Household contact TB case	√	√	√	√	√	√	√	√
Crowding	√	√	√	√	√	√		
Natural light	√							
Humidity	√	√						√
Ventilation	√	√	√		√			√
Indoor pollution		√	√					
Knowledge	√	√					√	

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## EXTENDED ABSTRACT

# A Systematic Review on the Effectiveness of Biological Larvaside the Vector Control Efforts in Dengue Fever Disease

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### SUMMARY

The use of temephos as larvasida in the prevention of the disease dengue fever in Indonesia has already lasted for 40 years. Currently the most widely used larvacide for controlling *Aedes* sp larvae is 1% temephos. The use of insecticides for a long time for the same targets provides unmatched pressure, which encourages the development of the population of *Aedes aegypti* to become more resistant faster. One effort to overcome this problem is to find a more selective and safe biological insecticide. Biological insecticides are interpreted as an insecticide whose basic ingredients come from plants that contain chemicals (bioactive) that are toxic to insects but are biodegradable in nature, so they do not pollute the environment and are relatively safe for humans, besides biological insecticides are also selective.

**Keywords:** Biological larvaside, Vector control, *Aedes aegypti*

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### INTRODUCTION

Dengue hemorrhagic fever (DHF) is a vector-borne disease caused by the Dengue virus of the genus *Flavivirus*, family of *Flaviviridae*. DHF is transmitted to humans through the bite of the *Aedes* sp mosquito infected with the dengue virus [1,2].

Drugs and vaccines to prevent dengue fever have yet to be found. One way to control the disease is to control the vector by deciding the life cycle of the mosquito using larvacide and insecticide. Currently the most widely used larvacide for controlling *Aedes* larvae is 1% temephos (Abate). The use of insecticides for a long time for the same targets provides unmatched pressure, which encourages the development of the population of *Aedes aegypti* to become more resistant faster [3,4].

There are four vector control methods, one of which is a method of biological control using natural ingredients [23]. The use of plants to control insect pests has been widely used by traditional communities of antiquity [24]. As with Lemongrass oil has many widely used as insect repellent with secondary metabolites it generates. Based on this, larvasida is a natural for this much attention of researchers to continue to develop research-based insecticides that can be used as a controller of the vector *Aedes aegypti*. Vegetable insecticides currently has many contribute meaningfully to a new alternative

in improving public health, especially in the decrease in the number of diseases that many posed by vector mosquito [12,26].

Indonesia has a very diverse flora, contain pretty much the type of vegetation that is the source of the material the insecticides can be used to control vector. The purpose of writing this article is to examine the diversity of plants in Indonesia that have been tested as larvicides *Aedes* that gives an overview of research results, and follow-up for implementing vector control programs.

### MATERIALS AND METHODS

Journal Articles were identified through online databases, searching engines. All unrelated studies were excluded, and duplicated studies removed. The remaining Journal Articles were reviewed restaurants one by one in full text. The inclusion criteria applied for eligibility assessment of full-text Articles were: study the method of extraction plants, a compound that contained vegetable Also the effectiveness of larvicides against the death of the larvae. and published between January 2008 and December 2016. Reviews These plants contain essential oils, saponins and flavonoids, the which are effective as larvicides.

### RESULTS

After the screening process, only 10 journal articles were selected as shown in Table I and Table II

To measure the toxicity level of a compound can be used some measurements, namely LC50 (Lethal

**Table I:** Types of plants tested As larvicides and the content of its compounds are on various Research

Ref-er-ence	Plant name	Part used	Compounds	Effectiveness in the control of Aedes sp (Vector DHF)
[5]	White Turmeric ( <i>Curcuma zedoaria</i> )	rhizome	Essential oil	Effective as larvicides
[6]	Trees Tanjung ( <i>Mimusops Elengi L.</i> )	rod	Alkaloids, tannins, saponins	Effective as larvicides
[7]	Jatropha ( <i>Jatropha curcas</i> )	Seed	piperine	Effective as larvicides
[8]	Cloves ( <i>Syzygium aromaticum L</i> )	Leaf	eugenol, saponins, flavonoids and tannin	Effective as larvicides
[9]	Kaffir Lime ( <i>Citrus hystrix</i> )	Leaf	Essential oils, flavonoids, saponins, and terpenes	Effective as larvicides
[9]	Lime ( <i>Citrus amblycarpa</i> )	Leaf	Essential oil	Effective as larvicides
[9]	Pomelo ( <i>Citrus Maxima</i> )	Leaf	Essential oil	Effective as larvicides
[10]	Beet ( <i>Beta vulgaris L</i> )	Fruit	Flavored alkaloids, sterols, triterpenes, saponins and tannins	Effective as larvicides
[11]	Betel ( <i>Piper betle Linn.</i> )	Leaf	Tannins, saponins, alkaloids, polyphenols and flavonoid	Effective as larvicides
[12]	Fragrant pandan ( <i>Pandanus amaryllifolius (Roxb)</i> )	Leaf	alkaloids, saponins, flavonoids, tannins, and polyphenol	Effective as larvicides
[13]	Aloe Vera ( <i>Aloe vera</i> )	Leaf	saponin, flavonoids, tannins	Effective as larvicides
[14]	Legundi ( <i>Vitex trifolia</i> )	Leaf	saponins, flavonoids and alkaloids, Essential meek	Effective as larvicides

**Table II :** Plant name and Extraction Methods Used in Various Research

Plant name	The extraction method	The effectiveness of Substance For Vector Control DBD
White Turmeric ( <i>Curcuma zedoaria</i> )	Distillation / evaporation	Essential oil potential as larvicides because it is known to be toxic in a wide pH range, stable to light and heat, and do not form a permanent coating on the surface of the water for a long time <sup>[5]</sup> .
Trees Tanjung ( <i>Mimusops Elengi L.</i> )	Reflukd and fractionation	Hexane proved to be the most active extracts due kills 100% of larvae at concentrations less than 100 ppm for 24 hours <sup>[6]</sup> .
Jatropha ( <i>Jatropha curcas</i> )	Oil Seeds Jatropha obtained from <i>Surfactant and Bio-energy The research Center (SBRC) IPB Bogor</i>	The active compounds are suspected as larvicidal <i>Aedes aegypti</i> is piperine is an alkaloid class of piperidine <sup>[7]</sup> .
Cloves ( <i>Syzygium aromaticum L.</i> )	Percolation (the leaves are dried then crushed and extracted)	Saponins, flavonoids and tannins in clove leaf extract act as larvicides against <i>Aedes aegypti</i> . Through the mechanism of cell membrane damage or interfere with the metabolic processes of larvae and as stomach poisoning <sup>[8]</sup> .
Kaffir Lime ( <i>Citrus hystrix</i> ), Lemons oranges ( <i>Citrus amblycarpa</i> ) and Pomelo ( <i>Citrus Maxima</i> )	Dried leaves for 1 month and then made powder. The powder is then macerated with methanol and evaporated	Saponins in the extracts were swallowed by the larvae of <i>Ae. aegypti</i> can irritate the digestive tract mucosal larvae of <i>Ae. aegypti</i> and <i>Ae</i> larvae damage the cell membrane. <i>aegypti</i> . Limonoid which is an essential oil in orange can lead to a loss of coordination of the larva <i>Ae aegypti</i> larvae <sup>[9]</sup> .
Beet ( <i>Beta vulgaris L</i> )	Milled and dried fruit pulp to form a powder. The powder was extracted by percolation method. Extract Concentrated with using evaporator	Phenol, alkaloids, flavonoids, saponins, sterols and triterpenes in fruit extracts Beet ( <i>Beta vulgaris L.</i> ) together and cause death in larva <i>Ae aegypti</i> <sup>[10]</sup>
Betel ( <i>Piper betle Linn.</i> )	Powder	The toxic polyphenols, tannins, flavonoids, essential oils, saponins and alkaloids when contact with the larvae will damage the mucosa of the skin and enter the body cavity <sup>[11]</sup> .
Fragrant pandan ( <i>Pandanus amaryllifolius Roxb.</i> )	How research work started from making fragrant pandan leaf extract by percolation	Alkaloids, saponins, flavonoids, tannins, and polyphenols. Saponins can damage cell membranes and interfere with the metabolism of the larvae while polyphenols as larvae digestive inhibitor <sup>[12]</sup> .
Aloe Vera ( <i>Aloe vera</i> )	-	Saponins and flavonoids, which are compounds of plant defenses that can be Inhibit larval digestive tract and also is taxed <sup>[13]</sup> .
Legundi ( <i>Vitex trifolia</i> )	Preparation of test solutions in the form of using the leaf Legundi extract ( <i>Vitex trifolia</i> ) and solvent in the manufacture of test solutions in the form of 96% ethanol and extraction by maceration to obtain a concentration of 100%. then extract Legundi leaf is diluted using distilled water so as to get the concentration of the extract.	Saponins, flavonoids, and alkaloids are toxic substances for larvae resulting in test larvae deaths <sup>[14]</sup> .
Neem ( <i>Azadirachta Indika A.Juss</i> )	Extraction is done by maceration method using ethanol solvent	Components of compounds that are organic acids that are hexanoic acid, stearic acid, oleic acid, ethyl oleate, oktadecanoic acid, ethyl oktadecanoate, Dioktil heksadioat. It is suspected that the above compounds are antilaracids against the <i>Aedes aegypti</i> mosquito larva <sup>[15]</sup> .

Concentration 50%), LD50 (Lethal Dose 50%) and ED50 (Efective Dose 50%). LC50 is a concentration that can lead to death of 50% of animal experiments during a certain time. LD50 is the dose required to kill 50% of test organisms. ED50 is a dosage of 50% of

test organisms exposing real activits effects. A crop or insulating result is considered to exhibit toxicity activity when it has a small LC50 value of 1000 ppm, whereas for pure compounds it is considered to exhibit toxicity activity if it has a small LC50 value of 200 ppm [15].

**Table III** : Effective Dose Some Larvasida Biological For Vector Control DBD At Some Research <sup>[5, 6,7,8,9,10,11,12,13,14,15]</sup>

Plant name	Total samples	Total repeat	LC50 (24 Hours)	LC95 (24 hours)
White Turmeric ( <i>Curcuma zedoaria</i> )	25	4	54.5 ppm	
Trees Tanjung ( <i>Mimusops Elengi L.</i> )	10	3	59.36 ppm	
Jatropha ( <i>Jatropha curcas</i> )	25	5	1507 ppm	
Cloves ( <i>Syzygium aromaticum L.</i> )	25	4	400 ppm	
Kaffir Lime ( <i>Citrus hystrix</i> )	20	5		3,176
Lemons oranges ( <i>Citrus amblycarpa</i> )	20	5		4174
Pomelo ( <i>Citrus Maxima</i> )	20	5		6,369
Beet ( <i>Beta vulgaris L</i> )	25	3		
Betel ( <i>Piper betle Linn</i> )	20	5	314.4 ppm	
Fragrant pandan ( <i>Pandanus amaryllifolius Roxb</i> )	25	4	9000 ppm	
Aloe Vera ( <i>Aloe vera</i> )			10000 ppm	
Legundi ( <i>Vitex trifolia</i> )	25	4	8370 ppm	
Neem ( <i>Azadirachta Indika A.Juss</i> )	10	1	282.29 ppm	

Description: The LC50 is the concentration of an insecticide (usually in food, air or water) to kill 50% of the experimental animals. LC50 is usually expressed in mg/L or mg/insects. The smaller the value of LD50 or LC50, the more toxic the insecticide. Animals used to determine the value of the toxicity of insecticides usually mammals such as mice.

Following table III The description of the effective dose of some of the biological larvacide research results for the control of DBD vector.

## DISCUSSION AND CONCLUSION

These plants above average contains essential oil compounds, saponins and flavonoids. Saponin is a surface active compound and is soap-like, and can be detected based on its ability to form a foam if shaken in water and hams blood cells [17]. Saponins can damage cell membranes and interfere with the metabolism of insects while polyphenols as inhibitors of insect digestive. Some saponins work as an antimicrobial. Saponins work as an antibacterial to destabilize the bacterial cell membranes causing cell bakterilisis [18].

Flavonoids are known to have antioxidant activity and teratogenic substances. Flavonoids play an important role in forming pigment plant as yellow, red or blue on the petals. Flavonoids also have antimicrobial activity and insecticidal [19].

Extraction is the most common terms to obtain a compound derived from a mixture obtained from the contact between the solvent with dissolved compounds in the material that we wanted. Solvent mixture with the compound may be solids or liquids, and a variety of techniques and measuring instruments used for different situations. Inorganic chemical synthesis, reaction continuously produced is in the form of a solution or suspension form. When stirring the mixture of water with an organic solvent, the resulting product was transferred to the solvent coating and may be repeated with the evaporation of the solvent. Variety is certainly the right extraction depends on the texture and water content of the material extracted plant material on the types of compounds isolated. Generally, we need to kill

the plant tissue to prevent the enzymatic oxidation or hydrolysis. Submerge the fresh leaves or flower network, if necessary, cut into pieces, into the boiling methanol is a good way to achieve that goal. Alcohol, in any way is a good solvent for the extraction preliminary versatile. Furthermore, the material can be macerated in a grinder, and then filtered. But this is utterly inconceivable only required if we want to extract out [20].

Maceration is a crude drug screening process using a solvent with soaking and some time shaking or stirring at room temperature (room). It will penetrate the cell wall and into the cavity of cells containing an active substance that will dissolve, because of differences in the concentration of a solution of the active substance in the cell and outside the solution of the cell is concentrated out. This process is repeated so that a proper balance between the solution concentration inside and outside the cell. Liquid filters used may be water, ethanol, methanol, ethanol-water or other solvents. Remaserasi means the addition of solvents after the first macerate filtering, and so on [20,21,27].

The studies mentioned above use an average of the samples (larvae) of 20-25 tail with 4-5 times the treatment. Larviciding said to be effective if it can turn off 90-100% of larvae test [22]. A compound is said to be active in the test larvicides with a maximum concentration of 1000 ppm. If you have an LC50 ≤ 500 ppm and said to be active if it has LC50 > 500 ppm, whereas pure compounds said to be active and have bioactivity properties if it has LC50 ≤ 50 ppm and inactive if the LC50 > 200 ppm [23,25,26,27]. There are Several limitations to acknowledge in this review. Biological larvicides which contain essential oils, saponins and flavonoids effective as larvicides and extraction method most widely used is meserasi with ethanol solvent. There needs to be more research about the making of a good formula that can be

used by the people as larvicides. The authors would like to thank Universitas Airlangga for the funding support. Also Monika Noshirma, Ruben Wadu Willa at Loka Litbang P2B2 Waikabubak-Indonesia

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## EXTENDED ABSTRACT

# The Effect of Organophosphate Pesticide Exposure: A Case Study in Vegetables Farmers in Junrejo, Batu, Indonesia

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### SUMMARY

Exposure to organophosphate pesticides even in a short term could inhibit the activity of cholinesterase enzymes. Pesticides accumulated in a long term, it would cause damage to the liver through biotransformation. Impaired liver function due to organophosphate pesticides could be observed from the enzymes that were excreted by the liver cells (hepatocytes) into the blood. This impaired liver function could be observed from the activity of some enzymes. The levels of Serum Glutamic Oxaloacetic Transaminase (SGOT), Serum Glutamic Pyruvic Transaminase (SGPT), and Alkaline Phosphatase (ALP) were higher in the groups which exposed to organophosphate pesticides. In this study we analyzed the correlation of organophosphate exposure with Serum Glutamic Pyruvic Transaminase (SGPT) and Alkaline Phosphatase (ALP) on vegetable farmers in Torongrejo, Junrejo, Batu. This research is an analytical study with a cohort retrospective design research. Thirty farmers who exposed to pesticides organophosphate and 30 participants as a comparison were recruited using simple random sampling method. Questionnaire, observation sheets, and examination laboratory blood sample were used as research instruments. Blood samples were analyzed for a number of parameters including SGOT, SGPT and ALP. The results showed that there was no significant correlation ( $P>0,05$ ) of knowledge, duration of spraying, working time, frequency spraying, completeness personal protective equipments, a dose of pesticides, and the number of pesticides with SGPT and ALP. Yet, there was a significant correlation with ( $P<0,05$ ) between toxicity organophosphate pesticides with ALP, although there is no significant correlation with SGPT. This research concludes that farmers are expected to use personal protective equipments during pesticide spraying activities in order to minimize the impact on health in particular on farmers liver function.

**Keywords:** Organophosphate, Pesticide, Exposure, Effect on liver function

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### INTRODUCTION

Organophosphate are highly toxic insecticides but easily decomposed by nature. Organophosphate functioned as stomach poison, contact poison, and some of them are neurotoxin [1]. Exposure to organophosphate pesticides even in a short term could inhibit the activity of cholinesterase enzymes. If the pesticides accumulated in a long term, it would cause damage to the liver through biotransformation. Impaired liver function due to organophosphate pesticides could be observed from the enzymes that were excreted by the liver cells (hepatocytes) into the blood. This impaired liver function could be observed from the activity of some enzymes. The levels of Serum Glutamic Oxaloacetic Transaminase (SGOT), Serum Glutamic Pyruvic Transaminase (SGPT), and Alkaline Phosphatase (ALP) were higher in the groups which exposed to organophosphate pesticides [2]. The SPGT enzyme was more specific on impaired

liver rather than SGOT. Basically, the SGPT and SGOT enzymes were normally located in the liver so that the increase and decrease activity could be the indicator of liver function disruption. The impaired liver would cause the enzyme released into the bloodstream so that blood levels increases and indicates the presence of impaired liver function [3].

### MATERIALS AND METHODS

This is an analytical research using cohort retrospective research design. There were two populations in this research; farmers who worked in the vegetable plantation in Krajan, Torongrejo village, Junrejo, Batu as the exposed group and non-peasant population as the comparison group. Thirty participants were recruited in each of the exposed and comparison group using simple random sampling. The instruments used in this study are questionnaires and observation sheets containing the dosage, amount of pesticide used, toxicity, spraying time, spraying frequency, and the complete use of personal protective equipment (PPE) [13]. Micro lab 300 is a instrument was used to measure SGPT and ALP. The data analysis is conducted by using Linear Regression

statistic test with  $\alpha = 0.05$  with IBM SPSS 21.0.

## RESULTS

### **The Results Measurement of Serum Glutamic Pyruvic Transaminase (SGPT) and Alkaline Phosphatase (ALP)**

The measurement of SGPT levels in the exposed group were varied from 14.66 U/L to 31.93 U/L. In the comparison group, the lowest measurement of SGPT levels was 10.96 U/L and the highest was 46.77 U/L. As for Alkaline Phosphatase (ALP), the measurements in the exposed group ranged from 109 U/L to 269 U/L, while the comparison group ranged from 21 U/L to 231 U/L.

### **Correlations of Farmer's Characteristics with Glutamic Pyruvic Transaminase Serum and Alkaline Phosphatase in Torongrejo Village, Junrejo, Batu**

Knowledge in this case is defined as the understanding of farmers related to proper usage of pesticide. The results of this study indicated that 60% of farmers know the proper way of using pesticides and the rest (40%) do not know about that. The result of correlation analysis showed that there was no correlation between knowledge and SGPT and ALP.

The spraying time is defined as how many times did the farmers spray the pesticides. The results of this study indicated that there were 45% of farmers who sprayed for 1-2 hours/day and 55% of farmers who sprayed for 3-4 hours/day. The result of bivariate analysis showed that there was no correlation between spraying time or with SGPT and ALP. The duration of spraying in this study was calculated by the time to complete a spraying activity. In average the farmers spent 1 - 2 hours for spraying and conducted in the morning (06.00 am - 08.00 am) and afternoon (03.30 pm - 05.30 pm).

The period of work is defined as the time a person starts to become a pesticide sprayer and calculated from the first time of spraying until the research conducted. The results of this study indicated that there were 90% of the farmers who worked for  $\geq 20$  years and 10% of farmers who worked for 16-19 years. The result of bivariate analysis showed that there was no correlation between the period of work with SGPT and ALP.

The frequency of spraying is defined as the frequency of pesticide spraying done by farmers in a week. The results of this study indicated that there were 90% of farmers sprayed 2-3 times a week and 10% of farmers sprayed 4-5 times a week. The result of bivariate analysis showed that there was no correlation between spraying frequency with SGPT and ALP. Majority of the vegetable farmers in the village of Torongrejo sprayed 2 - 3 times a week.

Completeness of PPE is defined as a set of tools used by farmers to protect them from the toxins enter to the body. The results of this study indicated that 60% of

farmers did not use the complete set of PPE and 40% of them used complete set of PPE. The result of bivariate analysis showed that there was no correlation between the completeness of PPE with SGPT and ALP. Majority of the farmers only used trousers, long sleeves, and hats as PPE, while the masks, gloves, boots, and glasses were never used.

### **The Correlation of the Usage of Pesticide with Serum Glutamic Pyruvic Transaminase and Alkaline Phosphatase on vegetable farmers in Torongrejo, Junrejo, Batu**

Pesticide dosage is defined as the dosage of pesticides used by the farmers in mg/ha. The results of this study indicated that 50% of the farmers did not use pesticides according to the proper dosage and the rest (50%) used according to the proper dosage. Bivariate analysis in this study showed that there was no correlation between of pesticides dosage with SGPT and ALP.

The number of pesticides is defined as the total number of pesticides used in spraying. The results of this study indicated that 35% of the farmers used more than 4 types of pesticides in one blend and the rest (65%) use 3-4 types in one mixing. The result of bivariate analysis showed that there was no correlation between the number of pesticides with SGPT and ALP. In general, the farmers used 4 types of pesticides in one spray, while the agriculture agency of Batu City advised that the spraying should be conducted with only one type of pesticide in a single spray.

Toxicity is defined as potential toxicity posed by pesticides in causing death of animals and also humans. The results showed that 55% of the farmers used pesticides with high toxicity level and the rest (45%) used it with medium toxicity level. The result of bivariate analysis showed that there was no correlation between toxicity and SGPT. However, result show that there was a correlation between toxicity and ALP. LD50 or toxicity of pesticides was known from the active ingredient of organophosphate pesticide used, and also from the WHO regulation in 2009 [4] regarding pesticide classification.

## DISCUSSION AND CONCLUSION

The exposure to toxic substances could be seen based on its path, for example the exposure paths for humans and other animals were through the skin (percutaneous route), lung (inhalation), and oral route [10]. The lungs were most likely to inhale toxic gases, inhale both liquid and solid particles. In addition to inhalation, solid toxic substances could enter the body in oral ways. Skin absorption is also likely to occur for liquid toxic substances. This is supported by the use of personal protective equipment used by the farmers. It was known that every time in spraying, the farmers always use long sleeves that could reduce about 80% exposure to

pesticides.

Stated that the wearing of long-sleeved clothing in pesticide-related workers could protect about 80% of exposure, the use of chemical and oil-resistant gloves and pesticide solvents would be more effective since it protect 90% when handling the liquid pesticides, and 95% when holding the solid pesticides or powders [9]. Wearing gloves could avoid exposure to pesticides in dermal or skin. The use of masks could be used as a filter to the contaminated air. The use of masks could also protect them from pesticide exposure by 90% and avoid exposure to dermal and inhalation.

5 hours/day or 30 hour/week were the working period conditions of pesticide risk poisoning in a working place[4]. The long exposure of spraying done by vegetable farmers in this area was still qualified by WHO. Therefore, there was no significance between the duration of spraying and SGPT farmers since the pesticides exposure was less. ALT/SGPT levels in exposed groups to organophosphate pesticides for 2-30 years had an average with 41.22 U/L with a significance of  $P > 0.005$  which means there was no correlation between length of service and SGPT [5]. Pesticide spraying with high frequency would cause a big effect, because there would be resistance and resurgence on pests and plants. The different conditions occurred in this study might be due to the mixing of some pesticides types that might be able to kill toxic substances existed in other pesticides, thus, it would decrease the effect of the toxic substance. According to Mukono (2005), the chemical interactions could cause some effects for humans when exposed to such as additive, synergistic, potential and antagonistic effects [10].

ALP is used as an assessment of cholestasis and biliary obstruction or hepatic infiltration. Cholestasis is a disorder of the bile glands, therefore, the gall glands could not function properly or disturbed[12]. Liver damage, ALP would slightly rise and a huge increase would be occurred in acute liver disease[13]. In addition to assessing the presence of disorders of liver function, ALP could also be used as an indicator of bone abnormalities. Toxicity is a potential caused by pesticides to cause death in high animals category and also humans. In this study, pesticides were often used with active ingredient; chlorpyrifos (LD50 135 mg/kg), profenovos (LD50 358 mg/kg), and acephate (LD50 945mg/kg). Each has high toxicity for chlorpyrifos and profenovos seen from dermal LD50 and medium for acephate seen from dermal LD50. These were occurred because the high possibility of pesticides could enter into the body of farmers through the skin.

It is concluded there was no correlation between spraying duration, work period, frequency of spraying, completeness of PPE, and knowledge of Serum Glutamic Pyruvic Transaminase (SGPT) and Alkaline Phosphatase

(ALP). There was no correlation on pesticide use which included dose, amount of pesticide, and toxicity with Serum Glutamic Pyruvic Transaminase (SGPT). There was no correlation on pesticide use which included dose, amount of pesticide, and toxicity with Alkaline Phosphatase (ALP). There was correlation between toxicity and Alkaline Phosphatase (ALP).

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## EXTENDED ABSTRACT

**Reduction of Lead (Pb) in *Kangkung Darat* (*Ipomoea reptans*) and *Kangkung Air* (*Ipomoea aquatic*): A Systematic Review**

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**SUMMARY**

*Kangkung* consumed by people as a source of vitamins and minerals. *Kangkung* darat (*Ipomoea reptans*) which grows into the thoroughfare be polluted the surrounding air, because Pb is polluted by smoke from vehicles passing through road, the presence of the nearby factories also released original results its production. *Kangkung air* (*Ipomoea aquatic*) that grows in the river or watering place, therefore many are planted near streams and watered by the river water. If the river polluted with heavy metals, then most likely the plants that grow there, too polluted. This study aims to discover a method to reduce the content of heavy metals lead (Pb) in *Kangkung darat* (*Ipomoea reptans*) and *kangkung air* (*Ipomoea aquatic*). This study is a review journal. Of the 34 journals that review that examines the heavy metal pollution of lead (Pb) in *kangkung*, retrieved four journals that conduct research to reduce the content of heavy metals lead (Pb) in *kangkung*. Of the 34 articles in the review obtained that *kangkung darat* (*Ipomoea reptans*) and *kangkung air* (*Ipomoea aquatic*) water polluted by heavy metals lead (Pb). There are 4 articles that contains methods to reduce the content of Pb in *kangkung* is to boil the *kangkung* and harvesting will be consumed at the age of 3 weeks. To reduce the content of heavy metals lead (Pb) in *kangkung* can be made by boiling and harvest the sprouts at the age of 3 weeks. Further research done by doing modifications to reduce the content of heavy metals lead (Pb) in *kangkung*.

**Keywords:** Prevention, Heavy metals lead (Pb), *Kangkung darat* (*Ipomoea reptans*), *Kangkung air* (*Ipomoea aquatic*)

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**INTRODUCTION**

In a prolonged period of heavy metals can cause environmental damage because it can be toxic to plants, animals and humans. It is the nature of metal namely have the ability damage. The level of pollution of heavy metals (Pb) high is usually found in the environment of human activity high [1]. Because of the environmental pollution of Pb in the great, then the food consumed, drink water and air that is inhaled is likely to have been contaminated by Pb, so lead, also known as non essential trace element simply applied the most high in the human body. Contamination of river water by factory waste containing Pb causing plant growing consumption in the area of the river being polluted by Pb [9].

Rukmana (2000) mentions that in Indonesia, there are two types of *kangkung*, that is, *kangkung darat* (*Ipomoea reptans*) and *kangkung air* (*Ipomoea aquatic*) that grow naturally in the middle of rice paddies, swamps or trenches. An important part of the *kangkung* leaves and

young stems are as vegetables [3]. Other research has also found the content of the heavy metals lead (Pb) in *kangkung*. Nurul, et al (2017) found that the content of the heavy metals lead (Pb) in *kangkung darat* (*Ipomoea reptans*) was 0.0591 ppm, which is much higher than the *kangkung air* (*Ipomoea aquatic*) 0.0457 ppm [1]. Joseph, et al (2016), that the content of the heavy metals lead (Pb) *kangkung darat* (*Ipomea reptans*) as much as 5 mg/kg [4]. *Kangkung* and water in Sleman, Yogyakarta contain Pb, reflected by the presence of heavy metals (Pb) on the leaves, roots, stems, and water in each 3.9; 2.84; 0.57; and 19.8 mg/Kg [6]. Another study found that the average content of lead (Pb) in *kangkung* was 1.494 and 1.241 ppm [7]. Mimin (2015), found *kangkung air* (*Ipomoea aquatic*) positively had metals lead (Pb) from 0.0122 ppm; 0.01980 ppm and 0.0343 ppm [8].

Because of heavy metal polluted *kangkung* (Pb), there is a need to find a method to decrease the content of heavy metals lead (Pb) in *kangkung darat* (*Ipomoea reptans*) and *kangkung air* (*Ipomoea aquatic*).

**MATERIALS AND METHODS**

The methods used in this review is looking for journals or articles published from anywhere and anytime. All titles, abstracts, contents and conclusions of the article in the

form of the language of Indonesia as well as the United Kingdom. Books, manuals, theses and articles related to testing the content of heavy metals lead (Pb) in *kangkung darat (Ipomoea reptans)* and or *kangkung air (Ipomoea aquatic)*, methods or ways to reduce the content of heavy metals lead (Pb) in *kangkung darat (Ipomoea reptans)* and or *kangkung air (Ipomoea aquatic)*. We choose articles that his research is experimental methodology/ laboratory analysis. Whereas the criteria we set is (1) the sample used is *kangkung darat (Ipomoea reptans)* and or *kangkung air (Ipomoea aquatic)*, (2) the results of testing the content of heavy metals lead (Pb) in *kangkung*, (3) the existence of a method or how to reduce the content of heavy metals lead (Pb) in *kangkung*. The article also described how used to measure the content of Pb in *kangkung*, a number of treatments are made, and the method used to reduce the content of heavy metals lead (Pb) in *kangkung*. Is the author of the first and second are independent researchers, data extracted or derived from data required all studies that have been done. The third author helped give input in the making of this article. The data and information that are taken are as follows: (1) the author, (2) journal (3) the year of publication, research design (4), (5) years of research, and the main findings (6) of the publication is eligible for in the systematic review. The data retrieved is typed in Microsoft Excel table is created so that the 2018 to make it easier to analyze. In this study, the sample used was not of humans and animals.

Data collected through search database (N = 34):

- 1) Garuda.ristekdikti.go.id (n=14)
- 2) Researchgate.net (n=18),
- 3) Plos one (n=1)
- 4) E-journal (n=1)

From the literature, found 34 journal 4 can be used to address existing problems. Figure 1 illustrates the PRISMA chart for the journal articles removed from the searching result followed by another journal articles excluded because of not meeting the inclusion criteria. After the screening process, only 9 journal articles could be reviewed in full text. Then, after another screening process, only 4 journal articles were selected

**RESULTS**

Summary of Reduction of Lead (Pb) in *Kangkung Darat (Ipomoea reptans)* and *Kangkung Air (Ipomoea aquatic)* was shown in Table I.

In a systematic review has been done, is obtained that the way to reduce the content of heavy metals lead (Pb) in *kangkung*:

- a. Age of plant *kangkung* is harvested while reducing the metal content of lead (Pb). Indrajati, et.al. (2005) found that after testing the content of Pb in plants without roots retrieved content of lead (Pb) in *kangkung darat (Ipomoea reptans)* which are harvested at age 3 weeks is 1.86 mg/kg, while that are harvested at age 6

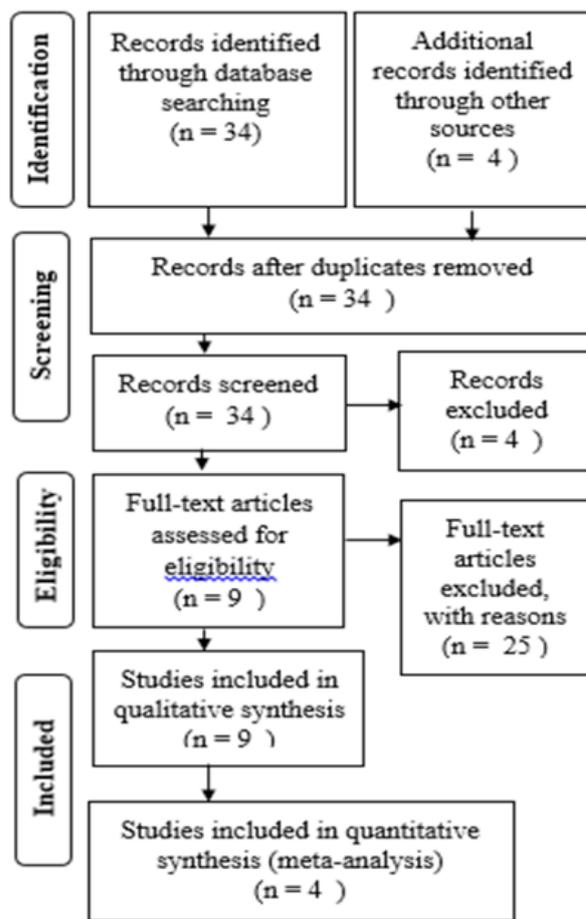


Figure 1: PRISMA flow chart of search process [12]

the week contains Pb of 2.09 mg/kg wet weight. The maximum limit allowed in vegetables and petrol results is 2 mg/kg of vegetables [9].

The content of Pb in the plant sprouts that grow on contaminated Pb media continuously, and are harvested at age 6 weeks higher than in plants that are harvested in 3 weeks, and the largest Pb accumulation occurred in roots of plants *kangkung*. To minimize contamination of Pb in *kangkung* that consumed it is recommended that *kangkung* is harvested maximum at the age of 3 weeks, although preferably sought to minimize contaminants [9].

- b. Boil the *kangkung* reduce the levels of metals lead (Pb). Research conducted Indrijati, (2005) in *kangkung darat (Ipomoea reptans)* is obtained from the statistical analysis it appears that the content of Pb in *kangkung* boiled after water boils (0.294 mg/100 g) is greater than the boiled *kangkung* before the boiling water (0.272 mg/100 g).

Boiling the stems or leaves of the *kangkung* contaminated with metal Pb content Pb can reduce in the leaves or stems of *Ipomoea aquatica*. Boiling *kangkung* by entering into the water at room temperature before it is boiled it turns more remove Pb from inside the *kangkung*

**Table I: Summary of Reduction of Lead (Pb) in *Kangkung Darat (Ipomoea reptans)* and *Kangkung Air (Ipomoea aquatic)***

Author & Year	Methodology	Reduction of Lead (Pb) in <i>Kangkung Darat (Ipomoea reptans)</i> and <i>Kangkung Air (Ipomoea aquatic)</i>
Indrijati et al 2004	Ingredients : <i>Kangkung Darat (Ipomoea reptans)</i> Measurement Tools : <i>Inductively Coupled Plasma Spectrometer (ICPS)</i>	Average levels of Pb part <i>kangkung</i> after boiling, on leaf 0.264 mg/100 gr, on the stem 0.042 mg/100 gr.
Indrijati et al 2005a	Ingredients : <i>Kangkung Darat (Ipomoea reptans)</i> Measurement Tools : <i>Inductively Coupled Plasma Spectrometer (ICPS)</i>	1. The average levels of Pb in all parts of the plant <i>kangkung</i> 3 weeks 1.13 mg/g, and average levels of Pb in roots of 3 1.13 mg/g 2. All parts of the plant <i>kangkung</i> without root 6 week 2.09 mg/g and an average rate of Pb on root 6 weeks 3.36 mg/g
Indrijati et al 2005b	Ingredients : <i>Kangkung Darat (Ipomoea reptans)</i> Measurement Tools : <i>Inductively Coupled Plasma Spectrometer (ICPS)</i>	1. Levels of Pb in <i>kangkung</i> (leaves and stems) after inclusion in water at room temperature, then simmer for 5 minutes 0.272 mg/100 gr. 2. Levels of Pb in <i>kangkung</i> (leaves and stems) after put in boiling water, then continue boiling for 5 minutes 0.294 mg/100 gr.
Lani et al 2012	Ingredients : <i>Kangkung Air (Ipomoea aquatic)</i> Measurement Tools : <i>Atomic Absorption Spectrometry (AAS)</i>	Average levels of Pb (identifikasi) 1.494 and 1.241 ppm, with <i>kangkung</i> boiling treatment on levels of Pb ranges between 1.197-1.302 ppm

compared entering into boiling water before boiled [11]. In addition, Indrijati (2004) has been conducting experiments in the time of boiling also added acetic acid or NaCl turns result does not reduce the content of Pb in leaves and stems of *kangkung* as much as much caused by without the addition of NaCl [10].

Lani, et. al, (2012) that to reduce the content of Pb in *kangkung* is done for 3, 5, 7 and 9 minutes. The result is an optimal time to boil the vegetables without reducing the nutrient content and somewhat reduced levels of Pb with boiling the *kangkung* for 5 minutes (after boiling water) [7].

## DISCUSSION AND CONCLUSION

Based on systematically review, showed that the rate of content of Pb in *kangkung darat (Ipomoea reptans)* and *kangkung air (Ipomoea aquatic)* water can be reduced by doing the boiling and harvest the sprouts at the age of 3 weeks. Future expected to doing research for other methods that can reduce the content of Pb in *kangkung* or by modifying existing methods such as add, they add an other material in the processing of *kangkung* so the content of Pb in *kangkung* can be reduced below the threshold and content of Pb that is recommended for the vegetables.

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## EXTENDED ABSTRACT

# Physical Environmental Factors of Diphtheria in Indonesia: A Systematic Review of the Literature

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### SUMMARY

Diphtheria was caused by *Corynebacterium diphtheriae* bacteria. The number of diphtheria cases in Indonesia in 2017 was 954 with the number of deaths of 44 cases in 140 districts / cities in Indonesia. Diphtheria cases are influenced by several factors such as incomplete immunization status, and physical environmental factors. This study is a literature review category, by collecting scientific references related to the environmental factors that are associated with diphtheria events. The results of the review showed that the environmental factors observed in the occurrence of diphtheria includes temperature, humidity, lighting, occupancy density, home floor, ventilation and wall type. The factors that could provide a connection with diphtheria are unqualified standard of moisture, lighting, too many inhabitants which do not qualifies the house and types of floors (ceramic / plaster).

**Keywords:** Physical environmental, House, Diphtheriae

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### INTRODUCTION

Diphtheria is an acute infection commonly affecting the upper respiratory tract. It is caused by *Corynebacterium diphtheriae*, bacteria which transmitted by the respiratory droplets from an infected person or an asymptomatic carrier to a susceptible person [1]. Diphtheria generally affects children aged 1-10 years. During 2017, Disease Outbreaks occurred in 170 districts / cities and in 30 provinces, with the total 954 cases, with 44 deaths. In 2018 (up to 9 January 2018), there were 14 case reports from 11 districts / cities in 4 provinces (DKI Jakarta, Banten, West Java and Lampung), and fortunately of them were deaths cases [2].

Diphtheria spreads when an infected person coughs or sneezes. It spreads rapidly among close contacts. Rarely, the transmission might occur from skin lesions or articles soiled with discharges from lesions of infected persons (vomits). A person who does not receive treatment could spread the disease for about 2 weeks after infection [3]. There were 182 cases of diphtheria in Indonesia in 2009 and 2010 with 432 cases, 806 cases in 2011 and 1192 cases in 2013. In 2013, it decreased to 775 cases. Indonesia ranks as the second highest diphtheria case in the world below India (WHO, 2014). In Indonesia, the dispersed diphtheria is one of the health problems

that also spread all over the world [4]. Since diphtheria transmitted by direct contact or patient droplet [5], the spread of this droplet requires certain environmental conditions so that the bacteria in the droplet could immerse to the body and cause infection. Based on these phenomena, the literature review on the physical environmental factors of diphtheria in Indonesia was conducted.

### MATERIALS AND METHODS

We created a strategy to search all published studies with the keyword about environmental. factor keyword related to diphtheria. The search was limited to articles published between 31st January 2002 to 31st December 2018. The search was done in Respositori Ilmiah Indonesia and Scencedirect databases. The search terms combined terms and text words including "diphtheriae", "environment", and "Indonesia". The articles were methodologically diverse and comparative between descriptive studies, correlational, analytical studies, case-control studies and cross-sectional study. The data and information extracted such as 1) authors, 2) journal 3) year of publication and 4) key findings from publications that were eligible for inclusion in the final systematic review. The total articles that match qualify for the reviews are 6 journal articles.

### RESULTS

Based on the literature study, there were several environmental factors that have correlation with

diphtheria. These factors include temperature, humidity, lightning, people density in the house, type of floor of the house, ventilation and wall types. Some environmental factors have the conditions or within standard by Indonesian legislation of healthy house standard (Keputusan Menteri Kesehatan Republik Indonesia Nomor 829/Menkes/SK/VII/1999) and some were not. These environmental factors could or could not have an effect on the diphtheria. The summary of environmental factors with the outcomes effect could be seen in table I.

Humans are the main source of transmission of *Corynebacterium diphtheriae*. Each bacterium has an optimum temperature. At this optimum temperature, bacterial growth progresses rapidly. The Temperature affects the division of bacterial cells at a certain temperatures that do not fit bacteria's needs, thus, it could cause cell disruption [11]. Diphtheria germs are quite resistant to hot and cold air, also resistant to dust and a vomit for 6 months [12]. Diphtheria bacteria could die at 60 °C for more than 10 minutes. The disinfectants could easily kill these bacteria. Another characteristic of this bacterium, it could be dispersed with dust and killed to a direct exposure to the sunlight within a few hours [7,13]. Kartono mentioned that house temperature did not have significant relation with diphtheria occurrence, where the proportion of uncomfortable temperature in case (56,0%) and control (44,0%) did not look significantly different [6]. Humidity could be a risk factor associated with the occurrence of diphtheria, as stated

by Saifudin and Kartono's research. The humidity of the room in Saifudin's study was associated with diphtheria cases [7]. Houses or rooms that have bad humidity have a risk as much as 60 times greater for exposure to diphtheria than those that have a good humidity [7]. Diphtheria germs are resistant to high humidity, therefore, a wide range of eligible ventilation is required to reduce humidity and reduce these germs [8].

*Corynebacterium* species are gram positive non-motile rods, and their size is between 2-6 µm in length and 0.5µm in diameter [14]. The particles > 10 µm in diameter entering the air might rapidly fall out of the air because of their mass was under prevailing environmental conditions, especially temperatures and relative humidity, whereas the smaller particles could not only remain airborne for extended periods but could also be transported readily indoors by air currents over the considerable distances.

Respirable particles fall in the range of 0.2-5.0 µm in diameter, whereas the smaller particles were generally exhaled because of the aerodynamics breathing. The actual site of retention of the inhaled particles depends on their nominal size. It is noteworthy here that persons with respiratory infections, they breathe out pathogen-laden particles during the tidal breathing [15]. With environmental conditions such as exceed from standard condition of humidity and temperatures, it was possible that the bacteria could enter easily into the respiratory

**Table I: Summary of environmental factors with diphtheriae cases**

No	Variable	Correlation with Diphtheriae	No Correlation with Diphtheriae
1	Within temperature standard	-	-
	Exceed temperature standard	Uncomfortable, < 18 °C / > 30 °C [6]	-
2	Within humidity standard	-	-
	Exceed humidity standard	< 40% or > 70% [6] < 40% or >70% [7]	-
3	Within lightning standard	-	Natural lightning ≥3 hours [8]
	Exceed lightning standard	<60 lux or >300 lux [7]	Unnatural lighting [6]
4	Within peoples density in a house standard	-	-
	Exceed with peoples density in a house standard	58,7% respondent with 5-7 people in a house [9] Peoples density <4 m <sup>2</sup> [6,8,10]	
5	Ceramic/plaster		Ceramic [8]
	Board/Stage	Ground or Board [6]	
6	Within ventilation standard		
	Exceed ventilation standard		Exceed ventilation standard [8]
7	Plastered wall		Plastered [8]
	Non-plastered wall		Board [6]

tract. The type of house floor made from the board or stage could cause the increase of house humidity because it was not waterproof material and the effect of soil and high humidity of the house could affect a person's immune deficiency which further would increase the body's susceptibility to diseases, especially infectious diseases [6]. The results of this study was differed from Lestari research, in the bivariate analysis of floor types variables there was not significantly related to the occurrence of diphtheria. This was possible due to the majority of respondents in this study using ceramic floor in their houses [8]. Lighting is one factor that could be associated with bacterial growth. A lack of natural lighting might be associated with diphtheria [7], while the presence of natural lighting  $\geq 3$  hours a day did not give a correlation with the occurrence of diphtheria [8]. The light factor gave two different effects which caused by the difference in the amount of light intensity into the room, where in Lestari study, the majority of diphtheria cases occurred in natural lighting  $\geq 3$  hours [8]. Houses with poor lighting are 16.6 times more likely to get diphtheria than those with good lighting [7]. Good lighting could reduce air humidity [16].

The house lighting variables did not significantly correlate with diphtheria events. When the Sunlight comes only through the window and ventilation, thus, the room exposure to the sun (ultraviolet) was limited, the possibility would not be enough to reduce the room's humidity and the ability to kill germs becomes limited. House variables were not significantly associated with diphtheria occurrence due to the percentage of ineligible of ventilation in cases (56%) and control (44%) did not show a significant difference [6]. A healthy room must have a good natural lighting so that sunlight could enter easily and could kill microorganisms in the house. Providing a room with lots of holes for sunlight could provide a healthy effect for the inhabitants [18].

The high peoples density of 58.7% could be a possible factor causing the spread of diphtheria, along with the immunization patterns and parents low educational factors [9]. These were in accordance with Lestari, Kartono and Sitohang's research. The peoples density provides a great association with diphtheria occurrence, high density of people allowed the transmission by direct contact through the air or indirect contact [17]. Kartono stated that there was a significant correlation between the density of  $<4$  m<sup>2</sup> / person with the occurrence of diphtheria in Garut and Tasikmalaya. Based on multivariate test, the density of occupancy that exceed standard to the occurrence of diphtheria were 15,7 times higher than compared to the within standard density. These were also in accordance with Sitohang's study [10]. Therefore, there was a significant correlation between the density of  $<4$  m<sup>2</sup> / person with the occurrence of diphtheria in Cianjur, the person slept in a dense populated room which increased 6 times risk of diphtheria compared to the person who slept in

unsoiled the bedroom [10].

The ventilation conditions in Lestari study were not significantly associated with diphtheria events. The possibility existed due to the majority of diphtheria cases occurred in the area were matched to within standard ventilation. The house physical condition variable was not significantly associated with diphtheria occurrence; this might be due to the exceed standard ventilation percentage in case (56%) and control (44%) which did not show a significant difference [8].

The wall type's variables from Kartono and Lestari research did have differences. In Lestari study, bivariate analysis of wall type variables did not correlate significantly with diphtheria. After further examination, the majority of unsupported respondents had the condition of the house wall in the form of brick plastered, thus, it could show unrelated case. The non-plastered brick walls allowed the dust to come in to the brick and make it difficult to clean; this would potentially become the bacterial habitat. Diphtheria bacteria could survive for about 6 months [8]. These condition were in accordance with Kartono's research, he stated that there was no significant relationship between the walls types (board types) with the occurrence of diphtheria in Garut and Tasikmalaya [17].

## CONCLUSION

Based on the review, the environmental factors that could correlate to the occurrence of diphtheria in Indonesia are exceed standard humidity, lighting, exceed standard density of inhabitants and the use of floors types (non ceramic, non-plastered).

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## EXTENDED ABSTRACT

# Risk Factors Associated with Urolithiasis in Arosbaya Health Center Bangkalan Regency, Indonesia

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### SUMMARY

Urolithiasis disease (urinary tract stones) is a rock formation along the upper urinary tract (kidney and ureter) and lower urinary tract (bladder and urethra) caused by the deposition of substances contained in the urine that excessive amounts. The overall probability of forming stones differs in various parts of the world and is estimated as 1% to 5% in Asia 5% to 9% in Europe, and 13% in North America. In Asia, a stone-forming belt has been reported to stretch across Sudan, Saudi Arabia, the United Arab Emirates, Iran, Pakistan, India, Myanmar, Thailand, Indonesia, and the Philippines. Based on medical records of Arosbaya health center from January 2014 to June 2015 found 40 there was found urolithiasis patients. The aim of research to identify the extrinsic and intrinsic risk factors affecting the incidence of urolithiasis in Arosbaya health center, Bangkalan regency. This research used analytic observational with case-control as research design. The sample used 27 respondents for case group and 54 respondents for control group. Sampling technique used simple random sampling. Instruments in the study using the questionnaire and laboratory examinations. This study using chi-square test analysis, to find out factors associated with incidence of urolithiasis. The result for intrinsic factors were age OR=3,25, sex OR=1,60, extrinsic factor drinking water treatment OR=1,16, Old water consumption OR=1,36, and the level of hardness of well water of respondents OR=1,25. While for protective factors, intrinsic factor offspring / family history OR=0,09 extrinsic factors consumption of source calcium OR=0,85, and the consumption of drinking water OR=0,67. Factor related to the occurrence of urolithiasis in the work area of Arosbaya Health Center, Bangkalan Regency is the consumption of calcium source, drinking water treatment, length of using well water as drinking water, and level of water wellness of respondents water hardness.

**Keywords:** Risk factors, Intrinsic, Extrinsic, Urolithiasis

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### INTRODUCTION

Urolithiasis disease (urinary tract stones) is a stones formation along the upper urinary tract (kidney and ureter) and lower urinary tract (bladder and urethra). It caused by deposition excessive amounts of substances in urine or other factors which affects solubility of substance [1,2]. The overall probability of forming stones differs in various parts of the world and is estimated as 1% to 5% in Asia 5% to 9% in Europe, and 13% in North America. Geographically, incidence is higher in the United States, the Middle East, Mediterranean countries, Scandinavian countries, the British Isles, and Central Europe, whereas a lower incidence is reported in Central and South America and Africa. In Asia, a stone-forming belt has been reported to stretch across Sudan, Saudi Arabia, the United Arab Emirates, Iran, Pakistan, India, Myanmar, Thailand, Indonesia, and the Philippines [3].

The outline, formation of urolithiasis is influenced by intrinsic and extrinsic factors. The intrinsic factor is individual characteristic such as age, sex, and heredity / family history. Extrinsic factors are consumption of calcium sources, drinking water consumption, drinking water treatment, the length of using well water as drinking water, and hardness of water [4,5,6]. Consumption of drinking water in Indonesia is increase, one of the main drinking water of Indonesian people is groundwater. Based on the Decree of the Minister of Health No. 492 / Menkes / SK / IV / 2010, that drinking water used by the community have to meet the requirement of drinking water. Drinking water quality requirements contain chemical, radioactive and physical requirements [5]. Arosbaya health center Bangkalan regency is one of health center surrounded with limestone in their geographical condition. Limestone in their environment makes the ground water contains excessive lime or increasing hardness of water. The working area of Arosbaya Health Center covers 9 villages, with 41,402 people as their population. Based on medical records of Arosbaya health center from January 2014 to June 2015 found 40 urolithiasis patients. The aim of this research

to identify the extrinsic and intrinsic risk factors affecting incidence of urolithiasis in Arosbaya health center, Bangkalan regency.

**MATERIALS AND METHODS**

The research using observational analytics with case-control method as the research design (case-control study). This research was conducted in 2016 in the working area of Arosbaya Community Health Center covering 9 villages with a total population of 41,402 inhabitants. The population of this research consists of two cases and control populations. Population of case is 40 urolithiasis patients that treated at Arosbaya Community Health Center during January 2014-June 2015. Control population in this research is all of non-urolithiasis patients who went to Arosbaya Community Health Center, Bangkalan and did not have a specific symptom that similar to urolithiasis disease during the period of January 2014 - June 2015. The sample of this study used a large sample calculation using OR (Odd Ratio) from the previous similar research, which obtained a result of 27. The size of the control sample is determined by the ratio of the number of cases and the control which is 1: 2 (27:54). Sampling technique is using simple random sampling. Independent variables in this study is an intrinsic and extrinsic, while the dependent variable is urolithiasis disease. Instruments used in this research are questionnaire sheet about the history of the disease, drinking water consumption, and the consumption of calcium sources, as well as laboratory examination of the hardness of the well water [7].

**RESULTS**

Intrinsic factors which affects the Urolithiasis Incident (urinary tract) includes age, gender and heredity or family history (Table I). The odd ratio for age is 3.25, indicating that the age of ≥ 25 years has a risk 3.2 times more urolithiasis, from someone <25 years old. As for gender, male had 1.6 times greater risk of urolithiasis than female. Family history is a protective factor which has a preventive effect on the occurrence of urolithiasis.

Extrinsic Factor affecting Urolithiasis Incident (urinary tract stones) includes calcium source consumption, drinking water consumption, drinking water treatment, lenght of using well water as drinking water and hardness level of respondent's well water (Table II). The odd ratio of 0.85, indicated that consumption of calcium sources is protective factors that have a preventive effect on occurrence of urolithiasis. Drinking water consumption is also a factor protective which has a preventive effect on the occurrence of urolithiasis. Direct consumption of well water without processing first has a risk 1.1 times greater against the occurrence of urolithiasis rather than drinking treating well water. Lenght of using well water as drinking water indicated that long usage of well water

**Table I:** Cross tabulation of Age Respondents, Gender, and Heredity / Family History with *Urolithiasis* Incident in the Working Area of Arosbaya Health Center Bangkalan Regency

Age	Case	Control	p	OR	CI 95%
	n	n			
< 25 year old	3	2	1.70	3,25	0,50-20,74
≥ 25 year old	24	52			
<b>Total</b>	<b>27</b>	<b>54</b>			
Gender	Case	Control	p	OR	CI 95%
	n	n			
Male	21	37	0.75	1,60	0,05-4,70
Female	6	17			
<b>Total</b>	<b>27</b>	<b>54</b>			
Family History	Case	Control	p	OR	CI 95%
	n	n			
Yes	18	9	21.74	0,09	0,03-0,27
No	9	48			
<b>Total</b>	<b>27</b>	<b>54</b>			

**Table II:** Cross Tabulation of Calcium Source Consumption, Drinking Water Consumption, Drinking Water Treatment, Lenght of Using Well Water as Drinking Water, Level of Water Wellness of Respondents Water Hardness With the Urolithiasis Incident in the working area of Arosbaya Health Center Bangkalan Regency

Calcium Source Consumption	Case	Control	p	OR	CI 95%
	n	n			
Yes	25	49	0.04	0.85	0.18-3.85
No	3	5			
<b>Total</b>	<b>27</b>	<b>54</b>			
Drinking Water Consumption	Case	Control	p	OR	CI 95%
	n	n			
<1.5 L/day	6	16	0.49	0.67	0.23-1.99
≥1.5 L/day	21	38			
<b>Total</b>	<b>27</b>	<b>54</b>			
Drinking Water Treatment	Case	Control	p	OR	CI 95%
	n	n			
Cooked	15	28	0.09	1.16	0.45-2.93
Directly Consumption	12	26			
<b>Total</b>	<b>27</b>	<b>54</b>			
Lenght of Using Well Water as Drinking Water	Case	Control	p	OR	CI 95%
	n	n			
<25 year	2	3	0.10	1.36	0.21-8.66
≥25 year	25	51			
<b>Total</b>	<b>27</b>	<b>54</b>			
Level of Water Wellness of Respondents Water Hardness	Case	Control	p	OR	CI 95%
	n	n			
Meeting standard	6	10	0,15	1.25	0.40-3.92
Not meeting standard	21	44			
<b>Total</b>	<b>27</b>	<b>54</b>			

as drinking water for  $\geq 25$  years has 1.3 times greater risk against the occurrence of urolithiasis than drinking less than 25 years. Finally the the level of hardness of well water that does not meet the standard has a risk of 1.2 times greater of the occurrence of urolithiasis.

## DISCUSSION AND CONCLUSION

Age is a risk factor for the incident of urolithiasis. People whose age  $\geq 25$  years have a risk of 3.2 times greater to be exposed to urolithiasis than the respondents whose age  $< 25$ . The increase of stone is in accordance with the age of someone and it will reach a maximum level when the person becomes an adult. Kidney which develops from infancy to adulthood leads to increased crystallization in the loop of Henle [8].

It was obtained that male has 1.6 greater risks of exposure to urolithiasis than female. Male has a longer anatomical structure than female. Thus, many substances which can form stone are likely settling in the saturation state. In addition, naturally male urine has a higher calcium level than female, and female urine also has a higher level of citrate (inhibitor) [8]. Sofia [9] reported ratio of male female was 1.82:1. Epidemiological studies revealed that nephrolithiasis is more common in men (12%) than in women (6%) and is more prevalent between the ages of 20 to 40 in both sexes. Initial presentation predominates in the 3rd and 4th decades. Some of the studies reported that in developing countries the male-to-female ratio range from 1.15:1 in Iran and 1.6:1 in Thailand to 2.5:1 in Iraq and 5:1 in Saudi Arabia [9].

It was obtained that hereditary/ family history is a protective factor that has the effect of prevention against the incident of urolithiasis disease with OR = 0.09. The research found that if one of the parents suffers from urolithiasis, the child will have more risk of urolithiasis compared to those whose parents do not have any history of urolithiasis. The insignificant relationship between urolithiasis family history and the occurrence of urolithiasis may be due to the ignorance of the respondents to the urolithiasis diagnosis in their family [8]. Kidney stones develop more frequently in individuals with a family history of kidney stones than in those without a family history. Sofia [9] the family history is significant association ( $p=0.009$ ) between kidney stone. Studies had proved that a family history of stones has been reported in 16% to 37% of patients who have formed a kidney stone, compared with 4% to 22% in healthy control subjects. A family history of kidney stones substantially increases the risk of stone formation. The relative risk increased in patients with family history for calculosis, with the tendency to eat protein-rich food and with over weight and body mass index (BMI) $>32\text{kg}/\text{m}^2$ . A patient with stones is twice as likely as a stone-free cohort to have at least one first degree relative with renal stones (30%vs50%). Those with a family history

of stones have an increased incidence of multiple and early recurrences.

Consumption of calcium is a protective factor that give preventive effect in urolithiasis disease with OR = 0.85. Among the presence of calcium in the human body, 99% of them is stored in the bones and 1% is stored in intracellular fluid. Therefore, bone serves as a large reservoir to store calcium and as a source of calcium. However, the calcium in the bone is balanced with the calcium excretion by the gastrointestinal and renal tract [10,11]. Although over 200 components have been reported in urinary stones, most stones are composed of calcium oxalate (40%–60%). Ho Yung et al [12], the most of requent component found in the stone analysis was also calcium oxalate (48.1%). The most important pathophysiological factor for calcium nephrolithiasis is hypercalciuria. Calcium can increase the ionic activity and saturation of crystallizing calcium salts (oxalate and phosphate) and binds stone inhibitors. Hyperoxaluria is also important to raise the level of saturation of calcium oxalate in the urine. High intake of carbohydrate, protein, and cereals, is significant risk factors for urolithiasis in this study, might be associated with hypercalciuria and hyperoxaluria.

Drinking water is a protective factor that has an effect of preventing the occurrence of urolithiasis disease with OR = 0.67. Consuming 1.5 liters of water/ day is one of the preventions of insoluble salts super saturation in urine and as part of the substances transport function in the body. Increasing fluid intake caused increasing urine volume, causing decrease saturation level of oxalate calcium and reduce the possibility of crystalline formation. Meanwhile, the less fluid intake will decrease the amount of urine resulting in increased reactants (calcium and oxalate) and reduced urine [1,13,14]. Pubali et al [3] found that 53.6% of the patients in the present study consumed less than 3 L of water.

Drinking water management is one of the risk factors of urolithiasis in Arosbaya Community Health Center working area with OR = 1.16. It means that respondents who directly consume well water have a risk of 1.1 times exposed to urolithiasis. Generally, groundwater has a high degree of hardness, this is because the groundwater have contact with lime rocks [15]. Hardness of water classified into soft to a high degree of hardness. Hardness of water can be reduced or removed by heating, that form insoluble and precipitated calcium carbonate salts. If the well water is consumed directly without any heating up first, the high calcium content of well water will settle in the urinary tract which under certain conditions will experience saturation and resulting in urolithiasis disease [8].

Respondents who use well water for more than 25 years is known have 1.3 times of risk to expose to urolithiasis [16]. Urolithiasis is a chronic disease caused by several

factors, both intrinsic and extrinsic. One extrinsic factor is the length of using well water as drinking water. The formation process of urolithiasis occurs gradually and takes a very long time with a peak incidence between the third and sixth decades [6,7,8].

It was noted that the hardness level of the respondent's well water is not eligible. The laboratory examination result of the well water hardness level in 3 case and control villages obtains a result that on average, the hardness value exceeds the threshold > 500 mg/l (Decree of Ministry of Health 492, 2010). The respondents who drink the water will have a risk of 1.25 times greater to be affected to urolithiasis than the respondents who drink eligible well water (16,17,18). The hardness of well water consumed continuously results in the accumulation of CaCO<sub>3</sub> and MgCO<sub>3</sub> deposits. CaCO<sub>3</sub> and MgCO<sub>3</sub> particles that are in a supersaturated solution will settle in the kidney nucleus to form a stone. The formation of stone core and saturation in urine is a precondition of stone formation. The formation of a nucleus alone without the accompanying elements or stone-forming minerals in the renal tubules will not lead to the formation of stone. Crystallization will be more and more united if the stone-forming elements are in excessive amounts in the tubular system. The crystallization will form a stone in the urinary tract that is often called urolithiasis [17,18,19].

It can be concluded that factor related to the occurrence of urolithiasis in the work area of Arosbaya Health Center, Bangkalan Regency is the consumption of calcium source, drinking water treatment, length of using well water as drinking water, and level of water wellness of respondents water hardness. Higher intakes of calcium could increase the risk for urinary stone formation. To reduce the risk of calcium sediment, it is sought to limit the consumption of ingredients foods that are high in calcium (Milk, Spinach, Kale, Tea) so that calcium levels in the urine still in normal condition, high urinary calcium levels are one factor risk of developing calcium stones. Then consume water that has been cooked and in settle for 1 x 24 hours.

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## EXTENDED ABSTRACT

# Heavy Metals Contamination in Groundwater Around Sidoarjo Mud Vulcano Area, East Java Indonesia

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## SUMMARY

Sidoarjo Mud Vulcano Disaster is a dangerous disaster that can pollute the environment. Mud eruption due to errors of petroleum drilling since 2006 until now and there are 13 villages impacted. The mud vulcano becomes dangerous because it contains oil and heavy metals that have a risk for the environment and public health. This study aim to evaluate content of heavy metals in groundwater that can cause adverse health effects. The method used in this study was analytical descriptive. Samples were taken by purposive sampling in 6 villages of impacted areas. Each of that, took five points of the well water as sample. It tested by Atomic Absorption Spectrophotometer, then compared to WHO & Minister of Health Standard for drinking water quality. The results of this study show that level of iron (Fe), Cadmium (Cd), Zeng (Zn), and Lead (Pb) were still meet the standard of drinking water quality. While Manganese (Mn) in 3 locations exceeds from drinking water quality standard (> 0.4 mg/l). The Manganese level which have exceed of the standard can be risk for neurological disorders, liver damage, and kidney. Therefore, appropriate technology was required such as cascade aerator, bubble aerator, and waterfall aerator to reduce Mn concentration or using bioremediation technique. Furthermore, needs some research to identify the carcinogenic metals in water and the effect to population.

**Keywords:** Heavy metal, Contamination, Mud vulcano, Manganese

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## INTRODUCTION

The hot mud vulcano of Sidoarjo is the event of spraying hot mud at the location of oil drilling owned by PT. Lapindo Brantas Inc. in Balongnongo Sub-Village, Renokenongo Village, Porong Sub-district, Sidoarjo Regency, East Java, Indonesia, since May 29, 2006. Mud volcanoes have caused flooding of settlements, agriculture and industrial areas in three sub-districts, affecting economic activity in East Java for several years. The incident became a complex problem, especially the problem of environmental pollution. Environmental pollution that occurred in the form of air pollution, water, and land greatly impact on public health [1]. The mud vulcano in November 2006 covered approximately 250 hectares of land, including seven villages, rice fields, sugar plantations, irrigation canals, and has disrupted transportation routes. Forecast the mud vulcano volume between 50,000 - 120,000 m<sup>3</sup>/day. So that the water separated from the sludge ranges 35,000 - 84,000 m<sup>3</sup>/day [2]. Every year the volume of outflow is increase and the impacted area is widen. This happen because the dam is not able to accommodate the amount of mud

vulcano that overflows into the surface.

The problem occurs because of the condition have potential pollution to the well water of residents who are in the impacted area. Pollution due to Sidoarjo mud vulcano is detected to contain some metals that are harmful to the human body. The characteristics of Sidoarjo mud vulcano is clay textured, having pH about 6.6-7, containing a heavy metals of Pb 0.19-0.34 mg/L, Cu 0.19-0.85 mg/L, and moisture content about 40.41-60.73% [3]. Other study said the metals was detected in mud Sidoarjo sediments are contain copper (Cu), iron (Fe), mangan (Mn), cobalt (Co), zinc (Zn), cadmium (Cd), molybdenum (Mo), and boron (Br)10. Based on the research that has been done on groundwater, it is identified that the heavy metal content of Pb (lead) and Cd (cadmium) in well water are exceed from the standard of clean water quality. Besides, the content of Hg (mercury) taken from gill samples also exceed the standard limit [4].

During this time, residents use well water for everyday purposes such as bathing, washing, processing food, including for drinking needs. If the decimation then the heavy metal content in the water consumed by residents will be a serious threat to health. These heavy metals have a devastating effect on human health if absorbed excessively in the body and for a long time. Heavy metals

can block the action of enzymes that interfere with the body's metabolism, causing allergies, mutagenic, teratogenic or carcinogens for humans and animals. Therefore it is necessary to periodically examine and evaluate heavy metals contaminating groundwater in the Sidoarjo mud volcano in accordance with applicable regulations. The aim of this research is evaluate content of heavy metals in groundwater of impacted area mud volcano. Some of the content is iron (Fe), Cadmium (Cd), Zinc (Zn), Manganese (Mn), and Lead (Pb) that can cause adverse health effects to population.

**MATERIALS AND METHODS**

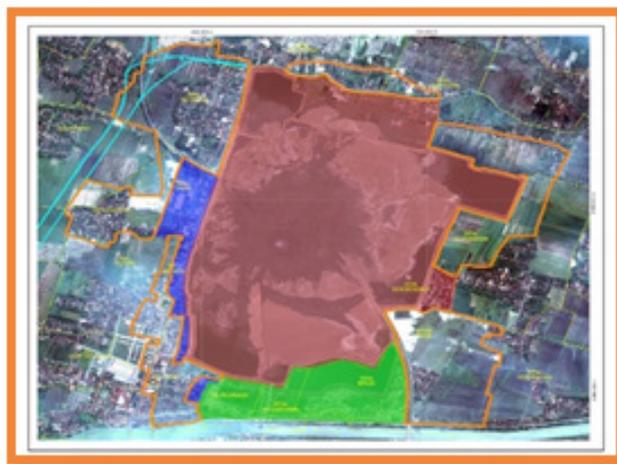
Sampling is done by taking groundwater from residents's wells located in the impacted area. Data was taken on 6 - 11 March 2014 in 6 locations taken in a moment. The locations are Perum Puri Sampurno, Ketapang Village, Mindi Village, Pejarakan Selatan Village, Buaran Keboguyang Village, and Porong Village (Figure 1). The location is an area that still inhabited by the community, so that the results are expected to be useful as an effort to monitor groundwater quality. Sampling at each location was drawn from 3 to 5 samples of wells. The preferred heavy metal components are Fe, Cd, Mn, Zn, and Pb. Then the sample is tested on the laboratory by using the Atomic Absorption Spectrophotometer (Inductively Coupled Plasma Mass Spec (ICP-MS) technique). Then performed tabulation and presentation of data to the test results. The data analysis used descriptive analysis with evaluation using the standard concentration published by WHO (Guideline for Drinking-Water Quality 3rd edition) and the Minister of Health of the Republic of Indonesia (PERMENKES 492/2010 Water Quality Requirements) and analysis based on the research literature.

**RESULTS**

Figure 2 shows the map of Sidoarjo mud impacted areas according to Presidential Regulation no. 37 in 2012. The dark red map is the point of the mudflow and the boundary of the impacted area on March 22, 2007 based on Presidential Regulation no. 14/2007. The green



**Figure 1: The Map of Sample Points Research**



**Figure 2: The map of sidoarjo mud vulcano impacted area**

map is the boundary of the mudflow management area based on Presidential Regulation no. 48/2008. Some villages included in the green map are Besuki Village, Pajarakan Village, and Kedungcangkring Village. The blue map is the boundary of the mudflow management area based on Presidential Regulation No. 68/2011. In the regulation, there are additional new areas impacted by Sidoarjo mud volcano: Siring village west of RT 1, RT 2, RT 3, and RT 12 which is in the scope RW 12; in addition, in Jatirejo Village, RT 1 and RT 2 in RW 1; and Mindi Village RT 10, RT 13, RT 15 in RW 2. The orange colored line shows the border of unsafe area. Some areas included in the orange line are East Besuki Village, Glagah Arum Village, Mindi Village, Pamotan Village, Siring Village, Ketapang Village, Gempol Sari Village, and Kali Tengah Village.

The results of the concentration have different values (Table I). Some are almost the same at each point in one location. Even many have values <LD (less than the device detection limit). This means that the detected concentration level is very small.

**DISCUSSION AND CONCLUSION**

From the results, the highest iron (Fe) concentration in the Buaran Keboguyang Village at the third point (0.0226 mg/l). The lowest concentration was obtained from several sampling points having Fe <LD concentration (less than limit of detection). When compared to the region, the highest average concentration of Fe is located in the well water dug Buaran Keboguyang Village (0.0131 mg/l). While the lowest average concentration of Fe in Ketapang Village - Tanggulangin (0.001 mg/l). All of the samples had an average of 0.0046 mg/l. Based on the test results all samples showed safe levels of Fe concentration level. Not exceed from the standard limit set by PERMENKES or WHO that is equal to 0,3 mg/l5,6. Analyzing from the distance of the sample with pollutant sources, Kapatang Village, Tanggulangin sub district has the lowest average concentration because the area is more distant ( $\pm 3$  km) from the source of the

**Table I: Maximal Concentration Level of Heavy Metals in Samples Area**

Parameter	Standard	Unit	Perum Puri Sampurno V.	Ketapang Village	Porong Village	Mindi Village	Pejarakan Village	Buaran Keboguyang V.
			Max	Max	Max	Max	Max	Max
Fe	0.3	mg/l	0.0148	0.004	0.0216	0.0114	0.0093	0.0226
Cd	0.003	mg/l	<LD	<LD	<LD	<LD	<LD	<LD
Mn	0.4	mg/l	<LD	0.4469	1.7649	0.1515	<LD	1.3227
Zn	3	mg/l	0.0463	0.0103	0.0231	<LD	<LD	0.0085
Pb	0.01	mg/l	<LD	<LD	<LD	<LD	<LD	<LD

Sidoarjo mudflow, in contrast to the Buaran Keboguyang Village which is only  $\pm 2$  km from the mudflow source. Besides that, the flow of water in the surrounding area flows from the source area of the mudflow to the area around the buaran keboguyang village. This can be seen from the flow of the tributaries (small river) leading to the village area of Keboguyang, this is also influenced by the geographical location of the Keboguyang village which is lower than Perum Puri Sampurno or Ketapang village.

Cadmium (Cd) and lead (Pb) level test results all samples have a concentration of <LD (less than limit of detection). The test results of all samples ensure that the level of Cd concentration in water is safe (not exceed from 0.003 mg/l) and the concentration of Pb in water is declared safe in not exceed from 0.01mg/l. Similar concentration level conditions have also occurred in Kurichi Industrial Estate - India. In the study it was mentioned that the results of Cd measurements in groundwater located around the industrial sites are worth BDL (below detectable level) or <LD (less than limit of detection) with detectable level - 0.0010 mg/l= $\mu$ ppm [7].

The highest zinc (Zn) concentration is obtained from Perum Puri Sampurno - The fourth sample point is 0.0463 mg/l. The lowest concentration is obtained from several sampling points having Zn <LD concentration (less than limit of detection). All water samples that have been tested show concentration levels below the maximum limit of Zn in drinking water ie 3 mg/l [5,6]. Comparing based on the sample area, the highest value of Zn concentration was obtained from dug well water samples at Perum Puri Sampurno at 0.0261 mg/l. While the rural areas of keboguyang, pejarakan, and mindi have an average of lower Zn concentrations even <LD, even though the distance to the source is relatively close ( $\pm 2$  km). This is possible because flooding and soil climatic conditions that occur in the village area result in Zn deficiency in the soil. Flooded soils will increase nutrient concentrations except Zn because Zn deficiency will occur due to increased acidity (pH) under reduced conditions and precipitation of franklinite ( $ZnFe_2O_4$ ) or sphalerite ( $ZnS$ ) besides Zn deficiency occurs in cold and wet soils [16]. The results of these tests showed similar results in mud vulcano non-occurring areas in the Nigerian Kaltungo, ie having a Zn level in groundwater of 0.073 mg/l - 1.672 mg/l [8].

Manganese (Mn), based on the above chart it can be seen that the highest Mn concentration value is obtained from the 3B sample (Porong Village-The second sample point) of 1.7649 mg/l. The lowest concentration was obtained from several sampling points having Mn <LD (less than limit of detection) concentration. The average concentration of Mn from all samples in the dug well test was 0.2699 mg/l. The highest average concentration value of Mn was obtained from the dug well water sample in Porong Village at 0.893 mg/l. While the lowest average concentration of Mn was obtained from dug well water samples at Perum Puri Sampurno and Pejarakan Village with concentration value <LD (less than limit of detection). The test results showed a high Mn concentration level and exceeded the maximum limit of Mn in drinking water in accordance with PERMENKES and WHO standards (no more than 0.4 mg/l).

The location detected has an insecure Manganese concentration level there are in sample A of Ketapang Village Kec. Tanggulangin (0.4469 mg/l); sample A (1.0451 mg/l), sample B (1.7649 mg/l), sample C (1.6552 mg/l) in Porong Village; and Sample B (1.3227 mg/l), sample C (0.9023 mg/l) in Buaran Keboguyang Village. The Mn concentration level is similar to the results of a study on hydrochemical in the Sidoarjo Mud Vulcano area which shows a high Mn rate of 3.25 mg/l [9].

The heavy metal manganese (Mn) detected in the well water is possible from two sources. The first source is derived from the original Mn element content in the ground and the second source is strong estimate derived from Sidoarjo mud vulcano contamination. According to other research, the biggest 3rd metal heavy content in Sidoarjo mud is manganese (Mn) after boron (B) and iron (Fe), it show that sediment concentration have Mn about 7,2% (samples in HCl 0.1N) of all heavy metal in research ( $B > Fe > Mn > Co > Mo > Cd > Cu > Zn$ )<sup>10</sup>. From the facts can be known Sidoarjo mud vulcano has a high Manganese (Mn) content and can affect the surrounding ecosystem especially in water. Manganese is an essential element for humans and animals. Manganese is required various cellular enzymes in the human and animal bodies such as manganese superoxide dismutase and pyruvate carboxylase, as well as activating other enzymes enzyme kinase, decarboxylase, transferase, and hydrolase [11]. However, excessive exposure to chronic up to a high

dose can endanger health.

The main target due to manganese toxicity is the nervous system but it can also be buried in the liver and kidneys that have potential damage to the liver and kidneys [12]. An epidemiological study in Greece showed that drinking water consumption which naturally contained a high enough lifetime manganese concentration, caused neurological symptoms and increased manganese retention (characterized by high manganese concentrations in hair) in people over 50 years of age [13]. In addition, according to Connel & Miller research manganese is toxic to algae *Chlorella vulgaris*, protozoa (*Paramecium*), platyhelminthes (*Polycelis*, planaria), vertebrates (stickleback), and mammals [14]. According to the Agency for Toxic Substances and Disease Registry - CDC, manganese that enters the body through oral can travel to the blood, brain, through the placenta, to the developing fetus and can cause nervous system disorders. Including potentially sperm damage and decrease the level of female fertility [15].

The theories indicate the danger of manganese that may occur in the future, according to UNDAC's 2006 "Environmental Assessment" report in the area around the Sidoarjo mudflow, it is mentioned that the mud-releasing contents into the waters will cause the death of aquatic animals and cause serious consequences for human who depending on the waters [4]. To prevent the occurrence of health problems, the community is expected not to consume well water directly, but to provide processing in advance such as using appropriate technology for cascade aerator or simple waterfall aerator. It suggested the community uses well water only for wash, while for drinking water use gallon water (bottled water) or water from the PDAM (local company of drinking water).

It is concluded that heavy metals found in groundwater from wells in the form of iron (Fe), Cadmium (Cd), Zinc (Zn), and Lead (Pb) do not exceed safe standards of drinking water quality. While the level of Manganese (Mn) concentration falls into the criteria of insecurity as it exceeds the safe standard of drinking water quality and has the potential to cause important health problems. We suggest to take action for decreasing Mn concentration level in the well water such as cascade aerator, bubble aerator, waterfall aerator, or using bioremediation technique to reduce Mn concentration. It still needs some research to identify the carcinogenic metals in water and the effect to population.

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## EXTENDED ABSTRACT

# Muscle Discomfort in Prolonged Standing among Industrial Workers

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### SUMMARY

Prolonged standing has been identified as one of the risk factors which is associated with occupational injuries. Therefore, the primary aim for this study is to determine the association between prolonged standing and muscle discomfort among workers who have to stand for long periods of time. A total of 74 respondents were given and asked to complete a self-administered Borg's Scale questionnaire. After that, the completed questionnaire was analysed using statistical analysis. This study highlighted the correlation between height, weight and age of the respondents with muscle discomfort following exposure to prolonged standing. Besides that, the association between prolonged standing and muscle discomfort also will be highlighted. In short, the prevalence of leg muscle discomfort was higher compared to the muscle discomfort experienced by the other body parts.

**Keywords:** Footrest, Muscle, Discomfort, Standing, Borg's CR-10

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### INTRODUCTION

Prolonged standing is part of occupational aspect especially in the service and manufacturing sector. Occupations such as hairdressers, sales clerks, food service workers and many factory jobs are related to prolonged standing [1]. Halim et al. [2] stated that prolonged standing can cause discomfort and muscle fatigue especially at lower extremities by the end of working day and result in performance decrement. Social Security Organisation reported that the number of accidents which are related to musculoskeletal disorder has increased to 194 cases in 2012 from 14 cases in 2006. This has triggered the researchers to study the issue as well as designing intervention in order to reduce the accidents related to musculoskeletal disorder. The Canadian Centre for Occupational Health and Safety (CCOHS) [3] suggests in using intervention such as shoe inserts, floor mats, footrest, compression hosiery and ergonomic seating to avoid such exposure. Based on a previous study by Sartika and Dawal [4], installation of the foot bar or footrest under the standing workstation allowed workers to change their posture and resulted

in relieving pain and fatigue by putting one leg on the footrest. Body weight will be automatically shifted to the leg which is on the floor while the other leg which is on footrest will relax and the posture of body will remain erect. A person with history of MSD as participant can affect the measurement of muscle activity as the pain/fatigue suffered may not due to the sampling (prolonged standing) but due to the existence of the disorder itself. Many studies indicated Body Mass Index is considered as one of risk factors of muscle fatigue during prolonged standing where persons within the overweight and obesity range tend to feel fatigue earlier than those with normal BMI. Implementation of intervention must be done in industry to prevent chronic exposure of prolonged standing that leads to MSD. Therefore, this study is very significant to be carried out as a result of using the intervention (footrest) on prolonged standing may help in reducing the rising issue of musculoskeletal disorder and muscle discomfort among the workers.

### MATERIALS AND METHODS

All 74 respondents were required to answer a pre-survey questionnaire before they could voluntarily participate in the study. The respondents were required to stand in static posture in a controlled room. Participants in the Control group (without footrest) and in the Experimental group (with footrest) were asked to stand for 2 hours in

two different sessions in a room with air conditioning at 26°C and adequate lighting. The respondents were required to evaluate their discomfort level on the Borg's CR-10 questionnaire. In addition, in order to simulate working conditions, the respondents needed to sort a box of mixed items and separated them in three specific boxes on the table based on the colour of the items. The first box is for red items, the second box only for blue items and the last box for green items [5]. This was done in order to simulate a proper working condition whilst standing. During the assessment, respondents were required to evaluate their discomfort level in every 15 minutes by using the Borg's CR-10 questionnaire.

## RESULTS

The discomfort level experienced by the respondents was rated by using Borg's CR-10 Scale questionnaire. This rating allowed the researcher to determine if there was any discomfort arising from certain body parts during the experimental session. In this study, the respondents were asked to determine their discomfort level for each body part for intervals of 15 minutes in 2 hours of prolonged standing. The Borg's Scale focused on 10 parts of the body which were the neck/head, shoulder, upper back, arms and hands, low back, buttocks, thigh, knees, calves and ankles/feet areas. Through the result, it can be observed that the discomfort rating trend indicated by the Experimental group was slightly higher than Control group at the beginning of 2 hours session of prolonged standing. This was because the respondents tend to not use footrest provided frequently at that moment and the level of discomfort experienced was lower than at the end of session for the Experimental group. Whereas, the frequency of footrest is used at end of session which started from the 90th minute was higher as the discomfort level started to increase. Knees (3.10), calves (4.10) and feet (4.50) had the highest mean compared to other body parts without using of footrest. Based on previous study by Lin et al. [6], the analytical result indicated that lower body discomfort is significantly affected by prolonged standing especially in the first 2 hours compared to the upper body part. On the other hand, subjective evaluation on body part discomfort done by Garcia et al. [7] indicated high significant of fatigue perception in lower extremities and back especially at the end session of prolonged standing.

Meanwhile, after the respondents in Experimental group were being tested with footrest during prolonged standing activity, the mean for those three body parts had reduced, with the mean of 1.15, 2.65 and 2.47 respectively. Sartika and Dawal [4] noted that by providing footrest for prolonged standing, it would be able to promote good blood circulation and muscles pumping. Besides that, the compression of body weight also can be reduced and finally produce more comfort for standing work. Furthermore, footrest allowed dynamic standing as the respondents can move and

change their leg or while performing task. According to Balasuabramanian et al. [8], the stationary static standing posture resulted in higher fatigue and discomfort rate compared to dynamic standing posture. Therefore, it is recommended that footrest at workstation are installed to reduce the fatigue and discomfort.

## DISCUSSION AND CONCLUSION

In conclusion, it can be observed that all of body parts (neck/head, shoulder, upper back, arms and hands, low back, buttocks, thigh, knees and calves) showed significant association with ankles/feet discomfort for both Control and Experimental group. Knees ( $r = 0.803$ ) and calves ( $r = 0.798$ ) had the highest correlation with ankles/feet discomfort compared to the others. Thus, the footrest was capable of providing comfort for respondents with prolonged standing. Yet, some additional modification may be needed on the features of footrest in order to improve the efficiency and adequacy in reducing muscle discomfort faced by prolonged standing workers.

## ACKNOWLEDGEMENT

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## EXTENDED ABSTRACT

# Hazard Identification, Risks Assessment and Risk Controls of Work Tasks in Selected Tea and Cocoa Plantations in Malaysia

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### SUMMARY

Frequent and high severity exposure to hazards can contribute to increased probability of harm among workers in agricultural sectors. Systematic risk assessment process will assist employers to mitigate risk using suitable control methods. The aim of this study was to perform Hazards Identification, Risk Assessment and Risk Control (HIRARC) in commodity-based agricultural plantation in Malaysia. This was a cross-sectional study among 74 workers in selected cocoa and tea plantations. All work activities performed at the plantations were video recorded and hazards were identified from interview-based questionnaire and work observations. The highest Risk Rating (RR) within work activities was harvesting characterised by prolonged standing with repetitive bending. Ergonomic hazard is the most common hazard. The outcome of this study can be used to provide information to assist employers and authorities in the management of safety and health at the selected type of plantations.

**Keywords:** Risk evaluation, Occupational safety, Occupational health, Agriculture, Farming

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### INTRODUCTION

Agriculture remains an important sector of Malaysia's economy and one of the most hazardous to health. According to the statistics of occupational accidents, agricultural is the main sector contributing to occupational accidents compared to other sectors [1]. In total, there were 441 cases of non-permanent disability, nine cases of permanent disability and 42 deaths for the year 2014, an increase from previous years [2]. To encourage good practice in occupational safety and health (OSH), "Guideline on OSH in Agriculture" was established to provide information on management of farm safety [3]. However, low awareness on OSH risks in plantation fields among workers and employers causing the number of injuries in this sector to remain high [4]. Implementation of OSH practice will continue to be poor if awareness on safety and health risks are not given due emphasis. To fill in the gap, there is a need to obtain information on hazards and significant risks present in plantation sectors. Current researches have focused significantly on palm oil plantation [2, 4] but not on other commodity plantations such as cocoa and tea. The obtained information can be used to develop training modules specific to the plantation to ensure

meaningful and effective training can be provided. The aim of this study was to perform Hazard Identification, Risk Assessment and Determine Risk Control (HIRARC) for OSH risk in tea and cocoa plantations.

### MATERIALS AND METHODS

This was a cross-sectional study conducted at a tea plantation at Cameron Highlands, Pahang and a cocoa plantation at Sungai Sumun, Perak. The study population is 74 full-time workers whose job tasks include soil preparation, sowing, pruning, spraying pesticides, manuring, harvesting, packing and transportation. Clustered sampling method was used to obtain participants in this study. Data was collected in 2015. HIRARC method [5] was used as the research tool. This study uses the Matrix Method in which 2 components of risk that is Severity and Likelihood were numerically assessed separately then compounded to obtain an overall estimation of the risk level by a numerical score. The numerical scores were then categorised into low, medium or high risk. The existing controls were also reviewed. The information regarding work tasks was obtained from interview-based questionnaire. The questionnaire included items on the type of personal protective equipment used and information on hazards, likelihood, severity exposure of hazards and existing controls. Video recording for a maximum of 5 minutes of work tasks was analysed to obtain the information to be filled in the HIRARC form. Institutional ethical

approval was obtained for the protocol for this study.

## RESULTS

A total of 37 cocoa workers and 37 of tea workers took part in this study. The workers worked for 8-hour per day. The majority of the respondents were male (73.3%) and 86.1% of them were of Malay ethnicity. Most of the respondents were between the ages of 20 to 50 years old. The average (standard deviation) duration of work in the plantation was 8.05 (6.94) years. About 80% of the workers had secondary level of education and more than 90% of them were of Malaysian nationality. Table I and II present the HIRARC results performed at the tea and cocoa plantations. Work activities indicated with the highest level of risks was harvesting (Risk Rating, RR=8, medium risk). To harvest tea leaves, the workers need to cut the leaves using a hedge-type clipper. The cutting process is repeated a few times before the worker toss the contents of the catcher tray over their shoulders into their back strap basket. This process can produce about 150 kg of leaves per day with a full basket of 25 to 30 kg of leaves. The workers were required to stand for a prolonged duration while carrying the back strap basket while harvesting. For cocoa plantation, workers were required to push or pull in addition to manoeuvring wheelbarrows containing fruits. The task is made worse because manoeuvring the wheelbarrow on an uneven ground requires the workers to exert excessive force to move the load. The health effects reported are strain injuries predominantly for the lower back and shoulders.

**Table I: HIRARC output assessment in the tea plantation**

Work Activities	Hazards	Effects	Control	Risk
<b>1) Cultivation</b> Tea seedlings planted into a hole in the ground. Then the soil is compacted by hand.	Standing and bending while planted the tea plant.	Low back pain Fatigue	Rubber boot Gloves	4 (Low)
	Insect bites	Fatigue	-	2 (Low)
<b>2) Pesticide control</b> Spray naturally made pest control solution using a knapsack pesticide sprayer once a month.	Exposure to the pesticide through inhalation and skin penetration. Spillage of the pesticide	Skin irritation Difficulty in breathing Coughing	Rubber boot Gloves Half-face mask	6 (Medium)
	Insect bites	Fatigue	Rubber boot Gloves	4 (Low)
<b>3) Weed control</b> Destroy pest by hand-plucking the infested leaves daily from tree to tree.	Standing and bending too long	Low back pain Fatigue	Half-face mask	4 (Low)
	Standing too long	Low back pain Fatigue	Rubber boot Gloves	6 (Medium)
<b>4) Pruning</b> Cutting dried leaves to allow new young shoots to flourish	Exposure to the sharp object and thorns of the fronds	Finger/hand injury	Rubber boot Gloves	3 (Low)
	Exposure to the sharp object	Finger/hand injury		4 (Low)
<b>5) Harvesting</b> The leaves are cut by using a tea leaves scissors and tossed into the knapsack basket carried on the back of the workers.	Insect bites	Fatigue	Rubber boot Gloves	4 (Low)
	Standing and bending too long	Low back pain Fatigue	Gloves Cap	8 (Medium)
	Heavy load knapsack basket containing tea leaves	Low back pain		8 (Medium)

**Table II: HIRARC output assessment in the cocoa plantation**

Work activities	Hazards	Effects	Control	Risk
<b>1) Soil preparation</b> Make a small hole in the ground by using a hoe. Insert phosphate fertilizer and lime into the hole.	Injury from sharp hoe	Finger/hand injury		2 (Low)
	Stung/bitten by poisonous animals	Fatigue		2 (Low)
	Chemical exposure due to fertilizer	Skin/eye irritation Skin sensitization	Rubber boot Gloves	2 (Low)
	Standing with forward flexion with force	Low back pain Fatigue		4 (Low)
<b>2) Cultivation</b> Cocoa seedlings planted into a hole which contains phosphate fertilizer and lime. Soil is compacted.	Prolonged exposure to direct sunlight	Heat stress Rashes /Dryness		4 (Low)
	Prolonged standing and bending	Low back pain Fatigue		4 (Low)
	Insect bites	Fatigue	Rubber boot Gloves	2 (Low)
	Prolonged exposure to the sunlight	Heat stress Rashes Dryness		4 (Low)
<b>3) Pesticide control</b> Spray around the plants using knapsack sprayer	Bending to spread fertilizers	Low back Pain		2 (Low)
	Exposure to pesticide (inhalation and dermal exposure)	Skin/eye irritation Skin sensitization Coughing		2 (Low)
<b>4) Pruning</b> Prune branches manually by using shears	Prolonged bending	Low back pain Fatigue		4 (Low)
	Prolonged standing and bending	Low back pain Fatigue	Rubber boot Cap Gloves	6 (Medium)
	Exposure to sharp object	Finger/hand injury		3 (Low)
<b>5) Harvesting</b> The fruits are plucked by using a scissors or a small sickle and placed into the wheelbarrow	Exposure to sharp object	Finger/hand injury		4 (Low)
	Insect bites	Fatigue	Rubber boot Gloves	3 (Low)
	Prolonged standing and bending	Low back pain Fatigue	Cap	8 (Medium)
	Pushing the wheelbarrow with fruits on uneven ground	Low back pain, shoulder pain		8 (Medium)

## DISCUSSION AND CONCLUSION

In the present study, ergonomic hazard linked with harvesting tasks was the most common type of hazard in the two plantations. As harvesting requires the workers to stand for prolonged period, workers would benefit if they were able to sit at regular intervals during short breaks to reduce muscle fatigue in addition to the inclusion of mechanical tools to help with harvesting tasks. The outcome of this study can be used to provide information to assist employers or the authorities in the management of OSH at the selected types of plantation.

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## EXTENDED ABSTRACT

# A Review: Muscle Discomfort of Police Officers in Vehicles

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### SUMMARY

This paper studies the muscle discomfort among police officers when carrying out their work. The objective of this study is to give a basic introduction of ergonomic problems in among police officers and risk controls in relation to minimize the ergonomics risk factors. This paper gives quick review of muscle discomfort problems and prevalence of musculoskeletal disorders (MSD) among police officer. An ergonomic application has been purposed in the literature to solve the problem related with design of mechanical.

**Keywords:** Musculoskeletal Disorders, Low Back Pain, Car, Motorcycle

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### INTRODUCTION

In the ergonomics field, the terms comfort and discomfort are a unique form of measurement because they involve the human perception (feedback) of the machine and work system environment [1,2] (Muscle discomfort is also known as one of the musculoskeletal disorders (MSD) symptoms. The risk of developing muscle discomfort has shown to increase when driving or riding distances and commute times increases [3,4]. In an occupational sector, people that are exposed to prolonged riding or driving situation of more than 4 hours per day have doubled the risk in getting muscle discomfort which could lead to MSD compared to office workers [5]. Roughly a quarter of police officers are considered prolonged riders which is more than 25 000 kilometer per annum [6].

### MATERIALS AND METHODS

In this study, systematic review methods were carried out. A systematic investigation of recurrent literature databases from the period between 1997 and 2017 was carried out. Science Direct, PubMed and Scopus were searched for the following key words: police officers, muscle discomfort, musculoskeletal disorders, vehicle, motorcycle, car, low back pain, occupational sector, absenteeism, seat design.

### RESULTS

They were several previous studies conducted to investigate muscle discomfort among police officers. One study was carried out in Japan by Mirbod et al. (1997) [7]. They carried out the study to assess hand-arm vibration exposure among police officer riding motorcycles. The study reported that the respondents suffered finger blanching and shoulder discomfort which was higher compared to the control group. The study also highlighted that the main factors of muscle discomfort were the posture of the hands and arms during the gripping of the handlebars, the surrounding environment, and the period of riding motorcycles. Besides, Weil et al. (2004) concluded that there is a low predictive value of pre-employment lumbar spine radiograph as a screening tool predicting sickness absenteeism due to low back pain among police officers in Israel[8]. However, Spondylolysis may increase the duration of sickness absenteeism in patients with low back pain.

Many researchers agree that the problem of muscle discomfort and MSD among police officers was serious. The different respondents have different pain in parts of their body because of the different body muscle used, level of the severity of body muscle used and working conditions [9]. Lipscomb et al. (2004) found that a quarter of the respondents reported their WMSDs caused them to take sick leave up to five days [10]. The majority of policemen did not experience low back pain before joining the force which proves that some on the job factors caused the muscle discomfort among

policemen [11].

Gyi and Porter (1998) concluded that traffic policemen had high prevalence of muscle discomfort in low back since they had high exposure to driving where they needed to spend their shift in the same car all day [5]. They agreed that traffic policemen experiencing MSD for longer periods of time within the past year compared to other policemen on general duty. They also found that police motorcyclists had a higher percentage of muscle discomfort in their shoulder compared to traffic car drivers. Lower back is also found as most frequently reported muscle discomfort area compared to other part of body [12]. The summarised of MSD in previous studies among police officers was illustrated in Table 1.

Hanumant and Dhamejani, (2015) suggested that poorly designed motorcycle seat or car seats can affect the driver health such as MSD [17]. He found that health and safety parameters are the most important parameters in order to design a good seat. Besides, Nishant et al., (2015) concluded that contour and design of the seat directly affects individual health [18]. He suggested that in order to reduce muscle discomfort among drivers, a proper seat for them has to be designed.

### DISCUSSION AND CONCLUSION

Overall, police officers have a high incidence of MSD and high risk of developing muscle discomfort during vehicle usage. Further research is required to tackle this muscle discomfort and MSD problem especially in ergonomic vehicle design and intervention to reduce this risk among police officers.

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**Table 1: The Prevalence of MSD among Police Officers**

Previous study of MSD among police officers					
Ref.	Author (Year)	Country	Number of respondents	Part of body studied	Prevalence of MSD
[6]	Yusof (2016)	Malaysia	137	Neck, shoulder, upper back, elbow, hand, low back, thigh, knee, ankle	67.9%
[13]	Ana et al. (2015)	Brazil	262 police officers	Neck, shoulder, back. Elbow, forearm, low back, wrist, hips, knee, ankle	75%
[14]	Phadke et al. (2015)	India	270 traffic police	Neck, shoulder, back. Elbow, forearm, low back, wrist, hips, knee, ankle	74%
[12]	Cho et al. (2014)	Korea	353 police officers	Neck, shoulder, Elbow, lumbar, wrist, leg	76.8%
[15]	Nazmul (2013)	Bangladesh	40 traffic police	Lower back	80%
[11]	Anderson et al. (2011)	Canada	30 police officers	Lower back	86%
[16]	Brown (1998)	Canada	1002 police officers	Lower back	44 - 62%
[5]	Gyi and Porter (1998)	United Kingdom	80 traffic car drivers and 91 general duty officers	Lower back	38% (traffic car drivers) and 22% (general duty officer)

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## EXTENDED ABSTRACT

# Indoor Airborne Bacteria and Fungi (Bioaerosol) and Respiratory Symptoms among Manufacturing Workers

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### SUMMARY

This is a cross-sectional study aims to estimate the concentration of bio-aerosols in a manufacturing factory. There were 108 respondents involved with 100% response rate. Self-administered questionnaire was used to collect information on socio-demographical characteristics and work characteristics. IUATLD standardized questionnaire was used to measure respiratory symptoms among respondents. Duo Sas Super 360 was used to measure the concentration of airborne bacteria and fungi. Twenty four air sampling was completed. Findings shows that only prayer room (650 cfu/m<sup>3</sup>) recorded to have bacteria concentration beyond the standard acceptable limit. The most prevalent reported respiratory symptoms were cough and phlegm (22.2%) followed by wheezing and chest tightness (20.4%). There were no significant association between socio-demographical factors, work factors and airborne bacteria and fungal concentration with respiratory symptoms. Better ventilation with regular cleaning of prayer cloth and carpet is warranted for the prayer room. Future study is recommended to include knowledge, attitude and practice related to hygiene among workers.

**Keywords:** Indoor, Bioaerosol, Respiratory symptoms

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### INTRODUCTION

Generally, people spent most of their time indoor either in their home or at their workplace. The WHO (2009) recognized good indoor air quality (IAQ) is a basic human rights and a very important determinants of people's health and productivity[1]. Growing evidence shows that IAQ can be more hazardous than outdoor air due to the presence of various contaminants [2] including chemicals, physical, bio-aerosol and radiation. For example, exposure to bio-aerosol can cause respiratory infection, sensitization and allergic reaction [3]. The main indoor bio-aerosol airborne bacteria, viruses, and fungi which originates from human, pets, plants, piping, air-conditioning systems, mold, dust resuspension and the outdoor background [4]. This study is among a few that aims to determine the concentration of indoor airborne bacteria and fungi and its association with respiratory symptoms among manufacturing workers.

### MATERIALS AND METHODS

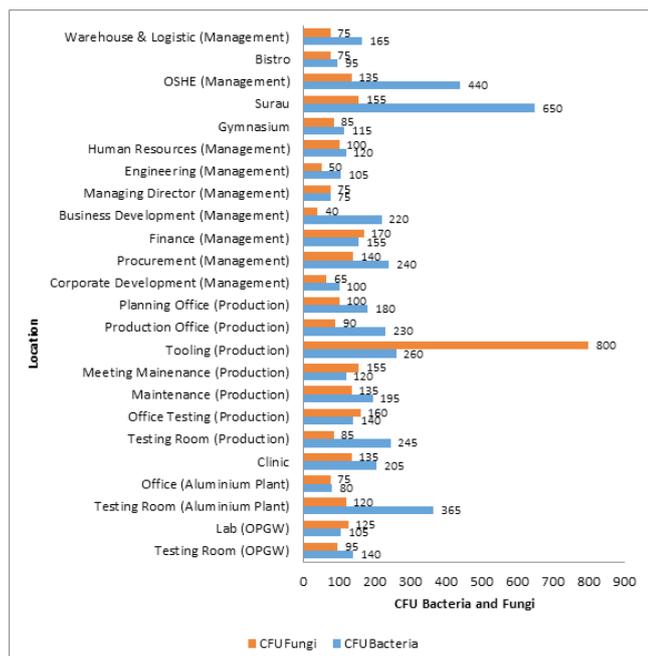
This is a cross-sectional study conducted in a cable

manufacturing factory in Selangor. The response rate was 100% involving 108 workers in the factory. Through observation, two types of air-conditioning system are used at study location, split air-conditioning system and centralized air conditioning system where 75% of sampling location used split air-conditioning system and only 25% was used centralized air conditioning system. The numbers of occupants at sampling location ranged in 2 to 20 peoples. Mostly, the room have six occupants but for the management office, the number of occupant was highest (10 to 15 workers). Malay language self-administered questionnaire were used to collect data on socio-demographic factors and working information. It consists of standardized questionnaire of International Union against Tuberculosis and Lung Disease (IUATLD) to measure respiratory symptoms. IUATLD consists of fourteen questions on respiratory symptoms such as cough, chest tightness, wheezing and phlegm. The IUATLD was reported to have significant inter-rater reliability (Kappa index = 0.70-0.95) [5]. Airborne bacterial and fungal concentration was collected using Duo Sas Super 360 with Trypticase soy agar (TSA) and Sabouraud Dextrose Agar (SDA) agar plate at 24 locations. Air samples were collected near occupants' breathing zone approximately 0.7 - 1.5 m above the floor. Sampling locations were no closer than 1 m to a wall, window, door, or ventilation system. The sampling was run for 2 minutes [6]. After sampling, the agar

media plates were sealed using parafilm to avoid cross contamination from the environment. The sampling media were incubated in an inverted position at 37oC for 1-2 days for bacteria culture and at 20-25 oC for 3-5 days for fungi culture and the colony forming unit/ m3 (CFU) was calculated. The techniques for sampling the air sampling was used as proposed in the NIOSH Method 0800 (1998). All data were analyzed by using Statistical Package for Social Science (SPSS) Version 21.0. The ethical approval and consent was obtained from the Universiti Putra Malaysia (UPM) Ethical Committee (FPSK (EXP16-OSH) U051).

**RESULTS**

Among the respondents, 74.1% were males and 25.9% were females and mostly ranged between 26-30 years old, married (77.8%), university or college graduates (50.9%). Only 5.0% had income above RM5000 and 32.4% were smokers. The CFU calculated for bacteria was 75-650 and for fungi was 40-800. The highest concentration of bacteria (650 cfu/m<sup>3</sup>) was found in female prayer rooms whereas the concentration of fungi found highest in tooling room (800 cfu/m<sup>3</sup>) (Figure 1).



**Figure 1: CFU Bacteria and Fungi based on different location in different location**

For respiratory symptoms, 20.4% of respondents had wheezing and chest tightness, 5.6% had shortness of breath, 22.2% had cough and phlegm, 5.6% had allergic reaction, and 14.8% had being diagnosed to have asthma (Table I). In bivariate analyses, none of the socio-demographical factors and bio-aerosol concentration of bacteria and fungi were significantly associated with respiratory symptoms.

**DISCUSSION AND CONCLUSION**

Findings showed generally the concentration of bacteria

**Table I: Respiratory symptoms among respondents (N=108)**

Symptoms	Yes (%)	No (%)
Wheezing and Chest Tightness	22 (20.4)	86 (79.60)
Shortness of breath	6 (5.6)	102 (94.4)
Cough & Phlegm	24 (22.2)	84 (77.8)
Allergies to animal, dust and fur	6 (5.6)	102 (94.4)
Asthma	16 (14.8)	92 (85.2)

and fungi was within the acceptable limit. Only the prayer room recorded to have bacteria concentration exceeded the acceptable limit [7]. The prayer room was small and installed with split unit air conditioning system and placed with female prayer cloth and carpet which consistently in contact with water from ablution. Without proper ventilation system, this condition favours the accumulation of bacteria. Therefore, better ventilation for the prayer room with regular cleaning of prayer cloth and carpet is warranted. Since most of the biological hazards measured in the study location is within acceptable level, the respiratory symptoms suffered by respondents might be due to other factors which is not covered in this study. Future study is recommended to include knowledge, attitude and practice related to hygiene among workers.

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## EXTENDED ABSTRACT

# Exposure to PM<sub>2.5</sub> and Micronucleus Frequency among Traffic Policemen in the Urban Areas of Klang Valley

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### SUMMARY

Exposure to PM<sub>2.5</sub> from traffic-related air pollution (TRAP) can cause health risk among residents in the urban area. Those who work outdoors are vulnerable to TRAP. PM<sub>2.5</sub> from TRAP contain various carcinogenic and mutagenic compounds that can cause genotoxicity to human health. This study indicated that exposure to the higher level of PM<sub>2.5</sub> in the urban areas had exhibited an increased in the formation of micronucleus (MN) among respondents. Traffic policemen experienced a high concentration of PM<sub>2.5</sub> that lead to higher MN frequency compared to the office workers.

**Keywords:** PM<sub>2.5</sub>, Traffic-related air pollution, Genotoxicity, Micronucleus, Traffic policemen

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### INTRODUCTION

Fossil fuel combustion from vehicle exhaust produces various compounds that can affect human health. Particulates matter (PM) generated from the combustion process, especially diesel exhaust particulates, are even more important in lowering the health effects of non-combustion processes [1]. An International Agency for Research on Cancer (IARC) has defined the diesel and petrol vehicle exhaust pollutants as group 2A and 2B carcinogenic to human [2]. These pollutants are the main source for traffic-related air pollution (TRAP) [3]. About 50% of PM with aerodynamic diameter  $\leq 2.5 \mu\text{m}$  (PM<sub>2.5</sub>) emissions in the urban was originated from TRAP especially from vehicle exhaust [1]. Exposed to TRAP also could cumulative DNA damage as an early step toward cancer risk [4]. Usually, due to the sensitivity of the micronucleus (MN) frequency on genotoxic assessment, this method is frequently used for DNA damage assessment and 1 to 3 per 1000 cells frequency of MN will explain healthy population [5]. Traffic policemen are the critical group that has a high level of exposure to TRAP especially those who involve in control the traffic flows. This study's was aim to discover the exposure risk of PM<sub>2.5</sub> to MN frequency formation among the respondents.

### MATERIALS AND METHODS

This was a cross-sectional comparative study conducted among the traffic policemen (160) and office workers (149) in Klang Valley. A set of questionnaires developed comprised of information on demographic, occupational, residential, environmental tobacco smoke (ETS), daily activities, food intake, allergies, and health status were distributed to both groups of respondents. This study was approved by the Ethical Committee, Universiti Putra Malaysia (JKEUPM-2017-247). The PM<sub>2.5</sub> personal exposure level was measured using Sidepak AM520 Personal Aerosol Monitor (TSI) during working hours. The buccal mucosal cell was collected from each individual by sterile cytology brush. Micronucleus assay was prepared, described and scored according to Philip Thomas [6]. Data collected were analyzed using the Statistical Package for Science Version 23 (SPSS Ver. 23).

### RESULTS

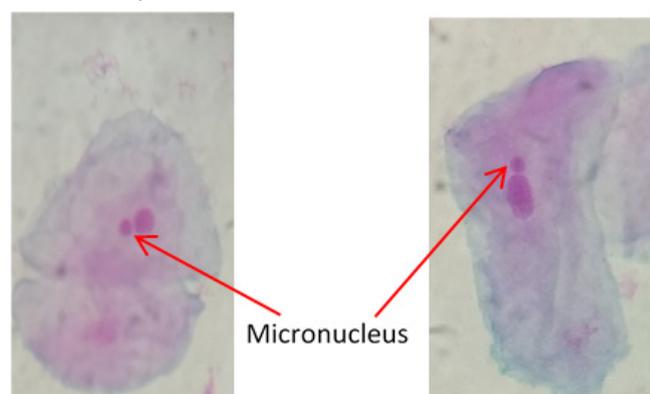
Out of 308 respondents, only 195 respondents selected for personal air sampling and 215 respondents selected for MN assay. The comparison of PM<sub>2.5</sub> exposure and MN frequency were presented in Table I. The median of PM<sub>2.5</sub> personal exposure was 89.00  $\mu\text{g}/\text{m}^3$  for the traffic policemen and 30.00  $\mu\text{g}/\text{m}^3$  for the office workers. The PM<sub>2.5</sub> exposure among traffic policemen was 3-fold higher than office workers. There was a significant difference of PM<sub>2.5</sub> levels among the traffic

**Table 1: Comparison of personal level of PM<sub>2.5</sub> and MN frequency among respondents**

Variables	Group	Median	IQR	Z	p
PM <sub>2.5</sub> (µg/m <sup>3</sup> )	Exposed (n=105)	89.00	41.00	-15.685	>0.001*
	Comparative (n=90)	30.00	9.00		
MN Frequency (%)	Exposed (n=110)	6.3	2.6	-10.848	>0.001*
	Comparative (n=105)	3.0	2.0		

\*Significant at p<0.05, N =195; exposed = 105; comparative = 90

policemen and office workers (z = -15.685, p = < 0.001). Meanwhile, the median percentage of MN frequency among the traffic policemen was 6.3 percent and 3.0 percent for the office workers. There was significant difference of MN frequency among traffic policemen and office workers (z = -10.848, p < 0.001). Figure 1 show MN in the buccal cell under 1000x magnification microscope. The correlation between PM<sub>2.5</sub> and MN frequency showed a strong positive relationship with r = 0.725 at p < 0.001.



**Figure 1: Micronucleus formation in the buccal cells under 1000x magnification**

### DISCUSSION AND CONCLUSION

As a conclusion the traffic policemen had three times higher of exposure to PM<sub>2.5</sub> pollutant compared to the

office workers. Furthermore, the formation MN among traffic policemen also two times higher than office workers. In addition, present study advised that exposure to pollutants from TRAP would increase MN frequency among traffic policemen.

### ACKNOWLEDGEMENT

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## EXTENDED ABSTRACT

# Traffic Related Air Pollution and Its Impact on Respiratory Health among Children

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### SUMMARY

Exposure to traffic related air pollution (TRAP) is a public health concern particularly in children, who are one of the most susceptible groups of the population. Children are more vulnerable to such exposure by virtue of their increased susceptibility and the higher doses received. The materials for this review was obtained from several online databases; PubMed, Proquest, Scopus, Springerlink and Science Direct (year 1990 to 2018). In this review, we emphasized several relevant studies on respiratory health effects among children living in the proximity to heavy traffic area and focus on the factors, which contributed to the severity of the health outcomes. Short term TRAP exposure reduces lung function, increases respiratory symptoms and incidence of asthma and allergic diseases especially for those who living within 75 m from the heavy traffic area. Preventive measures must be taken in order to protect children from exposure to traffic air pollutants.

**Keywords:** PM<sub>2.5</sub>, Traffic-related air pollution, Respiratory Health, Children

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### INTRODUCTION

Traffic related air pollution (TRAP) is the main contributor to global air pollution. The increasing number of vehicles remains the most significant source of air pollution in many urban areas. Traffic is an increasingly important source of particulate matter (PM), especially fine PM with an aerodynamic diameter less than 2.5µm (PM<sub>2.5</sub>). PM<sub>2.5</sub> can penetrate easily into respiratory tract and reach circulatory system and be more toxic than coarse particles. There are several epidemiological studies found that the exposure to TRAP plays important role in aetiology and prognosis of a large scale of illnesses, including asthma, impaired lung function, allergy, adverse birth outcomes, cardiovascular disease and cancer (1, 2). Exposure to TRAP is a public health concern particularly in children, who are one of the most susceptible groups of the population. In this review, we emphasize a summary of epidemiological studies conducted on various respiratory health outcomes among children who lived or attend school near heavy traffic area.

### MATERIALS AND METHODS

This review has been conducted by using the online

databases from scientific journal search engines, which were Science direct, Springerlink, Pubmed, and Google Scholar. The year of reviewed publication is within 2000 to 2018 and written in English Language. The articles used in this study were full-published papers, including original scientific papers, reviews and letters, which emphasized on TRAP and respiratory health outcomes among children only. The identified articles were chosen by keywords "Heavy Traffic and Children", "Traffic Related Air Pollution and Children's Respiratory Health", "Heavy Traffic and Acute Health Effect". Occupational exposure was excluded from the search criteria. The article that is fulfilled the criteria were reviewed in full.

### RESULTS

Based on literature surveys, we found 8 relevant studies on the association between TRAP exposure and acute respiratory health effects among children.

#### Respiratory Symptoms

Questionnaire filled by parent or legal guardians are commonly used to ascertain respiratory symptoms among children. A cohort study was conducted to assess the effect of exposure to TRAP on respiratory health of 147 asthmatic and 50 healthy children, residing in Mexico City (3). The subjects were followed up for an average of 22 weeks to assess the incidence density of coughing, wheezing and breathing difficulty by referring to daily records of symptoms and child's medication.

The exposure to PM<sub>2.5</sub>, NO<sub>2</sub> and O<sub>3</sub> were estimated from four fixed-sites for central monitoring at locations within the study area and air monitoring at each school were conducted to validate the data obtained from the fixed-site monitoring stations. Statistical analysis showed that wheezing was related significantly to PM<sub>2.5</sub> (95% CI: 2.4% to 15.5%); NO<sub>2</sub> (95% CI: 2.3% to 16.4%) and O<sub>3</sub> levels (95% CI: 3.2% to 17.3%). The traffic density was found significantly related to respiratory symptoms (coughing and/or wheezing) in asthmatic children. When accounting for the distance from the child's residence to the main avenue, the risk of wheezing decreased significantly with greater distance (IRR = 0.69; 95% CI: 0.49 to 0.98) with an increase in distance of 212 m.

Venn et al. (4) had conducted study on the effect of living close to a traffic bearing road on the risk of wheezing in Jimma, Ethiopia. They have used data from a previous study conducted by Yemeneberhan et al. (5) on survey of respiratory symptoms, allergic disease, and demographic and lifestyle factors among 9844 children and adults living in 21 administrative districts in Jimma, Ethiopia. In 2003, the homes of these people were retraced. The shortest distance to the nearest surfaced road and traffic flows on these roads were measured. The result of the study showed that among 3,592 individuals living within 150 m of a road, the risk of wheeze increased significantly in linear relation to proximity to the road (adjusted OR = 1.17 per 30 m proximity; 95% CI, 1.01–1.36). These findings indicate that living in close proximity to road vehicle traffic is associated with an increased risk of wheeze, but that other environmental factors are also likely to be important.

### Allergic Disease

Jung et al. (6) had conducted a cross sectional study to assess the relationship of living near to main roads to allergic diseases among 5,443 Korean children aged 6-14 years. The diagnosis of allergic disease was made on the basis of the questionnaire survey completed by parents and the measurement of allergic sensitization was made using skin prick test. The TRAP exposure including the distance to busy roads, the length of main roads and main road density in the home area were assessed using geographical information system (GIS). Based on the data, children living less than 75 m from the main road were significantly associated with lifetime allergic rhinitis (AR), past-year AR symptoms, diagnosed AR and treated AR. Moreover, there was a positive association between living alongside busy roads and allergic sensitization.

In another cohort study by Morgenstern et al. (7), they investigated atopic diseases and allergic sensitization among 2,860 children at the age of 4 years and 3,061 at the age of 6 years. Based on the study, a strong positive association were found between the distance to the nearest main road and hay fever, eczema, and sensitization. A distance-dependent relationship could

be identified, with the highest odds ratios (ORs) for children living less than 50 m from busy streets. For PM<sub>2.5</sub> absorbance, statistically significant effects were found for hay fever (OR, 1.59; 95% CI, 1.11–2.27) and allergic sensitization to pollen (OR, 1.40; 95% CI, 1.20–1.64). Moreover, NO<sub>2</sub> exposure was associated with eczema, whereas no association was found for allergic sensitization.

### Asthma

In a study of McConnell et al. (8) on traffic and childhood asthma, they found that residence within 75 m of a major road was associated with an increased risk of lifetime asthma, prevalent asthma and wheeze with odds ratio 1.29 (95% CI: 1.01–1.86), 1.50 (95% CI, 1.16–1.95), and 1.40 (95% CI, 1.09–1.78) respectively. Interestingly, the findings revealed that long-term residents with no parental history of asthma have increased susceptibility for lifetime asthma, prevalent asthma and recent wheeze with odds ratio 1.85 (95% CI: 1.11–3.09), 2.46 (95% CI: 0.48–4.09), and 2.74 (95% CI: 1.71–4.39). They concluded that residence near a major road is associated with asthma and the reason for larger effects in those with no parental history of asthma needs further study. Another study in New York City was conducted to assess the association of personal exposure to TRAP and acute respiratory health among schoolchildren with asthma (9). Based on statistical analysis, they found relative risks of wheeze [1.45; 95% confidence interval (CI), 1.03–2.04], shortness of breath (1.41; 95% CI, 1.01–1.99), and total symptoms (1.30; 95% CI, 1.04–1.62) with an increase in personal elemental carbon. The study indicated that adverse health associations were strongest with personal measures of elemental carbon exposure, suggesting that the diesel soot fraction of PM<sub>2.5</sub> is most responsible for pollution-related asthma exacerbations among children living near roadways.

### Lung Function

Lung function test is a common test used to assess how well the lungs work, through deep inhalation and expiration process by using a spirometer. The measurement reflects that children with the highest lung function possess the highest lung growth. In this review, several scientific studies have been identified demonstrating lung health condition among children living near the heavy traffic area. Anis and Juliana (1) had found that there was a significant difference of indoor PM<sub>2.5</sub>, lung function abnormality and respiratory symptoms between exposed and comparative group with the value of (t=-2.496, p=0.014); ( $\chi^2$  =17.926, p=0.000) and ( $\chi^2$  =7.259, p=0.007) for predicted FEV% and FVC%; and (p=0.000) respectively. However, it was reported in the study that overall lung function status was weakly associated with indoor PM<sub>2.5</sub>.

Another cohort study by Rice et al. (10) found that estimation of long-term exposure to ambient pollution, including proximity to major roadway, PM<sub>2.5</sub> and black

carbon were associated with lower lung function in Boston children. Statistical analysis showed that distances greater than or equal to 400 m, living less than 100 m from a major roadway was associated with lower FVC ( $-98.6$  ml;  $-176.3$  to  $-21.0$ ). The study indicated that residential proximity to roadway and prior-year and lifetime  $PM_{2.5}$  and black carbon exposure were all associated with lower FVC.

## DISCUSSION AND CONCLUSION

Various study designs are used in air quality studies including cross sectional study and cohort study. Based on TRAP related literatures, 2 studies used cross sectional study (1,6) and 6 studies used cohort study design (3,4,7-10). In cross-sectional survey, the limitation is causal inference cannot be made whereby the explanation of causal relationship is limited between traffic exposure and diseases. As compared to cohort study, the investigation on health effects in cross sectional study is conducted at a single point in time and therefore may create bias in reflecting real exposure. For instance, in a cross sectional study (6), they had identified the symptoms of allergic diseases based on parent-reported questionnaires. Responses could have been dependent on parents' awareness on allergic symptoms which may result in recall bias and probability of misclassification of disease. Meanwhile in cohort study, the use of rich information on the confounders could confirm the association between TRAP and the diseases. Besides, the prospective nature of cohort study also allow the evaluation of association between daily changes in air pollutants level and symptoms which can represent specific differences in children's health symptoms over time (3).

Several exposure metrics are used in TRAP studies investigating health effects, mainly on central-site monitoring data (3, 8), modeled exposure variables (7), or employed proximity to roadway (4, 6, 10). As compared to study that uses personal measurement, the study has the ability to obtain daily measures of personal exposure rather than distance from roadway indices or central site data. For example, a study (9) found associations using school-site monitoring for elemental carbon, suggesting that school-site stationary measurements of elemental carbon may be representative of average daily personal exposures across the study participants in urban setting. However, they found the strongest and most consistent health–elemental carbon associations with more accurate personal measure. Therefore, exposure–health effects studies that rely on exposure measurement from central-site monitors may be underestimating health relationships with pollutant. The use of estimated measures based of near roadway exposure based on model may not reflect actual personal exposure and thus lead to some exposure misclassification. Many studies found that a shorter distance from the residence to the nearest main road, especially within a

75-m home area, was significantly related to an increased prevalence of respiratory health symptoms. In German cohorts, children aged 4 and 6 years living closer than 50m to a busy street had the highest probability of getting allergic symptoms compared with children living further away than 50m, 250m and 1000m (7). A significant association was also found between the prevalence of asthma and living within 75 m of a major road in the Southern California Children's Health Study (8). In contrast, a study (4) found the prevalence of wheeze in those living away from roads ( $>150$ m) was greater than those living within 150m of a surface road suggesting that some other environmental factors may play an important role in asthma aetiology in this population. To evaluate the effects of air pollution on health, the potential involvement of indoor air pollution should be measured as it could also be responsible for asthma and allergic disease. Exposure to TRAP also is influenced by the type of building, the type of traffic on the road, the presence of physical obstructions between the road and the home, the amount of time spent at home and exposure elsewhere (6). Besides, assessment on genetic influences should be considered as genetic characteristics may also increase susceptibility to air pollutants (3).

In conclusion, most of the epidemiological studies demonstrated that children living nearby heavy traffic area have a greater risk of respiratory health impairment. Thus, preventive measures must be taken in order to protect children from exposure to environmental pollutants.

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## EXTENDED ABSTRACT

# Generation of Municipal Solid Waste in South East Asian Countries

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### SUMMARY

Agriculture activity in Cameron Highland is one of the sources of river water pollution. This study evaluates the physicochemical properties and heavy metals contamination (Cu, Cd, Zn, Cr, Pb) in Bertam River. The results indicate the river water pH was slightly acidic. Based on the Malaysia National Drinking Water Quality Standard (NDWQS), the river water is not suitable for drinking as it has exceeded the safe value for turbidity, chemical oxygen demand COD and lead (Pb). Spatial distribution of heavy metals showed that Cr, Cu and Pb were concentrated at the downstream area.

**Keywords:** Agriculture, River, Spatial analysis, Heavy metals, Health risk

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### INTRODUCTION

Heavy metals contamination in river water has been a major concern due to their potential ecological and health risk effect [1]. Heavy metal has high persistency and tendency to bio-accumulate in vital human organs such as liver, kidney and bones. Heavy metals enter the river through pesticides and other chemical fertilizer in agricultural runoff, stormwater drains and industrial discharges may persist in the environment for long periods and be transported by water or air over long distances [2]. Wastewater discharged from the residential area and domestic wastes also produced a significant contribution to heavy metals contamination in the river catchment area [3]. Other factors that contribute to the heavy metals pollution in the river are land use change, legal and illegal farming, uncontrolled river water abstraction in upstream, poor solid waste management, low awareness of local community, unplanned development, and inefficient administration [4]. Since river system is carrying a one-way flow of a significant load of matter from dissolved and particulate phases from natural and anthropogenic sources [5], it produces a significant health risk to human, especially through drinking water. The exposure to a toxic concentration of heavy metals can result in human health problems,

particularly in non-carcinogenic and carcinogenic risk to adult and children even at traces value [6, 7]. The objective of this study is to assess the pollution level of heavy metals (Cu, Cd, Zn, Cr and Pb) and potential health risk in the Bertam river of an intensive agriculture area Cameron Highland, Malaysia.

### MATERIALS AND METHODS

Water samples were collected along Bertam River of an intensive agriculture area and a well-known tourist attraction area, Cameron Highland, Malaysia. It is known as the center for extensive agriculture area [8] and heavy doses of various types of fertilizers and pesticides application by farmers were reported [9]. Bertam River covers an area of 73 km<sup>2</sup> and it provide an essential drinking water supply, irrigation for local cultivation activities and hydroelectricity generation [10, 11]. Bertam River catchment covers an area of 293.7 km<sup>2</sup> and is drained by complicated river network influenced by hilly and undulating terrain system. It is the main river flowing from Brinchang Mountain through Brinchang Town, Tanah Rata, Habu and into Ringlet Reservoir. Sampling was done at 14 locations within 15 cm depth of water surface, in April 2017. Water samples were analysed for physicochemical properties and heavy metals (by inductively coupled plasma mass spectrometry (ICPMS) (Thermo Scientific Element 2 High Resolution ICP-MS, USA). Inverse Distance Weighting technique, within GIS, was used to develop the spatial distribution of the contaminants.

The health risk was calculated using the average daily dose (ADD) and Hazard Quotient (HQ) for non-carcinogenic health risk and the carcinogenic health risk was calculated through lifetime average daily dose (LADDi) and lifetime cancer risk (LCR) (Eq. 1 to 4). The HQ less than 1 is indicating acceptable risk while the Lifetime Cancer Risk (LCR) value of 10<sup>-6</sup> to 10<sup>-4</sup> indicating a range of generally acceptable.

$$ADD = \frac{C \times IR \times EF \times ED}{BW \times AT} \quad (1)$$

$$HQ = \frac{ADD}{RfD} \quad (2)$$

$$LADDi = \frac{C \times IR \times EF \times ED}{BW \times AT} \quad (3)$$

$$LCR = LADDi \times CSF \quad (4)$$

Table I describes the details of the formula and the parameter used in the health risk calculation. All of the parameter used in the HRA calculation in this study was based on the secondary sources such as from previous studies and other authorized agencies.

**RESULTS**

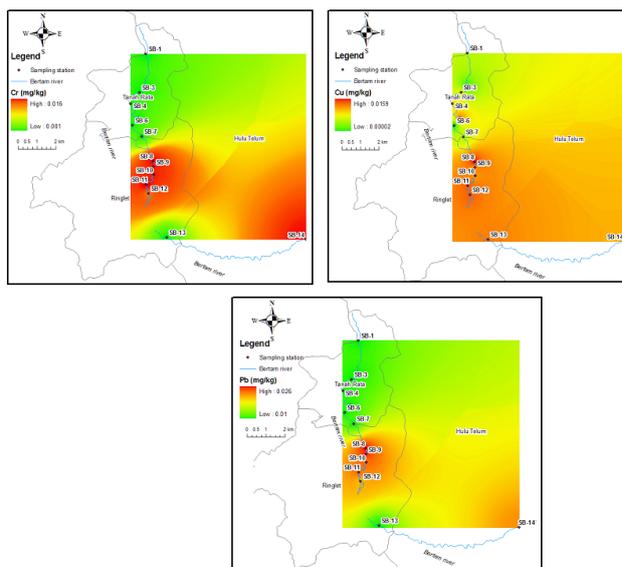
The pH value of the river water was ranged from slightly acidic to neutral (6.61 to 7.47). Most of the sample in the downstream have a high level of turbidity (234.74 ± 257.28 NTU) and chemical oxygen demand (COD) (17.23 ± 7.66 mg/l). The pH value, turbidity and Cu in the downstream area were significantly higher than in the upstream of the river (P < 0.05). The highest concentration of heavy metals was Zn (0.041 ± 0.027 mg/L), followed by Pb (0.009 ± 0.011 mg/L), Cu (0.009 ± 0.005 mg/L) and Cr (0.006 ± 0.007 mg/L). The values for all parameters were within the Malaysia National Drinking Water Quality Standard (NDWQS) with the

**Table I: The parameter used in health risk calculation**

Variables	Description	Value	Unit	Source	
C	Average concentration of heavy metal	From this study	mg/kg	From this study	
IR	Ingestion rate (average)	Adult	1.996l	l/day	12
		Children	0.0002	l/day	13
EF	Exposure frequency	Adult	365	days/year	13
		Children	350		
ED	Exposure duration	Adult	74	years	14
		Children	6		14
BW	Body weight	Adult	63	kg	12
		Children	15		14
AT	Average period of exposure	Adult	27,010	days	13
		Children	2,190		
RfD	Oral reference dose	Cu: 4.010 <sup>-2</sup> Cd: 5.010 <sup>-4</sup> Zn: 3.010 <sup>-1</sup>	mg/kg/day	15	
CSF	Cancer slope factor	Cr: 5.010 <sup>-1</sup> Pb: 8.510 <sup>-3</sup>	mg/kg/day	13	

exception of turbidity, COD and Pb. Thirteen of the samples exceeded the standard value for turbidity, 11 samples exceeded the standard value for COD and 6 samples exceed the standard value for Pb. Only one sample has exceeded the standard value of BOD (Table II).

Fig. 1 shows the spatial distribution of heavy metals contamination along Bertam River. Most of the metals were concentrated towards the downstream of Bertam River starting from SB-8 to SB-14. Cu and Zn are the most significant element found related to agriculture activity and the concentration of this element was mostly concentrated in a wider area along the river. Meanwhile, Zn was concentrated in the middle of the river (SB-8 and SB-9). The health risk quantification from heavy metals exposure via water consumption in this study, through HQ and LCR values were within an acceptable range as shown in Table III. However, if the heavy metals in the river increase with time and activities, and the people in the area continue to drink from the river, the exposure to heavy metals for long term would lead to an increased risk and might posed significant health hazard towards adult and children.



**Figure 1: Spatial distribution of Cr, Cu and Pb along Bertam River**

**DISCUSSION AND CONCLUSION**

Results indicate a significant impact of intensive agriculture activities in Cameron Highland to the river water of Bertam through the result of water pH, turbidity and COD level. Water pH is influenced by the amount of organic material within the water body. The decomposition of organic material will release carbon dioxide and formed carbonic acid with water and reduce the pH value. The increased use of alkaline detergents in residential areas and alkaline material from wastewater also associated with the increased of water pH [16-18]. High turbidity is associated with landslide and erosion in the area due to high rainfall that possibly produce

**Table II: The descriptive statistic of physicochemical properties and heavy metals in water samples (N=14)**

Catchment	Station	pH	TDS (g/L)	Turbidity (NTU)	COD (mg/L)	BOD (mg/L)	Cr (mg/kg)	Cu (mg/kg)	Pb (mg/kg)	Zn (mg/kg)
Upstream	SB-1	6.90	0.01	3.96	7.03	BDL	BDL	0.005	BDL	0.03
	SB-2	6.96	0.062	13.49	33.18	18.8	BDL	BDL	BDL	0.03
	SB-3	6.83	0.056	23.97	16.24	5.1	BDL	0.007	BDL	0.02
	SB-4	6.82	0.053	45.70	14.48	3.6	BDL	0.009	BDL	0.02
	SB-5	6.90	0.049	15.55	12.95	2.8	BDL	0.013	BDL	0.02
	SB-6	6.80	0.047	20.81	11.75	0.8	BDL	BDL	BDL	0.02
	SB-7	6.90	0.050	25.57	15.09	3.9	BDL	0.005	BDL	0.02
	SB-8	6.62	0.034	537.17	19.83	0.6	0.015	0.016	0.026	0.11
	SB-9	6.99	0.034	537.37	20.72	1.1	0.014	0.012	0.025	0.06
Downstream	SB-10	6.79	0.0267	527.55	21.24	1.1	0.014	0.012	0.022	0.06
	SB-11	6.79	0.037	523.14	29.64	1.1	0.016	0.014	0.022	0.06
	SB-12	6.76	0.040	389.63	21.23	0.8	0.01	0.014	0.017	0.05
	SB-13	7.01	0.025	34.71	9.35	1.4	BDL	0.013	BDL	0.02
	SB-14	7.47	0.080	587.45	8.52	BDL	0.015	0.011	0.02	0.06
Overall upstream	Mean (SD)	6.86 (0.17)	0.042 (0.002)	92.88 (51.95)	16.81 (7.40)	4.08 (0.88)	0.0032 (0.006)	0.0070 (0.006)	0.0057 (0.011)	0.0368 (0.031)
Overall downstream	Mean (SD)	7.01 (0.09)	0.044 (0.005)	371.68 (88.09)	18.00 (8.94)	5.79 (0.54)	0.0110 (0.007)	0.0128 (0.001)	0.0162 (0.009)	0.0490 (0.019)
Range		6.62-7.47	0.01-0.08	3.96-587.45	7.03-33.18	0.01-18.80	BDL – 0.016	BDL – 0.016	BDL – 0.026	BDL – 0.110
NDWQS		6.5-9.0	1.0	5	10 <sup>a</sup>	6 <sup>a</sup>	0.05	1.0	0.01	3.0
No. of sample exceed standard		0	0	13	11	1	0	0	6	0
p-value <sup>b</sup>		0.001*	0.120	<0.001*	0.436	0.150	0.918	0.025*	0.506	0.595

Note: BDL- below detection limit, SD = Standard deviation, NDWQS = National Drinking Water Quality Standard, <sup>a</sup>Recommended raw water quality standard, Ministry of Health Malaysia; BDL = below detected limit The comparison of physicochemical properties with the Malaysian National Drinking Water Quality Standard (NDWQS), <sup>b</sup>t-test was performed to compare the value of the parameter between the upstream and the downstream of Bertam river, \*significant difference was obtained at p < 0.05, Cd was below detection limit in all samples.

**Table III: Non-carcinogenic hazard quotient and carcinogenic lifetime risk for adult due to exposure to heavy metal**

Elements	Carcinogenic health risk				Non-carcinogenic health risk			
	Adult		Children		Adult		Children	
	LADDi (mg/kg/day)	LCR	LADD (mg/kg/day)	LCR	ADD (mg/kg-day)	HQ	ADD (mg/kg-day)	HQ
Cr	0.500	9.5 x 10 <sup>-5</sup>	6.57 x 10 <sup>-9</sup>	3.29 x 10 <sup>-9</sup>	0.0003	0.007	1.20 x 10 <sup>-7</sup>	2.99 x 10 <sup>-6</sup>
Pb	0.0085	2.54 x 10 <sup>-6</sup>	1.03 x 10 <sup>-8</sup>	8.78 x 10 <sup>-11</sup>	0.0013	0.004	5.26	1.75 x 10 <sup>-6</sup>

Note: LADDi - lifetime average daily dose; LCR – lifetime cancer risk; ADD – average daily dose; HQ – hazard quotient, Cr – chromium; Pb – lead; Cu – copper; Zn - zinc

upstream erosion and sedimentation in this area [19-20]. Total suspended solids (TSS) and turbidity in the water were strongly influenced by the agricultural coverage and land pattern development [21-22]. High COD level in the river suggest pollution in the water [23]. Heavy metals contamination by Pb is related to anthropogenic activities such as discharging waste from agriculture industries and untreated domestic sewage into the river is continually increasing in the concentration of heavy metals [11, 23 - 24]. Pesticide application also may produce heavy metals contamination [25] because only 25% of the pesticide product effectively reaches the target plant or crop, while the rest is carried by air or rain and flow to the water catchments. This may result in the increase of heavy metals particularly Cd, Pb, and As [26]. Ingestion of water containing a certain amount of heavy metals can cause health problems such as

shortness of breath and various types of cancer [27]. Pb can have serious consequences for children health. At high levels of exposure, Pb attacks the brain and central nervous system to cause coma, convulsions and even death.

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## EXTENDED ABSTRACT

# Human Health Hazard: The Registered Pesticides from Globally Harmonized System of Classification and Labelling of Chemicals (GHS) in Malaysia

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### SUMMARY

In Malaysia, chemical pesticides are widely used not only for agricultural development, but also to public health, household to control diseases, pests or weeds. In order to ensure that the information of the pesticides' hazard properties conveyed to all pesticide users, the Globally Harmonized System of Classification and Labelling of Chemicals (GHS) has initiated to promote standard criteria for classifying chemicals according to human health, physical and environmental hazards. Even though statuses of GHS implementation on pesticides are remained unstandardized across different countries, Malaysia has taken proactive measures to implement the GHS at the workplace through the promulgation of the Occupational Safety and Health (Classification, Labelling and Safety Data Sheet of Hazardous Chemicals) Regulations 2013 (CLASS Regulations). This paper attempted to summarize the health hazards of pesticide chemicals registered in Malaysia by summarizing the nature of the registered pesticides' hazards classification based on GHS in order to understand the current situation of GHS adoption in pesticides sector in the country. Overall, registered pesticides in Malaysia are known to cause either acute or chronic health effects. Out of 3,610 pesticides registered under the Pesticide Board, a total of 2,241 pesticides are listed as highly hazardous pesticides (HHP). Even though GHS includes appropriate labelling tools to convey information about each of the hazard classes and categories, several limitations have found when classifying appropriate hazard class and categories to individual pesticides.

**Keywords:** Pesticide; Globally Harmonized System; Health hazard; Highly hazardous pesticides

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### INTRODUCTION

Hazardous pesticides are used in different sectors and can cause serious effects on human health. Studies have shown that pesticides' toxicological effects can be ranged from carcinogenic, endocrine disrupting, to toxic to the reproductive system. The diffuse exposure to these hazardous substances can be harmful to vulnerable communities especially among children, women, pregnant women and elderly when even very small amount of exposure can cause severe health effects.

The Globally Harmonized System of Classification and Labelling of Chemicals (GHS)[1] is a worldwide initiative to promote standard criteria for classifying chemicals according to their health hazards. Even though GHS has been adopted for industrial chemicals in the workplace by a significant number of countries, many of them still follow the FAO Guidelines on Pesticide Registration

and the FAO Guidelines on Good Labelling Practice for Pesticides to carry out pesticide hazard classification and prepare pesticide labels. Neighboring country like Philippines, Thailand, Vietnam, and Singapore has not adopted GHS for pesticides yet. Countries in other Asia-Pacific regions, such as Japan, China, Korea has also yet to adopt GHS for pesticides, except Australia where the GHS hazard classification and safety data sheets are required when applying for pesticides registration approval [3]. In view of this, this paper aims to summarize the nature of the registered pesticides' health hazards classification based on GHS in order to understand the current situation of GHS adoption in pesticides sector in the country.

### DISCUSSION

#### Registered Pesticides and the WHO Recommended Classification of Pesticides by Hazard

In this paper, an updated list of registered pesticides from 1 March 2013 to 1 January 2018 acquired from Pesticide Board from Department of Agriculture, Ministry of Agriculture and Agro-based Industry Malaysia. A total of 3,610 pesticides are registered to use in the country in the agriculture, health and commercial sectors.

These pesticides were classified based on their target pest's organism to reflect their activity. Each registered pesticide are grouped into different classes based on their target pests which were recorded with active ingredient and its concentration, trade name, formulation, usage, pesticide toxicity level (WHO), mode of action (MoA) classification, and pesticide group.

Even though sales and the uses of pesticides are tightly regulated and controlled worldwide, different health hazards have reported to cause acute and chronic harm to humans [4]. Table I summarized the registered pesticide in Malaysia being classified based on "WHO Recommended Classification of Pesticides by Hazard". Among all, 0.7% of pesticides were classified as extremely hazardous (Class Ia), 3% as highly hazardous to human health (Class Ib), 22.5% as moderately hazardous (Class IV) and 42.4% are slightly hazardous (Class III). It is no surprise to note that pesticide market is mainly dominated by insecticides, herbicides and fungicides, which were widely known for their toxicity effects.

### GHS and Registered Pesticides' Classification

Based on the pesticide registered the Pesticide Board of

**Table 1:** Registered Pesticides and the WHO Recommended Classification of Pesticides by Hazard in Malaysia

	N	n (%)				
		Class Ia	Class Ib	Class II	Class III	Class IV
Fungicide	412	-	-	28 (6.8)	165 (40.0)	219 (53.2)
Herbicide	969	-	33 (3.4)	115 (11.9)	592 (61.1)	229 (23.6)
Insecticide	793	10 (1.3)	26 (3.3)	341 (43.0)	282 (35.6)	134 (16.9)
Rodenticide	49	-	3 (6.1)	3 (6.1)	6 (12.2)	37 (75.5)
Technical	568	3 (0.5)	35 (6.2)	210 (37.0)	375 (48.4)	45 (7.9)
Household	359	-	-	-	4 (1.1)	355 (98.9)
Public Health	127	-	-	18 (14.2)	62 (48.8)	47 (37.0)
Preservative	147	-	11 (7.5)	39 (26.5)	91 (61.9)	6 (4.1)
Termiticides	89	-	1 (1.1)	48 (53.9)	27 (30.3)	13 (14.6)
Acaricide	50	-	-	9 (18.0)	18 (36.0)	23 (46.0)
Fumigant	21	12 (57.1)	-	1 (4.8)	8 (38.1)	-
Molluscicides	26	-	-	1 (3.8)	-	25 (96.2)
<b>TOTAL</b>	<b>3,610</b>	<b>25 (0.7)</b>	<b>109 (3.0)</b>	<b>811 (22.5)</b>	<b>1,531 (42.4)</b>	<b>1,134 (31.4)</b>

Source: Pesticide Board, Malaysia (1 March 2013 – 1 January 2018)

Footnote: WHO Class Ia: Extremely Hazardous; Class Ib: Highly Hazardous; Class II: Moderately Hazardous; Class III: Slightly Hazardous; Class IV: Unlikely to present acute hazard

Malaysia, we further identify its health hazards on the from PubChem database (<https://pubchem.ncbi.nlm.nih.gov/>), a database system maintained by the National Center for Biotechnology Information (NCBI) to outline the GHS classification of each pesticide registered under Pesticides Board, as summarized as in Table II and Figure 1.

### GHS Health Hazard and Registered Pesticides' Classification

Among all the registered pesticide, the health hazard

was summarized based on H-code of each pesticide. Figure 1 shows that pesticides commonly reported as "may cause damage to organs through prolonged or repeated exposure" (H373)(22.3%), "may cause allergy or asthma symptoms or breathing difficulties if inhaled" (H332)(27.1%), "may cause allergic skin reaction" (H317)(28.2%), "harmful if swallowed" (H302)(38.5%), "toxic if swallowed" (H301)(23.5%) and "fatal if inhaled" (H330)(22%).

Table II tabulated a more detailed health hazard classification based on pesticide function and pest organism they kill. At least 41.7% of fungicides are harmful if swallowed (H302), 55.8% may cause allergic skin reaction (H317) and 20.9% are harmful if inhaled (H332). For herbicides, 39.9% are harmful if swallowed (H302), 26.3% may cause allergic skin reaction (H317), and 22.5% are harmful if inhaled. Insecticides, 50% are toxic if swallowed (H301), 36.2% are fatal if inhaled, and 36.8% are harmful if inhaled (H332). Besides, 95.9% of rodenticides are fatal if swallowed (H300), 92.8% are fatal in contact with skin (H310), 91.8% may cause damage to organs through repeated exposure and 57.1% may damage fertility. Fumigants used are likely to cause serious eye irritation (H320) and fatal if inhaled (H330).

### Highly Hazardous Pesticides (HHP) registered in Malaysia

The Pesticide International Network (PAN) provided a list of "highly hazardous pesticides (HHP)" which indicates the type of pesticides contains active ingredients intended to destroy, deter, render harmless, prevent the action of, or exert a controlling effect on any harmful or annoying organism [5]. The registered HHP are listed based on the criteria of acute toxicity, chronic health effects as shown in Table III. Out of 3,610 pesticides, a total of 2,241 pesticides registered in Malaysia are recorded to contain 91 types of active ingredients which are listed HHP.

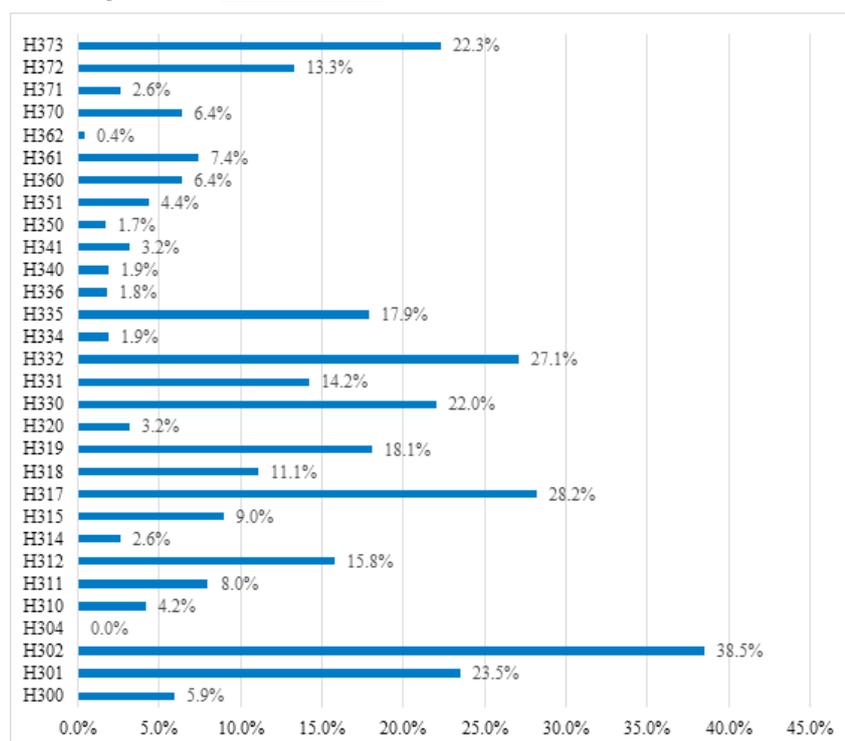
- ▶ Acute health toxicity: 5 pesticides are classified as extremely hazardous according to WHO (Class 1a), 9 pesticides are classified as highly hazardous according to WHO (Class 1b) and 18 pesticides are considered 'Fatal if inhaled' (H330).
- ▶ Chronic health effects: pesticides are categorized as probable carcinogen, likely carcinogen; induce heritable mutations or endocrine disruptor according to IARC and/or EU Regulations.

Pesticides, through the different steps from their production to their handling, transport and use, are a real danger for human health. Even though pest controls through pesticides have the advantages of fast action, high availability and reliability, human are suffering from the consequences of the pesticide's effects for decades. In fact, the HHP currently registered in Malaysia has shown to develop resistance in target organisms associated with the excessive and improper

**Table II.: GHS Health Hazard and Registered Pesticides' Classification**

GHS Label	n (%)											
	Fungicide	Herbicide	Insecticide	Rodenticides	Technical	Household	Public Health	Preservative	Termicite	Acaricide	Fumigant	Molluscicide
H300	1(0.2)	3(0.3)	86(10.9)	47(95.9)	21(3.7)	7(1.9)	2(1.6)	30(20.4)	5(5.6)	4(8.0)	8(38.0)	-
H301	21(5.1)	50(5.2)	397(50.1)	1(2.0)	130(22.9)	30(8.4)	51(40.2)	83(56.5)	49(55.1)	16(32.0)	5(24.0)	16(61.5)
H302	172(41.7)	387(39.9)	179(22.6)	6(12.2)	206(36.3)	232(64.6)	58(45.7)	77(52.4)	27(30.3)	17(34.0)	8(38.0)	16(61.5)
H304	-	-	-	-	-	1(0.3)	-	-	-	-	-	-
H310	-	33(3.4)	8(1.0)	45(92.8)	32(5.6)	7(1.9)	-	25(17.0)	1(1.1)	-	-	-
H311	5(1.2)	31(3.2)	112(14.1)	-	44(7.7)	14(3.9)	10(7.9)	54(36.7)	-	13(26.0)	5(24.0)	-
H312	37(9.0)	177(18.3)	60(20.2)	7(14.3)	98(17.3)	11(3.1)	22(17.3)	15(10.2)	28(31.5)	1(2.0)	-	16(61.5)
H314	4(1.0)	2(0.2)	12(1.5)	-	3(0.5)	1(0.3)	-	70(47.6)	-	-	2(10.0)	-
H315	27(6.6)	110(11.4)	26(3.3)	-	56(9.9)	53(14.8)	-	31(21.1)	3(3.4)	9(18.0)	9(43.0)	-
H317	230(55.8)	255(26.3)	158(19.9)	19(38.8)	126(22.2)	70(19.5)	36(28.3)	101(68.7)	6(6.7)	14(28.0)	2(10.0)	-
H318	66(16.0)	91(9.4)	38(4.8)	-	117(20.6)	-	1(0.8)	84(57.1)	-	3(6.0)	1(5.0)	-
H319	72(17.5)	98(10.1)	202(25.5)	1(2.0)	99(17.4)	94(26.2)	12(9.4)	14(9.5)	38(42.7)	4(8.0)	10(48.0)	6(23.1)
H320	-	1(0.1)	79(10.0)	-	21(3.7)	-	11(8.7)	-	-	5(10.0)	-	-
H330	60(14.6)	43(4.4)	287(36.2)	40(81.6)	93(16.4)	121(33.7)	21(16.5)	67(45.6)	39(43.8)	16(32.0)	7(33.0)	-
H331	58(14.1)	52(5.4)	127(16.0)	6(12.2)	48(8.5)	91(25.3)	26(20.5)	66(44.9)	16(18.0)	19(38.0)	4(19.0)	-
H332	86(20.9)	219(22.5)	292(36.8)	2(4.1)	131(23.1)	118(32.9)	48(37.8)	58(39.5)	13(14.6)	11(22.0)	2(10.0)	-
H334	1(0.2)	5(0.5)	28(3.5)	-	21(3.7)	3(0.8)	2(1.6)	9(6.1)	-	-	-	-
H335	51(12.4)	57(5.9)	201(25.3)	-	166(29.2)	69(19.2)	19(15.0)	59(40.1)	11(12.4)	6(12.0)	5(24.0)	-
H336	1(0.2)	-	1(0.1)	-	60(10.6)	-	2(1.6)	1(0.7)	-	1(2.0)	-	-
H340	41(10.0)	3(0.3)	-	-	5(0.9)	-	-	21(14.3)	-	-	-	-
H341	10(2.4)	7(0.7)	58(7.3)	-	14(2.5)	-	11(8.7)	7(4.8)	-	1(2.0)	4(19.0)	-
H350	-	1(0.1)	33(4.2)	-	8(1.4)	-	8(6.3)	12(8.2)	-	1(2.0)	-	-
H351	46(11.2)	34(3.5)	23(2.9)	-	26(4.5)	-	4(3.1)	16(10.9)	5(5.6)	5(10.0)	1(5.0)	-
H360	42(10.2)	88(9.1)	-	28(57.1)	39(6.9)	6(1.7)	-	29(19.7)	-	-	-	-
H361	107(26.0)	23(2.4)	73(9.2)	-	15(2.6)	20(5.6)	7(5.5)	11(7.5)	-	6(12.0)	7(33.0)	-
H362	-	-	5(0.6)	-	4(0.7)	1(0.3)	3(2.4)	-	-	-	-	-
H370	1(0.2)	2(0.2)	143(18.0)	-	35(6.2)	23(6.4)	18(14.2)	6(4.1)	-	2(4.0)	-	-
H371	-	-	16(2.0)	-	13(2.3)	48(13.4)	-	1(0.7)	-	4(8.0)	11(52.0)	-
H372	2(0.5)	36(3.7)	212(26.7)	45(91.8)	73(12.9)	36(10.0)	29(22.8)	21(14.3)	16(18.0)	12(24.0)	-	-
H373	60(14.6)	176(18.2)	270(34.0)	-	125(22.0)	77(21.4)	27(21.3)	36(24.5)	8(9.0)	16(32.0)	11(52.0)	-

Note: Refer Figure 1 footnote: Hazard Code definition



**Figure 1: Health Hazards of Pesticides Registered in Malaysia**

Hazard Code definition: **H300:** Fatal if swallowed; **H301:** Toxic if swallowed; **H302:** Harmful if swallowed; **H304:** May be fatal if swallowed and enters airways; **H310:** Fatal in contact with skin; **H311:** Toxic in contact with skin; **H312:** Harmful in contact with skin; **H314:** Causes severe skin burns and eye damage; **H315:** Causes skin irritation; **H317:** May cause an allergic skin reaction; **H318:** Causes serious eye damage; **H319:** Causes serious eye irritation; **H320:** Causes eye irritation; **H330:** Fatal if inhaled; **H331:** Toxic if inhaled; **H332:** Harmful if inhaled; **H334:** May cause allergy or asthma symptoms or breathing difficulties if inhaled; **H335:** May cause respiratory irritation; **H336:** May cause drowsiness or dizziness; **H340:** May cause genetic defects; **H341:** Suspected of causing genetic defects; **H350:** May cause cancer; **H351:** Suspected of causing cancer; **H360:** May damage fertility or the unborn child; **H361:** Suspected of damaging fertility or the unborn child; **H362:** May cause harm to breast-fed children; **H370:** Causes damage to organs; **H371:** May cause damage to organs; **H372:** Causes damage to organs through prolonged or repeated exposure; **H373:** May cause damage to organs through prolonged or repeated exposure

**Table III: Highly Hazardous Pesticides (HHP) registered in Malaysia**

Active Ingredient (number of pesticide registered in Ma- laysia)	Acute (Health) Toxicity			Long Term (Health) Effects				
	WHO 1a	WHO 1b	H330	IARC prob carc	EPA prob likel carc	EU GHS muta (1A, 1B)	EU GHS repro (1A, 1B)	EU EDC (1) or C2 & R2 GHS
Abamectin (55)			√					
Acephate (6)								
Atrazine (19)								√
Azamethiphos (2)								
Benomyl (10)						√	√	
Beta-cyfluthrin (43)		√	√					
Bifenthrin (14)								√
Borax (7)							√	
Boric acid (3)							√	√
Brodifacoum (24)	√		√				√	
Bromadiolone (8)	√		√				√	
Cadusafos (1)		√						
Carbendazim (50)						√	√	
Carbofuran (21)		√	√					
Carbosulfan (13)			√					
Chlorantraniliprole (5)								
Chlorfenapyr (19)								
Chlorfluazuron (11)								
Chlorophacinone (7)	√							
Chlorothalonil (42)			√	√				
Chlorpyrifos (167)								
Clothianidin (4)								
Coumaphos (1)		√	√				√	
Coumatetraly (7)		√	√				√	
Cyanamide (1)								√
Cyhalothrin (41)								
Cypermethrin (10)								
Deltamethrin (64)								
Dinotefuran (4)								
Diphacinone (4)	√							
Diuron (56)					√			
Epoxiconazole (5)					√		√	√
Esfenvalerate (5)								
Etofenprox (8)								
Fenazaquin (1)								
Fenitrothion (13)								√
Fenpropathrin (1)			√					
Fenpyroximate (3)			√					
Fenthion (5)								
Fenvalerate (16)								
Fipronil (61)								
Flocoumafén (8)	√		√				√	
Flufenoxuron (3)								
Flumioxazin (2)							√	
Glufosinate-ammonium (97)							√	
Glyphosate (409)				√				
Hexaflumuron (4)								

(continue....)

**Table III: Highly Hazardous Pesticides (HHP) registered in Malaysia (continued)**

Active Ingredient (number of pesticide registered in Ma- laysia)	Acute (Health) Toxicity			Long Term (Health) Effects				
	WHO 1a	WHO 1b	H330	IARC prob carc	EPA prob likel carc	EU GHS muta (1A, 1B)	EU GHS repro (1A, 1B)	EU EDC (1) or C2 & R2 GHS
Hexythiazox (1)								√
Imidacloprid (99)								
Imiprothrin (17)								
Indoxacarb (13)								
Iprodione (2)								√
Iprovalicarb (1)								√
Kresoxim-methy (3)								√
Lufenuron (14)								
Magnesium phosphide (3)			√					
Malathion (40)				√				
Mancozeb (76)							√	√
Metaflumizone (2)								
Metam-sodium (1)							√	
Methamidophos (8)		√	√					
Methidathion (1)		√						
Methyl bromide (4)								
Metiram (3)							√	√
Molinate (1)								√
Monocrotophos (10)		√	√					
Oxadiazon (1)							√	
Oxyfluorfen (7)							√	
Paraquat dichloride (54)			√					
Pendimethalin (10)								
Permethrin (287)							√	
Phosmet (1)								
Picloram (4)								√
Prallethrin (97)								
quizalofop-P-tefuryl (6)								√
Spinetoram (2)								
Spinosad (5)							√	
Spirodiclofen (1)							√	
Sulfoxaflor (1)								
Temephos (25)								
Terbutryn (3)								√
Tetraconazole (5)							√	
Tetramethrin (18)								
Thiacloprid (1)							√	√
Thiamethoxam (19)								
Thiophanate-methyl (9)							√	
Tridemorph (1)								√
Trichlorfon (2)								√
Warfarin (6)		√	√				√	
Zineb (12)								√
Ziram (5)			√					
<b>TOTAL (2,241)</b>	<b>5</b>	<b>9</b>	<b>18</b>	<b>2</b>	<b>17</b>	<b>2</b>	<b>16</b>	<b>15</b>

use, and devastating effects on human health.

## CONCLUSION

In Malaysia, about 2,241 pesticides are now listed as highly hazardous pesticides (HHP) out of 3,610 pesticides registered under the Malaysia Pesticide Board, which were used for agricultural development, public health, household and other technical use to control diseases, pests or weeds. These registered pesticides are known to cause acute or chronic health effects based on GHS hazard classification criteria.

GHS required appropriate labeling tools to convey information about each of the hazard classes and categories, however, several limitations have found when classifying appropriate hazard class and categories to individual pesticides. For instance, GHS has not report the detailed of toxicological information unless a strong and robust scientific research and literature has so defined. Also, pesticides that show side effects on endocrines disrupting properties are still poorly operationalized on appropriate definitions on hazard classification in GHS.

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## EXTENDED ABSTRACT

# Ergonomic Interventions: Comparisons between Footrest and Anti-Fatigue Mat In Reducing Lower Leg Muscle Discomforts during Prolonged Standing

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### SUMMARY

Ergonomics is a science focusing on the study of human fit, decreasing human fatigue and discomfort through the design of new product. Prevention related to workers injury and illness such as muscle discomfort is part of the main goals in ergonomics interventions. Thus, this present study investigates the effectiveness of ergonomic interventions such as footrest and floor conditions in reducing workers lower leg muscle discomforts during prolonged standing. The main objective of this study was to determine and compare the lower leg muscles discomfort (exertion percentage (%)) of Gastrocnemius and Tibialis Anterior among the respondents using the two ergonomic interventions (footrest and anti-fatigue mat). About 60 healthy subjects were recruited to stand for 2 hours (120 minutes) while using the two interventions in different session with one week interval between each test session. During standing, lower leg muscle discomfort of Gastrocnemius and Tibialis Anterior muscles were continuously monitored. Changes in lower leg muscle discomforts over standing time were measured using the surface Electromyography (sEMG). In this study, the sEMG readings showed that the percentage of exertion (%) were increasing with time (within 120 minutes) on muscles for both legs with the usage of the interventions (footrest and anti-fatigue mat). However, the percentage of exertion (%) from the sEMG readings were lower compared to previous studies. The independent t-test was used to find the mean changes on exertion percentage (%) between each muscles of both legs for the two interventions. Results found that there were significant exertion percentage at certain time with 15 minutes time period within the 120 minutes standing. This study showed that the ergonomic interventions (anti-fatigue mat and footrest) gives a low number of exertion percentage (%), showing a reduced muscle discomfort to the lower leg muscles compared to previous studies and interventions. In comparisons with footrest, this study showed that anti-fatigue mat is more applicable for the assembly workers in the industrial factory. The data produced by the comparisons between the two interventions can be useful especially to the Department of Occupational Safety and Health Malaysia (DOSH) in enhancing the safety and wellbeing of industrial workers in Malaysia.

**Keywords:** Interventions, Footrest, Anti-fatigue mat, Discomfort, Prolong standing

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### INTRODUCTION

Manufacturing workers, one of the important contributors to Malaysia's economy, are nowadays exposed to variable working positions [1]. To date, standing position has remained the main working position across many manufacturing industries around the world [2, 3]. There were studies found a positive

association between prolong standing and physical muscle fatigue, discomfort and pain amongst workers in various occupations in Europe, Northern and Southern America, Asia and Australia [1, 4, 5, 6]. Lower leg muscle discomforts during standing may cause by the fatigue conditions of lower leg muscles and pooling of blood in the legs [7]. Due to the impact of standing related musculoskeletal problems on workers, one of the priorities in many countries is prevention of muscle discomforts which are associated with prolonged standing in the workplace [8].

Many ergonomics simulation systems have been

introduced to improve the productivity, comfort and safety of workers in manufacturing workplaces and many assessment tools have been suggested to analyse the risk factors associated with prolong standing [1]. Examples are anti-fatigue mats, footwear, shoe inserts and footrest, but received not much attention in Malaysia [9, 10]. Sartika and Dawal [11] has stated that workstation that includes an optional seat (chair, sit/stand stool) and some kind of footrest increases the variety of body positions and encourages frequent changes between. On the other hand, Zander et al.[7] stated that one common ergonomic intervention has been used in industrial sectors are anti-fatigue mats.

Thus, this study will be done determining the comparisons between ergonomic interventions, the footrest and anti-fatigue mat on lower leg muscle discomfort among industrial workers due to prolong standing in Malaysia. The main purpose of this study was to determine and compare the lower leg muscle discomfort (exertion percentage (%)) of *Gastrocnemius* and *Tibialis Anterior* for both leg among the respondents for footrest and anti-fatigue mat, during a 2-hours (120 minutes) standing in the field settings.

## MATERIALS AND METHODS

An experimental study design by using Surface Electromyography (sEMG) was applied in this study. The study will involve healthy male industrial workers (n=60) from a manufacturing factory in Batu Caves, Selangor. All the respondent have been fulfil the inclusive criteria such as healthy male industrial workers, aged between 18 – 35, having a similar type of job (assembly workers), and should work in the same company in order to control the organizational factors such as job rotations, break cycle, work task, durations of work and work environment. Workers who having lower extremity injury/deformity, physical disability, or discomfort problem for the past 12 months and any cardiovascular diseases were excluded from the study. At the screening stage, each respondent will need to answer a pre-survey questionnaire before they actively participate in this study that consists of their personal information (example; age, weight) and health information to meet the criteria of fit and healthy respondent. After the calculation based on Lemeshow et al. [12], about 60 healthy male respondents were included in the study. Respondents were asked to stand for 2 hours (120 minutes) while using the ergonomic interventions (anti-fatigue mats and footrest). Each session was held at different days with a minimum of three days interval between each session of ergonomic intervention. The respondents were doing a sorting mix objects task while standing for 2 hours (120 minutes) and were asked to do the Maximum Voluntary Contraction (MVC) prior to each session to investigate the muscle separately. For quality control, the MVC tests were measured for three seconds repeated three times [11]. Throughout the 2 hours (120 minutes) standing, sEMG

electrode was attached to lower leg muscles for both legs (*Gastrocnemius* and *Tibialis Anterior*) to detect the muscles discomforts signals.

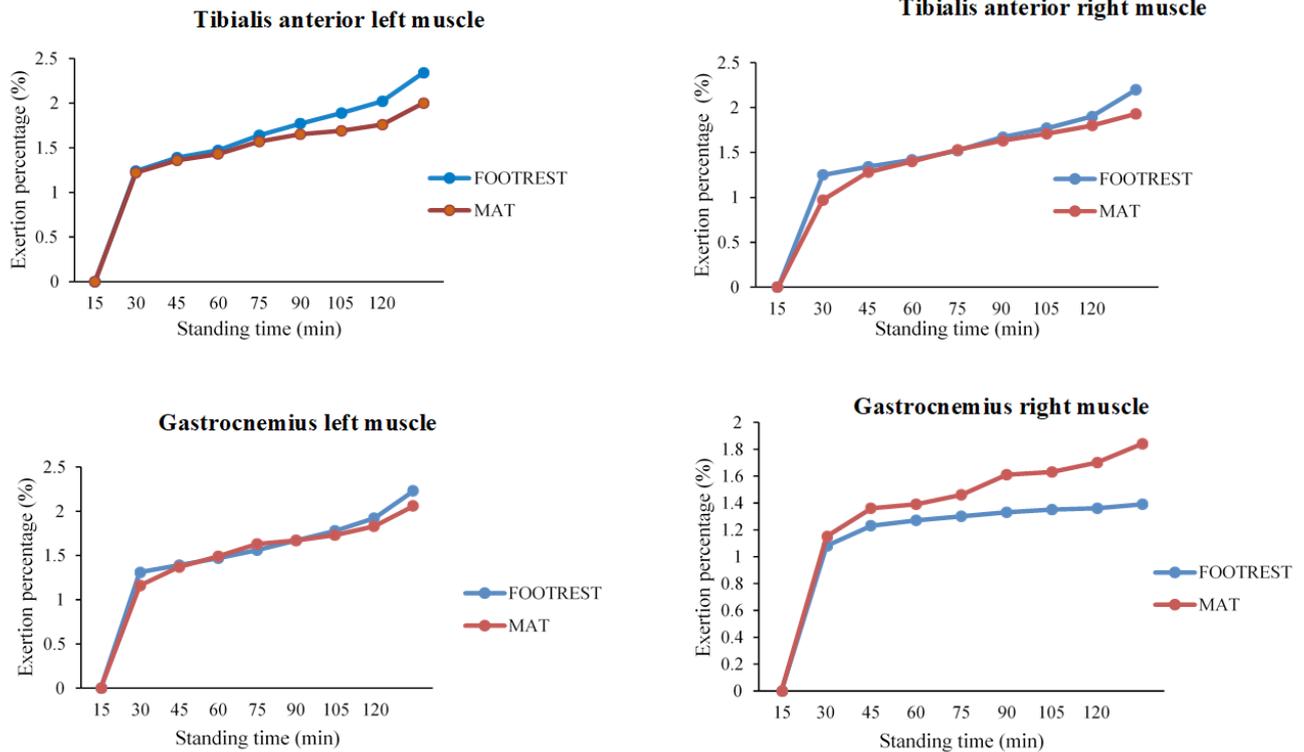
## RESULTS

Figure 1 illustrates the trend of mean values for respondent's lower leg exertion percentage (%) during 120 minutes (2 hours) standing period for the two interventions, anti-fatigue mat and footrest. The sEMG readings showed that the percentage of exertion (%) were increasing with time (within 120 minutes) on muscles for both legs with the usage of the interventions (footrest and anti-fatigue mat). According to Figure 1, the percentage of exertion (%) for footrest was higher than mat for left *Tibialis Anterior* (mean = 1.53), right *Tibialis Anterior* (mean = 1.45) and *Gastrocnemius* left (mean= 1.48) while lower than mat for right *Gastrocnemius* (mean = 1.15). In similar context, the percentage of exertion (%) for mat was lower than footrest for left *Tibialis Anterior* (mean=1.41), right *Tibialis Anterior* (mean = 1.36) and *Gastrocnemius* left (mean= 1.44) while higher than footrest for *Gastrocnemius* right (mean=1.35). However, the percentage of exertion (%) from sEMG readings were not too high compared to findings from study done by Sartika and Dawal [11].

The independent t-test was used to find the mean changes on exertion percentage (%) between each muscles for both legs among the two interventions. The results indicated that there was a significant difference of the exertion percentage between anti-fatigue mat and footrest for left *Tibialis Anterior* muscle at t=120 minutes (p<0.05) (Table I). On the other hand, this test revealed that there were significant difference of the exertion percentage between anti-fatigue mat and footrest for right *Tibialis Anterior* muscles at t=15 (p<0.001), t=105 minutes (p<0.05) and t=120 minutes (p<0.001) (Table II). Comparison of the lower leg muscle exertion percentage between anti-fatigue mat and footrest for left *Gastrocnemius* muscles in Table III showed that there were significant exertion within 2 hours standing at t=15 minutes (p<0.001), t=45 minutes (p<0.05), t=60 minutes (p<0.001), t=90 minutes (p<0.001), t=105 minutes (p<0.001) and t=120 minutes (p<0.001). In comparisons, the exertion within 2 hours standing for the right *Gastrocnemius* leg muscles showed significant exertion at t=15 minutes (p<0.05), t=75 minutes (p<0.001), t=90 minutes (p<0.05), t=105 minutes (p<0.001) and t=120 minutes (p<0.001) (Table IV).

## DISCUSSION AND CONCLUSION

Zander et al. [7] has stated that long periods of standing have been typically associated with significant amounts of fatigue and body discomfort at the end of the workday. Previous studies have revealed that the sit or stand stool such as footrest, may be applicable to reduce muscle discomfort where prolong standing was applicable [4,



**Figure 1: Mean values of respondents' lower leg exertion percentage (%) during standing period for anti-fatigue mat and footrest in muscles for both legs.**

**Table I: Comparison of the lower leg muscle exertion percentage between anti-fatigue mat and footrest for left *Tibialis Anterior* muscles**

Time (min)	Mean (SD)		z-values (df)	p-value
	Footrest	Anti-fatigue mat		
15	1.24 (0.17)	1.22 (0.14)	0.754	0.452
30	1.39 (0.45)	1.36 (0.29)	0.465	0.643
45	1.47 (0.73)	1.43 (0.21)	0.471	0.638
60	1.64 (0.85)	1.57 (0.23)	0.55	0.584
75	1.77 (0.97)	1.65 (0.25)	0.872	0.385
90	1.89 (1.04)	1.69 (0.25)	1.499	0.137
105	2.02 (1.09)	1.76 (0.27)	1.77	0.078
120	2.34 (1.11)	2 (0.34)	2.213	<b>0.029*</b>

N=120 \*p is significant at <0.05 \*\*p is significant at p<0.001

**Table II: Comparison of the lower leg muscle exertion percentage between anti-fatigue mat and footrest for right *Tibialis Anterior* muscles**

Time (min)	Mean (SD)		z-values (df)	p-value
	Footrest	Anti-fatigue mat		
15	1.25 (0.04)	0.97(0.18)	11.93	<b>0.000**</b>
30	1.34 (0.04)	1.28 (0.23)	1.863	0.650
45	1.42 (0.03)	1.4 (0.22)	0.771	0.442
60	1.52 (0.03)	1.53 (0.24)	0.168	0.867
75	1.67 (0.05)	1.63 (0.26)	1.034	0.303
90	1.77 (0.04)	1.71 (0.29)	1.668	0.098
105	1.9 (0.04)	1.8 (0.31)	2.537	<b>0.012*</b>
120	2.2 (0.09)	1.93 (0.35)	5.199	<b>0.000**</b>

N=120 \*p is significant at <0.05 \*\*p is significant at p<0.001

**Table III: Comparison of the lower leg muscle exertion percentage between anti-fatigue mat and footrest for left *Gastrocnemius* muscles**

Time (min)	Mean (SD)		z-values (df)	p-value
	Footrest	Anti-fatigue mat		
15	1.31 (0.04)	1.16 (0.23)	5.008	<b>0.000**</b>
30	1.39 (0.05)	1.37 (0.10)	1.567	0.120
45	1.47 (0.06)	1.49 (0.09)	2.065	<b>0.041*</b>
60	1.56 (0.04)	1.63 (0.07)	7.409	<b>0.000**</b>
75	1.67 (0.06)	1.67 (0.04)	0.166	0.868
90	1.78 (0.07)	1.73 (0.02)	5.320	<b>0.000**</b>
105	1.92 (0.08)	1.83 (0.03)	7.773	<b>0.000**</b>
120	2.23 (0.10)	2.06 (0.05)	11.768	<b>0.000**</b>

N=120 \*p is significant at <0.05 \*\*p is significant at p<0.001

**Table IV: Comparison of the lower leg muscle exertion percentage between anti-fatigue mat and footrest for right *Gastrocnemius* muscles**

Time (min)	Mean (SD)		z-values (df)	p-value
	Footrest	Anti-fatigue mat		
15	1.08 (0.22)	1.15 (0.16)	2.097	<b>0.038*</b>
30	1.23 (0.73)	1.36 (0.23)	1.298	0.197
45	1.27 (0.43)	1.39 (0.25)	1.984	0.050
60	1.3 (0.64)	1.46 (0.30)	1.735	0.085
75	1.33(0.49)	1.61 (0.34)	3.697	<b>0.000**</b>
90	1.35 (0.88)	1.63 (0.37)	2.260	<b>0.026*</b>
105	1.36 (0.49)	1.7 (0.38)	4.250	<b>0.000**</b>
120	1.39 (0.65)	1.84 (0.42)	4.563	<b>0.000**</b>

N=120 \*p is significant at <0.05 \*\*p is significant at p<0.001

11]. Instead of footrest, modifying the flooring such as providing an anti-fatigue mat is a common ergonomic intervention to ameliorate the complaints associated with prolonged standing [7]. In this study, the sEMG readings (exertion percentage %) for anti-fatigue mat showed much low readings for muscle discomforts than footrest. Thus, from this study, anti-fatigue mat was much applicable to reduce the muscle discomforts on lower leg muscles among the respondents. Furthermore, anti-fatigue mats are claimed to alleviate or reduce discomforts from standing as it will increase lower leg muscle activity and muscle contractions, which will increase the blood circulation [7].

In conclusion, this study showed that the ergonomic interventions (anti-fatigue mat and footrest) gives a low numbers of exertion percentage (%), showing a lower muscle discomfort compared to previous studies and interventions. In comparisons with footrest, this study showed that anti-fatigue floor mats in workplace is more applicable for the assembly workers in the industrial factory. The data produced by the comparisons between the two interventions can be useful especially to the Department of Occupational Safety and Health Malaysia (DOSH) in enhancing the safety and wellbeing of industrial workers in Malaysia.

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## EXTENDED ABSTRACT

# A Short Review of Bauxite and Its Production: Environmental Health Impact on Children in Mining Areas

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### SUMMARY

To achieve rapid economic development, many countries including Malaysia resort various activities to exploit natural sources such as mining. As a consequence, mining are an important economic activity which has the potential to contribute to the development of areas endowed with the ore. Studies have been carried out in countries where the impact were on the environment and health. However, fewer studies have been carried out on the effects of mining on health especially the children. This paper provides a review of the process description, properties of bauxite, bauxite production and the potential health effects of heavy metals from mining ores on children's health. The aims of this article are to evaluate the most frequently reported effect towards health and heavy metals levels in biomarkers such as blood, urine, hair and toenail among children mining areas. Respiratory problems were most commonly reported effects associated with mining activities. Heavy metals such as lead, aluminum, chromium, nickel are also elevated from normal levels due to mining activities. Specific mitigated measures need to be taken in order to solve the problems and protect the public health especially children as they are vulnerable and represent the non-occupationally exposed population.

**Keywords:** Bauxite, Environmental Health Impact, Children

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### INTRODUCTION

Mining activity is important as minerals are the major source materials, for example, bauxite ore are being converted to aluminum oxide to make aluminum metal [1,2,3]. In order to achieve rapid economic development, many countries resort to natural resources exploitation. Three top most bauxite producers countries since 2008, are Australia, China and Brazil [4]. Recently, Indonesia government has enforced a ban on supplying bauxite to China that account to almost 65% of its import, has created a negative implications on the demand of supply for China which resorted to another alternative import from Malaysia. Unfortunately, mining activities have negative effects on our natural geological of environment such as soil, water and air as well as the people's health and well-being. From the economic contributions of bauxite mining activities, several private companies have lost sight on environment and health effects associated with mining activities. Children comprises one third of world's population are one of the most vulnerable populations [5]. Respiratory problems, skin disease,

malaria, diarrhea, fever and cold are diseases prevalent in the communities exposed to mining activities [6]. Potential for adverse effects of exposure heavy metals to children is increasing due to intake of heavy metals per unit of body weight. The physiological uptake rates of children are much higher than adults, the undergoing rapid development in which their system are not fully developed and make them more vulnerable to toxicity [7]. In this paper, we aim to review the most frequently reported respiratory health symptoms and level of heavy metals in biomarkers of children exposed to mining activities, and to summarize the potential general health problems especially the respiratory symptoms associated with the heavy metals accumulation.

### PROCESS DESCRIPTION OF BAUXITE

Bauxite is the rock which is off-white, grayish, brown, yellow or reddish-brown in colour that contains high concentrations of aluminum hydroxide minerals. It is a common residual or transported constituent of clay deposits that can be found in tropical and subtropical regions. It was first discovered by P. Berthier, a French Chemist around year of 1821 who investigated the soil specimens near Les Baux in Southern France village [8,9,10]. Bauxite ore is primarily composed by one or more common aluminum hydroxide minerals such

as gibbsite, boehmite or diaspora [11,12]. There are 2 distinct stages that produced primary aluminium which were performed using Bayer Process or Hall-Heroult process [12, 13].

### PROPERTIES OF BAUXITE

Most red mud is composed of coarse sand and fine particle. Depending on the raw material processed about 1 tonne of alumina is produced from three tons of bauxite and one tonne of aluminium is produced from two tonne of alumina [14]. Aluminium ores consist several minerals that dominated by aluminium, oxygen and silicate in chemical composition with a mineral such as gibbsite, boehmite and diaspora and other subordinate amounts such as goethite, hematite, kalonite and quartz [15]. Gibbsite or hydrargilite is a trihydroxide of aluminium that mainly can be found in large lateritic-type deposits of tropical countries. It is one of the three component minerals of economically important aluminium ore of bauxite where it contains three basic of polymorphs; bayerite, nordstandite and doyleite [16]. Boehmite or aluminium oxide hydroxide is a monohydrate of alumina which is common occurring mineral in many bauxite deposits especially in China and Europe country. Boehmite is different from diaspora in internal structure where it is much softer [10]. Diaspore, another polymorphous modification of aluminium oxide hydrated with one molecule of water. Same as boehmite, it crystallizes in the same way which is rhombic system but in different lattice parameters [17,18]. Physical characteristics may different from one another based on deposits of bauxite. The principal reason for the colour of bauxite which are red and brown are hematite and goethite that are most abundant of iron impurities. While for in-situ specific gravity in most type of bauxite is between 1.5 to 2.4 but some of it may found as high as 3.7. For hardness characteristic diaspora have a greater hardness which are tightly bonded and denser atomic structure than gibbsite or boehmite [19].

### BAUXITE PRODUCTION

The major producers of bauxite are China, Brazil and Guyana since year 1950. Additionally, China has been adding this alumina production capacity in order to meet primary production needs and in year 2012 the bauxite consumption for Chinese alumina production was about 94.29 million ton which foreign bauxite around 39.61 million ton and 54.68 million ton for domestic bauxite which mostly 80% come from Indonesia [20,21]. China plans to increase the domestic aluminum production capacity where early of year 2014 Indonesia has banned on bauxite export by developing more than 52 new productions which mostly in eastern-north-eastern regions and Malaysia is one of the country while China still maintain between other countries; Australia, India, Ghana, Guinea and the Dominican Republic [15].

### HEAVY METAL IMPACTS ON HEALTH

Heavy metals are any metallic chemical element that relatively high density which most of the heavy metals are toxic even at low concentrations [22]. The levels of heavy metals and essential minerals can easily be tested in blood, urine and hair as a useful toxic metal bio-monitoring of environmental pollution on human health [23,24]. In children population, the potential for adverse effects of exposure to heavy metals is increasing due to intake of heavy metals per unit of body weight is higher in children than adults [7]. Aluminum and its compound mostly comprise around 8% in our Earth's surface which occur naturally in silicate, cryolite and bauxite rock. Bauxite is the most important raw material used in aluminum production. Among all aluminum hydroxide is produced from bauxite [25]. The guideline of aluminum in drinking water for treatment plant around 0.1 mg/l in large water treatment facilities and around 0.2 mg/l in a small facilities. Despite from their concentration in drinking water, bauxite mining activities that release some of aluminum hydroxide in water make it account more than a normal range which can cause negative impact towards population [10]. Aluminum also known to be neurotoxic with a chronic exposure such as dementia, autism and Parkinson's disease where excess of aluminum can inhibit the formation of alpha-keto glutarate and results in toxic levels of ammonia in body tissues. Previous studies showed significant association between heavy metal levels in blood with verbal comprehension ( $\beta = -2.0$ ,  $p = 0.04$ ) among boys aged 6 to 9 years old from high industrial and mining activities in Southwestern Spain [25]. Lead poisoning are occurs when people exposed through breathing air, taking drinks, eating foods and swallowing or touching dust or dirt that might contains lead [23]. Some epidemiological studies showed that exposure to lead among children in early stages caused deficits in later neurobehavioral performance. Cognitive ability affects school performance and educational attainment was the negative effects of lead among children [26]. The exposure to lead had increased DNA damage in children [23]. A case control study in Thailand where the villagers live near mining area showed that the blood lead level were higher than 10  $\mu\text{g}/\text{dL}$  in 89 children and 42 children had tooth lead level higher than 10  $\mu\text{g}/$  [27]. In China there were associations between hair lead exposure levels with increase of social problems, attention problems, thought problems, delinquent behavior, aggressive behavior and behavioral problems; depression, withdrawn and somatic complaints. Arsenic is the 20th most abundant component in Earth's crust and widely distributed in rocks, surface water, air, foods and soil [28]. In a long lifetime it can cause risk of cancer in internal organ such as bladder, lungs and liver [29]. The normal range of arsenic level in hair is generally around 0.02 to 0.2 mg/kg or less than 1 ppm [9]. A case control study in Mexico shown that urinary arsenic in children

who live near mining site is significantly higher (136 µg/g) than children who live far from mining site (34 µg/g) In Bangladesh, there was significant relationship between arsenic exposure with neurological effect in pre-school and school aged children whereby their IQ were affected.

### ENVIRONMENTAL HEALTH IMPACT ON CHILDREN

Health can be defines as a state of complete physical, mental and social well-being of an individual and not merely the absence of disease [18]. Environmental factors play a major rule in order to determine the health and well-being of our children. Children who comprise over one third of the world's population are the most vulnerable world's populations where they also have same fundamental human rights as adults. Children's health is more affected than adult from a complex interaction of influences; biological, social, behavioral and physical [26,29]. Mining activities may have a higher prevalence of certain diseases because it can alter the environment [30]. The adverse effects on health of significant non-occupational exposure to mining dust have been well known for many years and have been well characterized in recent decades. Dust from increased traffic of mining activities and dry season can cause exacerbate respiratory conditions in children [30]. Exposure to particulate matter (PM) affects lung development in children that include reversible deficits in lung function as chronically reduced lung growth rate and a deficit in a long-term lung function [31]. Previous studies show that PM10 were higher in open cast mining ore and caused significant respiratory problems such as asthma among children aged 1 to 4 years old who live nearby [28, 32]. Moreover, respiratory diseases are the major cause of poor health in children from developing countries and it is the most important cause of childhood death [9].

### CONCLUSIONS

We conclude that children who live in opencast mining areas exposed to mining activities are at a greater health risk in the future. A detailed study of interaction of bauxite mining activities with human health is of utmost importance because the vulnerability of the children. Heavy metal exposure in children is associated with adverse effects including developmental disorder, neurological symptoms and autoimmune dysfunction.

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## EXTENDED ABSTRACT

# Heavy Metal Levels in Bauxite Dust and Respiratory Health Reported Symptoms of School Children in Felda Bukit Goh, Kuantan, Pahang

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### SUMMARY

Bauxite mining activities in Felda Bukit Goh, Kuantan, has been in operation since early 2013. The uncontrolled mining activities created dusty environment which led to health complaints from the surrounding residence. The mining activities had also caused anxiety and stress among the community due to the noise which disturbed their well-being and their sleep (1). The objectives of this study were to determine and relate selected heavy metal levels (As, Cd, Cr, Ni, Pb and Al) in the dust in the classrooms of a school located near to the mines with the respiratory health symptoms reported by the parents of the selected school children. A cross-sectional study was conducted on 121 students randomly selected from the Primary 4 and 5 clusters. Questionnaires were used to collect information on their background and their respiratory health symptoms. Environmental sampling for 16 dust samples consisted of two samples (window and corridors) from each of the eight classes (four from each Primary 4 and 5) were collected using a 400W vacuum cleaner with special filter from these classrooms. The dust samples were analyzed using Inductively Coupled Plasma-Mass Spectrometry (ICP-MS). Results showed that the levels of heavy metal in the dust were high in both the Primary 5 and Primary 4 classes. The mean heavy metal levels in the dust from the classroom area varied significantly and decreased in the order of: Al > Cr > Ni > Pb > As > Cd. The mean ranges were as follows: Al (39360.15-110824.1 mg/kg); Cr (2364.84-4726.009 mg/kg); Ni (699.9606-1443.36 mg/kg); Pb (434.3067-1650.76 mg/kg); As (200.7891-454.7241 mg/kg); and Cd (10.9107-34.9902 mg/kg) respectively. The levels were higher at the corridor than the window. Nasal congestion (45.5%) was the highest respiratory symptom experienced by the school children. There was a significant correlation between the respiratory health symptoms reported with absenteeism in the year 2015 when the mining activities were at the peak. There was a significant correlation between dust Pb levels with respiratory reported symptoms of the school children. Other risk factors which contributed to the respiratory symptoms reported were the close location of their houses to the mining areas, young age and low family income.

**Keywords:** Bauxite dust, Respiratory Health reported symptoms, School children

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### INTRODUCTION

Mining is an exploration and removal of minerals from the earth. Mining activity is important because minerals such as bauxite ore are being converted to aluminum oxide to make aluminum metal (2). Bauxite is a rock containing aluminum hydroxide in which aluminum is the principle ore. The waste of the bauxite mining process is a huge amount of red sludge which are combinations of iron oxide, silica, calcium oxide, titanium oxide, chrome oxide, zinc oxide, aluminum hydroxide and organic compound which are toxic to human.

In Malaysia, there is no available studies on respiratory health problem among children exposed to mining activities, since most of the current studies are on workers. This study was designed to determine the levels of heavy metals in the dust collected from classrooms and the associations with the respiratory health reported symptoms among children from those classes.

### MATERIALS AND METHODS

The study was conducted in Felda Bukit Goh with high bauxite mining activities identified. A primary school in the area was selected as the study location since it is very close to the bauxite mining areas (<1km radius). The selection of four each of the Primary 4 and 5 classes gave a total of 8 classes with students selected randomly from the name lists obtained from the class teachers.

The children who is willing to participate and with parental written consent, were included in the study. The approvals of this study were obtained from the UPM Ethics Committee, Ministry of Education and the Principal of the school.

The questionnaire consisted of questions on the children’s background, house location, respiratory symptoms and medical history were distributed and filled out by their parents. Questionnaires were constructed with reference to the International Study for Asthma and Allergies in Childhood (ISAAC) and American Thoracic Society (ATS). Scores were given to the responses of the symptoms. If “Yes”, a score of 1 was given and if “No”, 0 score was given.

Sixteen dust samplings (corridors and windows) were conducted between January to February 2017 in eight selected classes. Settled dust was collected by using 400W vacuum cleaner with a special dust filter. The vacuum cleaning was performed where two minutes were on the corridor floor and two minutes were on other surfaces of windows. Later, all the filters were sealed in clean plastic bag, labelled, brought to the laboratory and stored at -20°C while later the sieved dust samples were stored in a low temperature freezer -80°C until analysis. The methodology of the heavy metals analysis was based on method by EPA 3050. The filtered samples with As, Cd, Cr, Ni, Pb and Al were analyzed by using the Inductively Couple Plasma-Mass Spectrometer (ICPS-MS) Perkin Elmer Model. All data were presented in ppm.

**RESULTS**

A total of 166 students were invited during the recruitment of this study but only 121 (73%) returned the consent form and questionnaire. From the total sample of 121 respondents, 45.5% (n = 55) of the students were male and 54.5% (n = 66) were female. About 55.4% of the total sample were Primary 4 and 44.6% were Primary 5. Table I shows the respiratory symptoms that the students had in the last 12 months. The highest symptom was reported was nasal congestion (45.5%), others, include runny nose, sore throat, asthma, wheezing and difficulty in breathing in the past 12 months as found in other studies (3,4,5,6,7).

The result presented in Table II shows the mean of the selected heavy metal levels in the dust from the

**Table I: Respiratory health symptoms reported**

Variables	Frequency (n)	Percentage (%)
Cough	44	36.4
Runny nose	52	43
Nasal congestion	55	45.5
Sore throat	45	37.1
Dry throat	33	27.3
Wheezing	12	9.9
Difficulty in breathing	7	5.8
Asthma	16	13.2
Skin rashes/rash	17	14.0
Eczema	4	3.3
Itchiness	36	29.8

N=121

classrooms. The levels varied significantly and decreased in the order of: Al > Cr > Ni > Pb > As > Cd. The heavy metals were easily released to the classroom by wind and sustained at the window and corridor. Dust samples from Primary 4 and Primary 5 classrooms, showed very high heavy metal levels because the proximity to the mining areas. Only a significant correlation was between dust Pb level with respiratory health reported symptoms were found (p=0.005) (Table II).

Both clusters of classes had high levels of heavy metals in the dust. Significant differences were found in the level of heavy metals between Primary 4 and Primary 5 classrooms. Cr (p=0.007), Pb (p= 0.005) and Al (p=0.013) levels were significantly higher for Primary 5 while As (p=0.001) and Cd (p=0.039) were significantly higher for Primary 4 (Table III).

From the attendance report of the children, obtained from the class teachers, showed significant correlations between the absenteeism with the respiratory health reported symptoms, in the year 2015 (p=0.016) as compared to the year 2016 (Table IV).

From the results in Table V, the independent variables namely the house location of less than 1km from the bauxite mining areas, age and income of respondents showed significant associations with scores of respiratory health reported symptoms. Meanwhile, all the selected

**Table II: The relations between heavy metal in dust and respiratory health reported symptom.**

Variables	As		Cd		Cr		Pb		Ni		Al	
	r	p	r	p	r	p	r	p	r	p	r	p
Respiratory reported symptoms	0.160	0.080	0.045	0.625	0.106	0.249	0.252	0.005**	0.021	0.819	0.174	0.056

\*\*Significant at the 0.01 level Spearman’s rank order-correlation

**Table III: The comparison of heavy metal level in dust between two primary groups of classes**

Variable	Mean (SD) mg/kg		Mean difference	95% Confidence Interval		t (df)	p
	Primary 4	Primary 5		Lower	Upper		
As	389.33 (49.92)	284.35 (52.91)	104.99	49.83	160.14	4.082 (14)	0.001**
Cd	19.62 (6.71)	13.73 (2.89)	5.89	0.35	11.43	2.28 (14)	0.039*
Cr	2586.53 (249.27)	3582.20 (759.62)	-995.67	-1640.98	-350.36	-3.52 (8.49)	0.007**
Pb	533.26 (67.91)	973.77 (312.32)	-440.51	-703.12	-177.9	-3.90 (7.66)	0.005**
Ni	1071.96 (182.87)	1046.99 (203.05)	24.97	-182.25	232.18	0.26 (14)	0.800
Al	50207.15 (838.21)	74220.14 (20578.14)	-24013	-41708.30	-6317.6	-3.06 (9.26)	0.013*

N=16 \*The significant difference p<0.05 Independent T-test

**Table IV: The relations of the absenteeism and the respiratory health reported symptoms**

Variables	2015		2016	
	r	p	r	p
Respiratory reported symptoms	-0.219	<b>0.016*</b>	-0.125	0.170

\*Significant at p<0.05 Spearman's rank order-correlation.

**Table V: Multiple risk factors related to the respiratory reported symptoms scores**

Variable	Respiratory reported symptoms			
	b (95% CI)	t-statistics	r <sup>2</sup>	p
House location to bauxite area	0.777 (0.111-1.442)	2.311	0.043	0.023*
Age	0.643 (0.035-1.232)	2.097	0.036	0.038*
Income	-0.437 (-0.784-6.024)	-2.499	0.042	0.014*

\*Significant at p<0.05

heavy metals did not show any significant association with the total scores of respiratory health reported symptoms

## DISCUSSION AND CONCLUSION

In this study, we found that there was only a significant correlation between the classroom Pb levels in the dust with the respiratory health reported symptoms. Lead exposure to children can lead to impaired cognitive development (8). There was a significant correlation between the respiratory health reported symptoms with absenteeism in the year 2015 because at this time, the bauxite activities were at their peak while the moratorium on all bauxite related activities started from the year of 2016 until 2017. In the cross-sectional study at Bukit Goh Health Clinic nearby the mining area, it showed a steadily increased in patient attendance for asthmatic and upper respiratory tract infection (URTI) for 2015 as compared to previous years (4). The As, Ni and Cd levels in dust were significantly higher in Primary 4 classes while the Primary 5 dust levels were significantly higher for Cr, Pb and Al. The corridor area showed

higher heavy metals levels than the window areas. The Primary 5 classrooms were located at the Ground Floor where the heavy metals were settled down on the lower part of the school. Teachers and students passing by through the corridors deposited heavy metals from their shoes and clothing. While Primary 4 classrooms were also near to the mining areas but on the Second Floor. The respiratory symptoms with highest report was nasal congestion (5), other symptoms were also reported. Materials from mining activities contain a complex mixture of minute particulate matter, metals, dust particles, released and transported to the surrounding communities by air, soil, or water (6,9). The increased bauxite mining and production during that years 2013-2015, was somewhat related to the exposure to bauxite dust in the environment, contributing to the health effects of the school children. School aged children are likely to spend most of their time in their neighborhood typically at home or school and they travel less than adults. Age of respondents was a significant risk factors contributing to the high number of reported respiratory health symptoms. Younger students were more vulnerable when exposed to bauxite dusts. Socioeconomic also a risk factor and according to World Health Organization (10) which in this study, was found to be contributing to the health risks in term of respiratory symptoms and have a strong potential for acting as confounders. Lower income families probably have less available medical facilities and could not afford to bear the cost of medical services and medication.

In conclusion, the level of heavy metals (As, Cd, Cr, Ni, Pb and Al) were high in the dust collected from the classrooms, even though it was almost 1 year after the bauxite mining moratorium. The levels varied significantly and decreased in the order of: Al > Cr > Ni > Pb > As > Cd. The most common respiratory symptom reported was nasal congestion. Pb was significantly correlated with the respiratory symptom scores which suggested that these metal fractions in the dust have an impact on health. The study results highlighted the importance of controlling the bauxite activities in these areas.

## ACKNOWLEDGEMENTS

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## EXTENDED ABSTRACT

# Mobile Outdoor Air Wireless Sensor Network for Exposure Monitoring among Traffic Policeman: A Review

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### SUMMARY

The effects of poor air quality are a serious issue in urban areas, wherever most people live and work. Precise monitoring of air quality in real-time is crucial to enable prompt and fitting resolutions for outdoor workers and the public. This study is meant to provide information and to understand current knowledge on the use of mobile wireless sensor network for outdoor air pollution assessments and monitoring. A search of the literature was carried out using an appropriate query for the search of papers across various databases. Majority of the previous studies researched have reported that mobile wireless sensors are versatile and could be applied in exposure assessments and monitoring of outdoor air quality. The reviewed articles proved that mobile wireless sensors are a practical device that can effectively detect air pollution and will facilitate to boost the protection of the community, personal health care as well as environmental monitoring.

**Keywords:** Wireless Sensor Network, Outdoor Air Monitoring, Traffic Policemen, Mobile Air Monitor

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### INTRODUCTION

In the latest report by Malaysian Department of Occupational Safety and Health (DOSH, 2017), occupational lung diseases are the fourth disease most reported where 56 (2.0%) cases were reported out of all confirmed cases as occupational diseases [1]. Exposure to air pollution at work is also an occupational disease for outdoor workers. Traffic police particularly usually work outdoors and are exposed to a number of hazards around them such as air pollution [2]. In Malaysia, two comparative studies among traffic police in Kuala Lumpur (KL) and general police in Bukit Aman Headquarters showed that there was a significant decrease in the lung function parameters tested which proves that working outdoor is a factor in developing respiratory health problems [3,4]. Increasing respiratory problems due to air pollution are critical issues to solve. Thus, pollution monitoring and controlling are one of the important issues in order to maintain good and ideal air quality [5]. However, many people are negligence about the air quality around them, particularly the air quality around the work of a traffic policeman as people have a little network with their local air quality. Also, it is difficult for a human to notice any major changes in

the air. Apart from that, the health effects of exposure to bad air are not properly communicated to the public particularly outdoor workers. Most importantly, how the air quality information being communicated via government websites are ineffective and troublesome [6]. Hence, the objective of this review is to understand current knowledge and discuss the use of a mobile sensor network in exposure monitoring among traffic policeman.

### MATERIALS AND METHODS

Different databases were searched including PubMed, Springer Online, BioMed Central and various university in order to be able to analyse the availability of mobile wireless sensor network for outdoor air and all relevant data in the field of traffic police with a special focus on environmental health effects. The research covered the years from 2000 to 2018. This wide range has been used to ensure that all possible research in this field has been covered.

### RESULTS

#### Traffic Policeman

In Malaysia, there is a total of 113,426 policemen, and about 4% of them are traffic policeman as stated in the Royal Malaysian Police bulletin [7]. The traffic policeman duties, according to Police Act 1967, are to protect the infrastructure and ensure the safety of all

roads and highway users. In addition, they monitor the compliance with the Road Transport Act 1987 through the mobile patrolling within a designated location [8,9]. As a traffic officer, they enforce the transportation legislation, policies and agreements for commercial vehicles using Malaysian roads. Exposure to dust and outdoor pollutant without any preventive measure taken has made traffic policeman highly susceptible to the decrement of pulmonary function with time. When travelling or standing along roads with heavy traffic, significantly during rush hours, humans are exposed directly to traffic-related air pollution.

### **Exposure to air pollutants**

Particulate matter comes from various sources including traffic, industries, commerce and domestic heating and cooking. Traffic-related particulates have been getting a lot of attention for two reasons [10]. First being that the particles are generated from combustion processes and more potent in posing adverse health effects than those of non-combustion. The second reason is that traffic-generated emissions are said to have more than 50% of the total emissions of particulate matter in urban areas especially in highly industrialized countries [11,12]. In Malaysia, a study found that all the lung function parameters were significantly lower ( $p < 0.05$ ) among traffic policemen compared to the general police who were less likely to work outdoors [2]. Another comparative study among traffic police in Selangor and general police in Putrajaya obtain similar results with the previous study where the traffic police had a significant reduction ( $p < 0.05$ ) in all lung parameters compared to control group [3]. Also, another study in Malaysia has shown that traffic police were exposed to high concentration of Particulate Matter 2.5 microns (PM<sub>2.5</sub>) (28.7  $\mu\text{g}/\text{m}^3$ ) and resulting in a majority of them having recorded abnormal lung function status (FVC, 91% and FEV<sub>1</sub>, 94%). The traffic police also had relatively high respiratory symptoms (Coughing 33.6%, Phlegm 25.4%, Wheezing 14.9% and 32.1%) reported in the study [13]. Above all, both of the studies show that there was a significant decrement in the lung function parameters tested which proves that working outdoors is a factor in developing respiratory health problems.

### **Wireless Sensor Air Monitoring**

A successful answer for the pollution monitoring is to utilize a wireless sensor network to give constant pollution data information. The different gases like Carbon Dioxide (CO<sub>2</sub>), Nitrogen Dioxide (NO<sub>2</sub>) are adjusted by utilizing fitting alignment advances and these recalibrated sensors are incorporated with the wireless sensor utilizing a multi-bounce information collection calculation. A lightweight middleware and web interface with the end goal to see the one pollution data as graphs and number. It is likewise accessible on the web. Alternate parameters like temperature and dampness are likewise detected alongside the gas focuses which empower the information investigation

through the information combination procedures this framework give precise contamination information [14]. In order to accomplish the wireless data transmissions, the system of air quality monitoring works with the virtual instrument technology and frequency hopping communication technology. There will be no signal disturbances during the wireless transmission process and information in real-time can be received effectively by the system, hence the non-professional staff can easily read the gas concentration data. All this will be possible by using specimens of spectrum hole detection which regulates the carrier frequency to the result and fully utilized of available radio spectrum [15]. The air quality monitoring station is utilized to screen the nature of air. However the greater part of this technique is costly and give low goals detecting information and these stations are less thickly sent hence the framework comprises of sensor mode portal and back-end stage controlled by the lab see program through which the information can be put away in the database the framework conveyed to the principal street in the city to screen the carbon monoxide fixation caused by the vehicle discharge the benefits of these remote sensors organize is that it is anything but difficult to set up, cheap and furthermore give ongoing information [16].

One of the main features of the sensor system is an innovative wearable device with embedded sensors installed on subjects; desiring minimal attention and lowest interference to the subject's wellbeing. This type of sensors will help to create awareness of their exposure to pollutants in the air and encourage them to take immediate action themselves.

## **DISCUSSION AND CONCLUSION**

The reviewed articles proved that mobile wireless sensors are a practical device that can effectively detect air quality and will facilitate to boost the protection of the community, personal health care as well as environmental monitoring. Hence, the finding of these studies quoted above can be used in future studies to help understand the current knowledge and usage of the mobile sensor network in exposure assessment and monitoring.

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## EXTENDED ABSTRACT

# Spatial Analysis of Heavy Metal Contamination in Bertam River, Cameron Highland, Malaysia

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### SUMMARY

The generation of municipal solid waste (MSW) in South East Asian and developing countries has become a serious concern worldwide. Population growth, urbanization, economic productivity and demand for consumption had accelerated the amount of waste generation each year. This paper presents a short definition of MSW landfill, an overview of current status of MSW landfills in Malaysia and generation of solid waste in Malaysia and other neighbouring countries.

**Keywords:** Solid waste, Landfill, Environmental health, Population growth, Malaysia

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### INTRODUCTION

Municipal solid waste (MSW) is mainly the waste from households, commerce, offices and public institutions, such as product packaging, clothing, food debris, electrical appliances, furniture, paper, plastic, glass, metals, textile fiber, wood timber, organic matter, ash, and others [1]. The composition of MSW is mainly influenced by the economic development, energy sources, cultural norms, geographical location, climate, etc. [2]. A study from [3], defines nine waste categories, including "special waste", representing municipal solid wastes. It contains various types of waste categorised as putrescible materials (organic material from food wastes), paper, plastic, metals, glass, wood, rubber, textile, and "special waste" (hazardous waste and e-waste).

### MUNICIPAL SOLID WASTE LANDFILL

MSW landfill is defined by the Environmental Protection Agency (EPA) as a waste disposal site that utilises to control the deposit of solid waste onto or into the land [4]. A landfill usually has liner systems and other safeguards to prevent contamination of the groundwater [5]. There are two types of landfills; sanitary and non-sanitary [6]. What makes these two landfills different is that the

former is equipped with a lining material underneath the surface together with a better technology to contain the contaminants from leaching out to the environment. The latter is merely an open dumping system without proper lining material underneath the surface. The government in Malaysia has classified landfills into different levels in improvising the efficiency of deposited landfill sites [6,7]. Different classifications in terms of levels are used to classify the landfills by the protection of technology it provides. Level 0 to Level 3 are classified as non-sanitary landfills. The classification was made based on the facility it has, such as:

- Level 0 is an open dumping
- Level 1 is a non-sanitary landfill with controlled tipping
- Level 2 is a non sanitary landfill with daily soil covering
- Level 3 is a non-sanitary landfill with a leachate recirculation system
- Level 4 is a sanitary landfill with a leachate treatment system

### MUNICIPAL SOLID WASTE LANDFILLS IN MALAYSIA: THE CURRENT STATUS

Malaysia currently has a total number of 158 operating landfills (Table I) leading by Sarawak [8], unfortunately only 12% of the total numbers are of the modern sanitary type. Sarawak has the highest number of operating landfills in Malaysia, with 46 non-sanitary landfills followed by Sabah (n=19) and Pahang (n=14). Johor recorded the highest number of non-operating/closed landfills with 24 landfills.

**Table 1: Current operating landfills by states in Malaysia by Ministry of Housing and Local Government (2016) shows the total of non-sanitary and sanitary landfill**

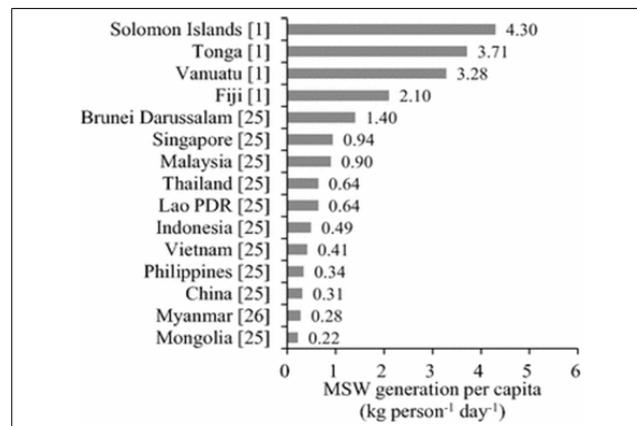
States	Operating Landfills			Non-operating Landfills
	Non-sanitary	Sanitary	Total	
Sarawak	46	3	49	14
Sabah	18	1	19	2
Pahang	11	3	14	18
Johor	12	1	13	24
Kelantan	11	-	11	8
Terengganu	9	-	9	11
Kedah	6	1	7	8
Negeri Sembilan	5	1	6	14
Selangor	4	4	8	14
Melaka	1	1	2	7
Pulau Pinang	1	1	2	1
Perlis	1	-	1	1
Wilayah Persekutuan Labuan	-	1	1	-
Wilayah Persekutuan Kuala Lumpur	-	-	-	10
Wilayah Persekutuan Putrajaya	-	-	-	-
<b>Total</b>	<b>141</b>	<b>17</b>	<b>158</b>	<b>82</b>

Source: [8]

**GENERATION OF MUNICIPAL SOLID WASTE (MSW) IN MALAYSIA AND OTHER SOUTH EAST ASIAN COUNTRIES**

Municipal solid waste is generated as a consequence of population growth, urbanization, economic productivity and demand for consumption [9,10,11]. The MSW generation in Malaysia has been increasing to more than 91% over the past 10 years [12,13]. The total amount of waste generated in 2016, was reported to be 38,200 tonnes per day at an average growth rate of 0.80 to 1.12 kilogram per capita per year [14]. Waste generation is expected to increase by 5.19% from 2015 to 2020 [15], and the amount of waste generated is predicted to rise from 38,563 tonnes per day in 2015 to 49,670 tonnes per day in 2020 [16]. Study had reported that the waste generation per capita in East Asia and the Pacific Island region was as illustrated in Figure 1 [17]. Malaysia generated approximately 0.90 kg per person per day of waste, far higher than neighbouring countries; Thailand (0.64 kg per person per day) and Indonesia (0.49 kg per

person per day). The lower waste generation reported in these countries was possibly due the data not were inclusive of all municipal wastes generated in the country [18]. Thus, the reliability and timeliness of the data cannot be guaranteed [17]. Singapore (0.94 kg/person/day) and Brunei (1.40 kg/person/day) had generated more waste when compared to Malaysia.



**Figure 1: MSW generation per capita in East Asia and the Pacific Islands [9]**

The largest category of solid waste composition in Malaysia was food waste (45%) followed by plastics (13%), diapers (12%), paper (9%), as well as metals and glass (3%) [9, 15, 18, 19]. The volume of solid waste composition generated in a community depended on the degree of volume and trend of consumption of the population. The quantity and quality of waste in landfills, however, were influenced by several factors which included recycling programmes, implementation of waste management strategies and waste minimization by the community [20]. The average waste composition in Malaysia is similar to that of other Asian countries [18,19,21]. The solid waste composition in Asian countries contained highly biodegradable material with high moisture content such as food and agriculture wastes, paper, leather, wood and textiles, as well as non-biodegradable such as plastic/foam, glass, rubber and metal [18,19]. Asian countries were among those contributing to a high rate of waste generation [18].

**THE DEPENDENCE ON LANDFILLING IN THE FUTURE**

Landfilling is still the most popular option of waste disposal worldwide [22]. It provides the simplest, cheapest and most cost-effective disposal method that has been used in the majority of low and medium income developing countries [22,23]. Many developed countries, for instance, those within the European Union (EU), landfilling is still the common option of waste disposal [23-25]. Despite landfilling being known to be the simplest, cheapest and cost-effective method of disposal of wastes, one of the key factors for it actually depends on the waste composition itself. The suitability of the method vary according to the composition [22]. The dependence on landfilling in Malaysia was attributed

to a very high percentage of moisture content in the form of organic wastes in MSW. The moisture content varied from 48% to 68% [2,22]. The implementation of the incinerator trial in Malaysia had failed due to the aforesaid high moisture content. They were designated for western characteristics of waste which was quite different from that of the Malaysian environment. Additionally, there were also faulty designs, improper operation, poor maintenance and a high usage of diesel [22,26]. In most Asian countries excluding Japan, the incineration method is least chosen because of the high moisture content in MSW. It may also be due to the installation of incinerators demands a high capital, operation and maintenance [9]. Majority of the Asian countries, are still preferred open dumping as the main disposal method despite composting, landfilling and the incineration [9] being introduced. Landfilling in Asian and developing countries will be the common method and is still relevant in the future even when there are several other ways being used for recycling and/or volume reduction [9]. Landfilling provide the lowest cost disposal option in Asian and developing countries.

## CONCLUSION

Heterogeneous types of waste produced were varies from region to region. Generation of municipal solid waste in Asian and developing countries increases yearly with the rapid urbanization and population growth, accelerated economic productivity and demand for consumption. The major problem that still exist in Asian and developing countries are the best disposal method of municipal solid waste and the landfill site availability. Most Asian and developing countries were still dependence to the landfilling method in the future because it provides the simplest, cheapest and cost-effective method of disposal.

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## EXTENDED ABSTRACT

# A Preliminary Study on Ergonomic Knowledge among Contractor in a Construction Site in Georgetown, Penang

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### SUMMARY

The purpose of this study was to determine the level of ergonomic knowledge and safety among contractor of a selected construction site located in Georgetown, Penang. The study also tried to identify the restrictions in implementing ergonomic and safety programs in the workplace. Prior to the study, a field investigation were conducted by the researcher and the researcher found out that workers are practicing poor body posture in the site and thus decided to conduct this study. Data were collected primarily from a questionnaire and the data were analyzed using Mann-Whitney test due to the small sample size which only involved 35 respondents. Results from the study shows respondents have high in ergonomic knowledge ( $p=0.962, >0.05$ ). Several factors restricting the implementation of ergonomic programs are "lack of management support" and "lack of information and training".

**Keywords:** Contractor, Ergonomic knowledge and safety programs, Workplace, Construction site, Restriction

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### INTRODUCTION

Health and safety is not a new thing in the construction sector as every new worker are given safety induction prior to entry into the site and is well aware of simple construction rules and regulations [1] such as the need to wear a safety helmet while working in the building for fear of being hit by fallen object. Thus, in the United States of America, construction labor is considered one of the most dangerous occupations [2]. Worldwide construction workers are easily susceptible to diseases, ill health, and injuries regardless of those working in develop or non-develop countries. Apart from disease and illness, pain in the body can arise from an injury or fatigue of the muscles as a result of poor practice of ergonomics and improper body posture while working.

Construction work consisted of various jobs and trades given to various sub-contractors. Work division among various trades eventually leads to a monotonous and repetitive job which can lead to various health and safety issues including work related to musculoskeletal disorder (MSD). MSD are a major cause of work-related disability

and lost time illnesses among workers and MSD in the construction sector have existed since ancient time when people started constructing buildings. Over the recent years, there had been many studies and statistics related to MSD in the construction industry. According to the Bureau of Labour Statistics, construction labourers have higher risk of 2.5 times more general workers to suffer MSD while working due to these labourers performing a wide variety tasks involving intensive manual handling in construction.

In Malaysia, a report by National Institute of Occupational Safety and Health Malaysia (NIOSH), stated that data from the Malaysia Social Security Organisation (SOCSO) shows there is an exponential increase of MSD cases in Malaysia from 2010-2016. Moreover, the report mentioned that the awareness and practice of ergonomics was still low and the number of cases could be higher as many cases had gone unreported. In SOCSO Annual Report 2016, the number of accidents in construction sector is 7338 cases. This shows that even with comprehensive acts, regulations, guidelines and code of practice being introduced by Department of Occupational Safety and Health (DOSH), accidents and injury related to MSD such as temporary and permanent body disability continues to happen at an alarming rate. Thus, the study aims to determine the level of ergonomics knowledge and awareness among

the respondents.

**MATERIALS AND METHODS**

This is a descriptive study which involved the contractors on the site. Data were collected using questionnaires only to the respondents who had attended the monthly Safety and Health Committee meeting at the construction site. The questionnaire consist of three different sections which are Section A (demographic data and Preliminary data on Occupational, Safety and Health Act (OSHA) 1994), B (to identify the respondent’s data on OSHA 1994) and ergonomic related questions) and C (used to identify the respondent’s knowledge on ergonomics and consist of eight pictorial questions which require respondents to select the correct body posture and method related to ergonomics while working at the workplace). This study was approved by the Universiti Science Malaysia Ethics Committee (Human), Ref No: USMKK/PPP/JEPeM [260.4.(4.3)]. The data then was analysed using Statistical for Social Package Statistical Software (SPSS). The data of Ergonomic Knowledge were analysed using non-parametric Mann-Whitney Test due to the small sample size. In addition, descriptive statistics were used to represent the respondent’s Demographic Data and question regarding OSHA 1994 and Ergonomic Awareness. Descriptive statistics were also used to identify the factors and restrictions in implementing ergonomic programs.

The study took place in a construction project consisting of a 3 phase development on the shorefront along Tun Dr Lim Chong Expressway in Georgetown, Penang. The First Phase is the Residential housing project consisting of condominium, apartments, club house and villas. Phase 2 is mixed development such as hotel, mall and business centres. A total number of 44 respondents were involved in this study [3]. However, only 35 respondents filled in and returned the questionnaire.

**RESULTS**

For demographic data, majority of the respondents were in the age of 40-49 years old (31.4%) and 25.7% in age group between 20-29 years old. From that, 97.1% or 34 respondents were male and 65.7% were married. All the respondents (100%) were Malaysian citizens. In term of education level, 51.4% have secondary school level education, 25.7% have a diploma and 17.1% possess a degree. The working experience shows that, 34.3% of the respondents which is majority have only 1-5 years’ experience and only 11.4% having more than 21 years of working experience in construction sector.

Out of total respondents, 40% of them possess a certificate of competency related to health and safety such as Safety Courses, Emergency Response Course, Fire Fighting Courses, First Aid Courses and related training while 21(60%) do not. In addition, 20 (57.1%) of the total

respondents possess a certificate of competency related to construction and building works such as competent person for Scaffold, Electrician, Crane operation, Welding operation and other construction works while the remaining 15 (42.9%) does not. Apart from that, all (100%) respondents possess a valid CIDB card.

Regarding general questions on health and safety and occurrence of past workplace injury in construction site (Table I), it shows that 24 (68.6%) of respondents knew about the existence of OSHA 1994 Act while 11(31.4%) of the respondents were not aware of the act. In addition, all 35(100%) respondents agree that health and safety is important in workplace.

**Table I: Preliminary Data on Health and Safety for Respondents**

A (ii)	Preliminary Data on Health & Safety	Frequency (f)	Percentage (%)
A1)	<b>Do you know about OSHA 1994</b>		
	Yes	24	68.6
	No	11	31.4
A2)	<b>Does your company have a Health and Safety Policy?</b>		
	Yes	32	91.4
	No	3	8.6
A3a)	<b>Have you or your workers ever been injured during work?</b>		
	Yes	19	54.3
	No	16	45.7
A3b)	<b>Was the injury serious of Life-threatening?</b>		
	Yes	4	11.6
	No	31	88.6
A4)	<b>Do you think Health and safety is important in the workplace?</b>		
	Yes	35	100
	No	0	0

Towards the OSHA Awareness of Occupational Safety and Health and ergonomic in the workplace, a score of 1 showed that the respondent strongly agreed to the statement given while a score of 5 showed that the respondent strongly disagreed. For questions 1,2 and 3 shows a mean score of 2.69 (Q1), 3.14 (Q2)and 3.03 (Q3) showing that the most contractor do knew about the OSHA 1994 as well but majority of them were not entirely sure regarding the duty of employers as stated in section 15 of OSHA 1994. Next, on question 4 and 5 related the importance of health and safety, a mean score 1.29 (Q4) and 1.43 (Q5) concluded that nearly all of the respondents strongly agreed that health and safety are important and their respective company do indeed practiced health and safety in their daily work. Then, on questions 6, 7 and 8 which were asked to find out the respond of respondent towards work related back pain and tiredness, the mean score was 2.86 (Q6), 3.43 (Q7) and 3.51 (Q8) showed the majority of respondents agreed to the feeling of tiredness after work however the occurrence of back pain and whether the back pain was work related are not significant as the mean results

showed that, most of them were not sure when asked about work-related pain. Questions 9 to 16 were related to the awareness of ergonomics among respondents. The mean score were 3.97 (Q9), 2.77 (Q10), 2.63 (Q11) showed that majority of respondents does not have strong understanding on ergonomics. However, respondents somehow agreed that it may be useful and important to learn ergonomics. When respondents were asked about the popularity of ergonomics (Q12) in terms of being frequently talked about, an average scored was 4.46 that clearly indicating that ergonomics are something that is not frequently talked about. For Question 13, a mean score were 4.63 clearly indicate that respondents disagreed that their workers were knowledgeable in ergonomics. From the mean score of 2.49 (Q14) and 2.91 (Q15), it could be concluded that most of respondents wants to know more about ergonomics and willing to spend time to learn and teach their workers about it, but a mean score of 3.2 for Question 16 indicated that the respondents were not entirely sure in spending money for the purpose of learning and teaching ergonomics to workers.

In addition, on questions ergonomics related program and restriction, 100% respondents agreed that Signboards, Poster and Signage regarding ergonomics and health and safety were implemented in workplace. Furthermore, majority of respondents (80.8%) also responded positively that there were indeed personnel teaching on ergonomics, on job training done for ergonomics related work and monthly/yearly worksite inspection. Respondents were also asked regarding the restriction faced by most company in implementation of ergonomics and health and safety related program in workplace, "Lack of management support" and "Lack of information and training" as the main factors leading to the restriction as more than 80% of respondents identified positively both factors. Other factors were "wasting fund", "ergonomic programs are expensive" and "insufficient competent/qualified person to guide them". Majority of respondents (71.7%) also agreed that workers are not capable of working safely by themselves and thus ergonomics related program might be implemented by companies in the future to increase the level of health and safety in workplace (76.7%) (Table II).

**DISCUSSION AND CONCLUSION**

The study showed that majority of the respondents seems to have a low level of knowledge regarding OSHA 1994 and have poor attitude towards implementation of safety and health related programs in workplace as well. This study also showed that most of respondents felt that safety programs are something that are forced to them and not something they ought to do as employees as stated in the OSHA 1994. This statement was supported by [4], who stated that safety related continuous promotion and educational process is being forcefully enforced in

**Table II: Restriction in implementation of ergonomics program**

B (ii)	Restriction in implementation	Frequency (f)	Percentage (%)
Q3	<b>Why do you think most company has NOT implement ergonomics related program</b>		
3a	<b>Not interested</b>		
	Yes	27	45.0
	No	33	55.0
3b	<b>Not important</b>		
	Yes	26	43.3
	No	34	56.7
3c	<b>Waste of time</b>		
	Yes	26	43.3
	No	34	56.7
3d	<b>Waste of funds</b>		
	Yes	45	75.0
	No	15	25.0
3e	<b>Ergonomics programs are expensive</b>		
	Yes	47	78.3
	No	13	21.7
3f	<b>Lack of management support</b>		
	Yes	50	83.3
	No	10	16.7
3g	<b>Lack of information and training</b>		
	Yes	51	85.0
	No	9	15.0
3h	<b>No qualified/competent personnel to guide</b>		
	Yes	46	76.7
	No	14	23.3
3i	<b>Workers can work safely by themselves</b>		
	Yes	17	28.3
	No	43	71.7
4	<b>Do you think company will implement Ergonomics programs in the future?</b>		
	Yes	46	76.7
	No	14	23.3

workplace towards contractors and [5] further state that this enforcement occurred because OSHA 1994 was a self-regulatory act.

In addition, this study also shows that even though all of the respondents as contractors were part of the Emergency Response Team of the construction site, majority of them lack the training and competency in emergency response such as firefighting and first aid knowledge. Thus, without that team are functionless as these members are not prepared and will not able to react to an emergency even though equipment's such as fire extinguisher and first aid kit are well prepared.

Respondents also seems to have a lack of awareness and understanding in ergonomics as majority of respondents rarely heard of the term ergonomics being talked about prior to this. Many of the respondents were briefed on what is ergonomics prior to the questionnaire answering session as majority of them does not know the definition

and term even though the definition of ergonomics was stated in the questionnaire booklet. This finding is in-line with a study by Ali et al mentioned in the journal "Ergonomic Issues in Malaysia" by [6] who had interviewed industrial engineers among the respondents. The findings showed that these industrial engineers were confused between the words "ergonomic" and "economics" and though there were no relationship between ergonomics and health and safety showing the low level of ergonomic awareness and knowledge. Another study conducted by [7], indicates the need to educate Malaysia university students with ergonomic as the level of ergonomic awareness was low.

Among the major factor as highlighted by the respondents from this study indicates that, "Lack of management support" and "Lack of information and training" as the main factors leading to restriction. These factors were identical to factors identified by previous studies. For example, a study by [8] identified that, lack of knowledge and training are among the factors obstructing organization from implementing ergonomic programs.

Management support are very important in order to increase the level of health and safety in workplace as without the support, there will be inadequate funds to organize and implement safety and health related programs. The traditional mindset of aiming for high productivity and high profit among top management in the construction sector needs to be changed [4] and everyone ought to realized that if a serious accident were to occur, the damages can be very costly such as workers fatality, loss of productivity, lawsuit, delayed of project completion and perhaps bring down the whole company into bankruptcy. A study on ergonomics intervention by [9] shows that results of a 5 year study on ergonomics intervention do decrease the rate of work related MSD and absenteeism in work.

As a conclusion, all employees from top management till the workers need to be aware of importance of safety and health activities such as ergonomic programs in the workplace. This study indicated that majority of the respondent do believed that ergonomics related program might be implemented by companies in the future as incidence in workplace injuries can be reduced if the awareness of ergonomics were being raised [10]. Thus, a change in mindset is needed to overcome the obstacles and challenges in ergonomics implementation as reported in this study and as reported by [11] and eventually increase the level of safety and health in the workplace in all Malaysian construction site and industries.

## ACKNOWLEDGEMENT

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## EXTENDED ABSTRACT

# The Impact of Heat on the Health and Productivity of Cassava Farmers in Kratie, Cambodia

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### SUMMARY

Heat stress is a serious problem among agricultural workers. Workers who are exposed to the extreme heat or work in hot environments may be at risk of heat stress. The physiological changes and heat related symptoms could occur due to heat stress. The objective of this cross-sectional study was to determine the impact of heat on the health and productivity of cassava farm workers in Kratie province of Cambodia. The sampling method was a convenient sampling with some inclusive criteria. A total of 125 cassava farm workers were selected to participate in this study. The information was collected through a face to face interview using a questionnaire form. Questions were asked on heat exposure during work and heat related symptoms. The environmental heat was measured using heat stress monitor WBGT and data logger for 2 hours for each day. Automatic blood pressure monitor was used to measure blood pressure and heart rate, while ear thermometer measured the body temperature. All measurements of physiological changes were conducted during the rest and work time of the workers. Observations were conducted to determine the production hourly output of workers by using productivity forms. The productivity was determined by calculating the total of cassava roots harvested per hour, which started from 9.00 a.m. to 11.00 a.m. The results indicated that the highest average of heat stress index were 32.11°C and 32.36°C respectively whereby the daily exposure to heat during work, exceeded the threshold limit value (TLV) of 27.5°C for heavy metabolic workload level with 75% work, 25% rest regimen. Meanwhile, the highest prevalence of heat related symptoms reported among workers were tiredness/weakness (84.4%), followed by heavy sweating (82.4%) and headache (61.6%). The blood pressure, heart rate and core body temperature were below the standard, indicated that the workers were fully acclimatized. There was no significant difference in the physiological changes between male and female during the resting and working period. Heavy sweating, heat, BMI and working time were the factors that were significantly related with productivity. In conclusion, the cassava farm workers in Kratie, Cambodia were exposed to high level of heat stress, which reduced their work productivity.

**Keywords:** Impact of Heat, Health, Productivity, Cassava Farmers

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### INTRODUCTION

The global climate change is already making the hot seasons become hotter in all part of the world. Therefore, the increasing in level of global temperature will lead towards the heat impact on worker in various sectors. Heat stress is defined by American Conference of Governmental Industrial Hygienists [1] as the net head load, including metabolic heat; environmental factors such as temperature, air currents/movement, and radiant heat; and the clothing or personal protective equipment (PPE) required for specific hazards to which workers may be exposed. Heat stress is a health hazard to the

workers, which include adverse health impact including a wide range of physical, mental, and psychological function deterioration like skin problems, heat strain, heat exhaustion, heat stroke and affects the productivity of the workers [2]. The objective of this study was to investigate the impact of heat on productivity and health among cassava farm workers in Cambodia. Agriculture is the fundamental sector of Cambodian economy which consists of 80% compared to the other sectors which is dominated by the small farmers and serve as a source of their daily income getting less than 1 to 3 US\$ per day. Cassava is normally planted during April-May and harvested in December-January depending on market price and the availability of labour for harvesting [3]. During harvesting, the workers start by cutting the stem of cassava. Simultaneously, other workers began to dig the cassava roots by using the pick hoes to pull out the cassava roots from the ground. Then, the cassava roots

were peeled by using a paring knife after which roots were chopped into smaller pieces. Lastly, the cassava roots were dried for a few hours and packed in a bag before loading into a tractor.

**MATERIALS AND METHODS**

This study was conducted among the cassava farmers around the Kratie province, Cambodia from 27th December 2014 to 30th January 2015. The study population were randomly selected and the convenient sampling was used on the respondents who met the following inclusion criteria: Full-time workers, age 13-60 years, have worked at the farm for more than a month and without any hypertension or heart disease were included. Questionnaires were used to gather information on their background, work tasks, heat-related symptom and their coping mechanisms. Pre-test were conducted and the questionnaire was translated in Khmer language by two Cambodian translators, hired to help in gathering more detail information. For the productivity assessment, observations were conducted to determine the work capacity. The total bags of cassava roots harvested were observed for two hours daily from 9.00 a.m. to 11.00 a.m. The hourly total bags of cassava roots harvested were calculated and recorded into the productivity form. The heat was measured by WBGT (QuesTemp<sup>o</sup>) which encapsulated the air temperature, humidity, radiant heat and wind speed in a single index. The WBGT index is based on the simple idea of signalling “how hot it is” through a device that mimics a sweating human body receiving heat from air temperature and solar radiation while cooled by the wind [4]. The WBGT data is measured using this formula:

$$WBGT = 0.7T_w + 0.2T_g + 0.1T_d$$

Where,

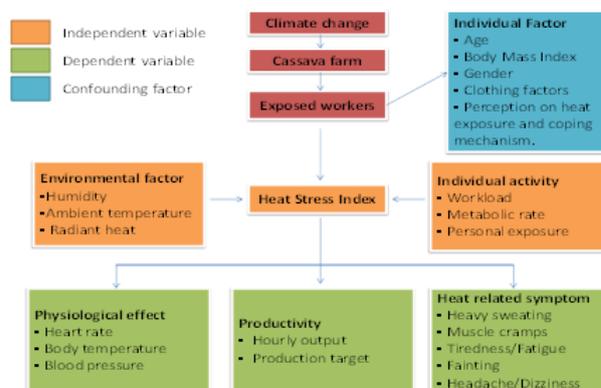
$T_w$  = Natural wet-bulb temperature (combined with dry-bulb temperature indicates humidity),

$T_g$  = Globe thermometer temperature (measured with a globe thermometer, also known as a black globe thermometer)

$T_d$  = Dry-bulb temperature (actual air temperature)

From this calculation, we compared the WBGT values with ACGIH screening criteria for heat stress exposure of 8 hour work day with conventional breaks. Before this comparison, several data such as metabolic workload, acclimatization and clothing factor were considered when measuring heat stress level. This instrument was installed around 100 m radius surrounding of work environment which operated for 2 hours each day from 9.00 to 11.00 a.m. at interval of 15 minutes. Meanwhile, a data logger was used to measure average temperature and humidity. The Omron T-3 Automatic Blood Pressure Monitor was used to measure of the blood pressure and heart rate, while Omron MC-510 Gentle Temperature Ear Thermometer was used to measure the core body temperature. All measurements were conducted on respondents during the rest and work period. Each

instrument was calibrated according to the Standard Operating Procedure (SOP) in the instruction manuals (Figure 1). Ethical clearance was obtained from the Ethics Committee, Universiti Putra Malaysia (Ref: FPSK (EXP14-OSH) U059). This study has also been approved by the National Ethics Committee for Health Research (Ref: 0268NECHR, 11/09/2014) under Ministry of Health of the Royal Government of Cambodia.



**Figure 1: The conceptual framework of heat stress assessment**

**RESULTS**

All respondents were Cambodian, with mean age of 32 years for male and 33 years for female workers with an average employment period of 7 to 8 years. All respondents were within the normal BMI (range 18.9-23.9 kg/m<sup>3</sup>). Table I presents the prevalence of heat related symptoms reported. The highest was tiredness/weakness (84.4%), followed by heavy sweating (82.4%).

About 54.5% of respondents would move to cooler environment during working period and 45.6% took a rest to reduce the heat exhaustion (Table II). All respondents stated that the water is sufficiently available as drinking sources in their workplaces and 59.2% drank water around 3 to 5 litres per day. Based on Table III, the mean for blood pressure, heart rate and body temperature were significantly different for both male and female during resting and working. Table IV, by using general linear model, heavy sweating, heat exposure (WBGT), working hours were the significant risk factors influencing productivity.

**DISCUSSION AND CONCLUSION**

Based on the ACGIH [1], the results showed that the work on each day had been exceeded the TLV which

**Table 1: The prevalence of heat related symptoms reported (N = 125)**

Variables	Prevalence (%)
Tiredness/weakness	106 (84.8%)
Heavy sweating	103 (82.4%)
Headache	77 (61.6%)
Dizziness	69 (55.2%)
Muscle cramps	68 (54.4%)
Nausea/vomiting	41 (32.8%)
Fainting	2 (1.6%)

**Table II: Coping mechanism during working hours**

Variables	n	%
How do you cope with heat exhaustion?		
Take a rest	57	45.6
Cool shower, bath, or sponge bath	0	0
Move to cooler environment	68	54.5
Is sufficient water available at all times when you need it?		
Yes	125	100
No	0	0.
How much do you drink in a day in hot condition? (per liter)		
<3 liter	29	23.2
3-5 liter	74	59.2
>5 liter	22	17.6
How often do you drink water at work?		
<3 times	16	12.8
3-5 times	39	31.2
>5 times	70	56.0

27.5 °C for heavy metabolic workload level with 75% work, 25% rest regimen. The high level of temperature at the cassava farm indicated that the workers were vulnerable to the exposure toward heat stress every day in their work. The highest prevalence of heat related symptoms reported among workers were tiredness/weakness, followed by heavy sweating and headache. These findings similar to [5], who found that the heavy sweating, headache and weakness are the three most commonly reported symptoms among farm workers in Oregon. Meanwhile, [6] also stated that the heat exhaustion was the most commonly cases of heat related illness occurred in the workplace. Moving to the cooler environment is one of the effective coping mechanisms which can help workers to avoid heat strain whereby the workers were able to reduce their body's heat gain from solar radiation. Resting from strenuous work is also important for workers to decrease the exertion on their

body and greatly diminishes metabolism that allows the body to release heat through passive cooling [7]. Another coping mechanism was high water consumption to maintain electrolyte balance in our body by replenishing fluids (and electrolytes) lost primarily through sweating and urination. Every individual have different needs for fluid replenishment. However, generally [8] stated that workers should drink about 1 cup of water per 20 minutes to avoid hydration. In term of physiological changes, we found that between male and female workers showed no differences in blood pressure, heart rate and core body temperature. The results showed there is no significant difference between gender in either metabolic heat production or in heat exchange by radiation, convection or evaporation. The American Heart Association [9] described that the range of hypertension of the workers for systolic and diastolic blood pressure should not be greater than 140 mm Hg and 90 mm Hg respectively. The mean average of the blood pressure for both gender are still below than the range of hypertension. [10] stated that blood pressure showed a tendency to decrease in relation to indoor and outdoor temperature increment. The blood pressure is lower in summer due to the veins of the skin expanding in order to diffuse body heat. Thus, this present study, heart rate was still considered under the limit as the mean value for heart rate within gender was still below 110 bpm. Meanwhile, ACGIH recommended that body core temperature not be greater than 38.5 °C for acclimatized workers or greater than 38 °C for un-acclimatized workers [1]. Both genders showed significant differences in blood pressure heart rate and core body temperature during resting and working. The increase in blood pressure during work could be related with the heavy type of work category.

**Table III: The comparison of physiological changes within gender during resting and working**

Variables	Male (N=65)			Female (N=60)			
	Mean (SD)	t	p	Mean (SD)	t	Z	p
Systolic (mm Hg):							
Resting	121.52(12.52)			121.82(14.20)			
Working	128.42(13.10)	-8.458	<0.001	128.95(15.69)	-7.905	-	<0.001
Diastolic (mm Hg):							
Resting	74.58 (9.69)			74.92 (11.07)			
Working	78.51 (11.12)	-3.399	0.001	77.27 (11.68)	-2.785	-	0.007
Heart rate (bpm):							
Resting	81.31 (13.79)			80.82 (9.74)			
Working	85.14 (14.35)	-2.526	0.014	87.20 (14.42)	-	-5.052	<0.001

**Table IV: The parametric estimates of selected factors related to productivity**

Variables	B	Std. Error	t	p	95% Confidence Interval	
					Lower Bound	Upper Bound
Intercept	237.694	21.979	10.815	<0.001	194.072	281.316
Heavy sweating	-3.632	1.273	-2.853	0.005	-6.159	-1.105
Heat exposure	-6.410	0.665	-9.632	<0.001	-7.731	-5.089
BMI	0.504	0.190	2.659	0.009	0.128	0.880
Working time	-1.576	0.239	-6.593	<0.001	-2.050	-1.102

When the body is over exposed to the heat, blood will increase and flow to the skin to lose the excess heat and to maintain the stability of the internal environment. Previous researcher [11] stated that performing task in the hot condition was sufficient to cause the core body temperature rising approximately 0.6 °C over per hour. When a task was completed and the workers are rested, the core temperature and heart rate declining as a result. Majority of the respondents had worked for more than one month which lead them become acclimatized them well with environment. ILO [12] stated that the process of acclimatization will results in an increased sweat rate, leading to lower core temperature and heart rate at the same work level and environment heat load. The heavy sweating, heat exposure (WBGT), work hours and body mass index (BMI) significantly influenced overall productivity. Prolonged sweating will depletes plasma volume and electrolytes, resulting in observable heat illness such as heat exhaustion. A study [13] mentioned that the worker's action to prevent ill health would lower productivity and a loss of daylight work hours would occur. [14] stated that an increase of temperature up to 24°C was associated with statistically significant decrease in performance. The physical work creates heat inside the body when internal heat was produced from the working muscles. When this internal heat combined with the heat from outside, it would risk the worker's health and productivity. Therefore, the work intensity must be slowed down to reduce internal heat production, cardiac strain, and heat exhaustion [15]. Meanwhile, there was also an association between working hours and productivity similar to a study [16], which stated that the diminishing in productivity were associated with working long hours. The long work hours probably caused fatigue among the workers which would directly reduce their productivity

As a conclusion, the cassava farmers in Cambodia were exposed to high level of heat. There were significant differences in blood pressure, body temperature and heart rate between rest and work hours for both genders. Most of the workers were already acclimatized to the heat, as the mean for heart rate and body core temperature were in the acceptable ranges. We found that the highest prevalence of heat related symptoms reported were tiredness, heavy sweating and headache. The productivity were also significantly decreased with the heat increase. Heavy sweating, heat exposure, long working hours and BMI were risk factors related with the decreased productivity output.

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## EXTENDED ABSTRACT

# Heavy Metals (Pb, Cd, As) Content in Instant Noodles From Malaysian Market

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### SUMMARY

Instant noodles had been found to be contaminated with heavy metals such as lead (Pb), cadmium (Cd) and arsenic (As). This study aims to determine the heavy metals (Pb, Cd, As) concentration in popular instant noodles from Malaysian market. Seven different brands of commercially popular instant noodles were randomly sampled from the market. The samples were prepared by dry ashing method prior to analysis by using Inductively Coupled Plasma Mass Spectrophotometer (ICP-MS). Results showed that all seven samples detected with heavy metals which the concentration for Pb in two samples exceeded the maximum permitted level of Malaysian Food Act and Regulation of 2 mg/kg. This finding indicated that instant noodle can be one the sources of chronic exposure to toxic heavy metals through food consumption which later might cause health effects. Instant noodles in Malaysian market need to be closely monitored to ensure the food quality and safety for consumption. Further study which focuses on the source of contamination as well as the health risk of consuming this contaminated noodles is strongly recommended.

**Keywords:** Instant noodles, Heavy metals, ICP-MS, Food consumption, Food safety

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### INTRODUCTION

Noodle is considered as one of the most important food in Asia. Instant noodle which was derived from Japan by Momofuku Ando in 1958 was then spread to Asia, America and Europe. Instant noodle is consumed in more than 80 countries around the world and has become an internationally recognized food. In 2012, instant noodles demand was exceeded 100 billion serving and still rising. It is made of simple ingredients such as water, salt, carbohydrate, protein and small amount of fatty acids. Besides that, acid regulators, flavour enhancers, thickeners, humectants, colours, stabilizers, anti-oxidants, emulsifiers, flour treatment agents, preservatives and anti-caking agents were allowed to use in the making of instant noodles which make it long shelf life (1). Each instant noodle is conveniently packed with flavoured ingredients, and simple preparation thus makes it highly preferred by busy consumers such as university students. A single serving of instant noodles is high in carbohydrates and fat, but low in protein, fibre, vitamins and minerals (2). In addition, it is unhealthy due to their ingredients made up of a low nutritive value and contaminated with heavy metal, especially during

food processing. Previous study found that instant noodles were contaminated with heavy metals (3,4,5,6). Heavy metals such as Pb, Cd and As may pose health effects with long duration chronic exposure especially from food sources. This is because the ability of heavy metal to accumulates in target organ and tissue where it will exert its effect. Pb can affect several organs such as kidney, central nervous system, liver, hematopoietic system, endocrine system and reproductive system (7). The long-term effect of Cd exposure was it can cause adverse effect on kidney, respiratory system and bone disease (8). Prolong exposure to As can cause cancer, skin lesions, developmental effects, cardiovascular disease, neurotoxicity and diabetes (9).

In Malaysia about 3.6 million packages of instant noodle were consume by people per day. Malaysia was listed in Top 15 countries highly consumed instant noodles with the rate of consumption is about 1360 million of cups or packets instant noodle in year 2015 (1). Considering the increasing trend in the consumption of instant noodles in Malaysia, the quality of the product that is being sold to the consumer need to be constantly monitored as it is very important to ensure that they are safe for consumption. This study was carried out to determine the Pb, Cd and As concentration in commercially popular brands of instant noodle. To the best of our knowledge, there is no published literature on heavy metals contamination in instant noodles available in

Malaysian market. This study is essential to fill in the gap of knowledge regarding this issue.

## MATERIALS AND METHODS

Seven commercially popular brands of instant noodles were randomly purchased from the market. The instant noodle samples were brought to the laboratory to be digested by a dry ashing method. The noodles were analysed together with the seasoning. Firstly, the samples of instant noodles were clean with distilled water. Then, the sample was soaked in water and mixed with the seasoning and flavouring powder. After that, the sample was homogenized by using food blender. Then, one gram of the samples was weighted on analytical balance and placed in the crucible. After that, the sample was put in furnace. The temperature of furnace was slowly increased from room temperature to 450°C in one hour. Then, the samples were ashed in 480°C for about four hours until white or gray ash residue obtained. Then, the sample was left to cool for one night in the furnace. After that, five mL of 0.24M nitric acid (HNO<sub>3</sub>) was added into the residue and heated slowly to dissolve the residue by using hot plate. Next, the residue was dissolved in 25ml distilled water. The solution was filtered using 0.45µm Whatmann filter paper and transferred to a 25ml of volumetric flask. Then the samples were analysed by ICP-MS model Perkin Elmer Elan Dre-e to determine the heavy metals concentration. Ten millilitre of standard solution were prepared and diluted to 5 ppb, 10 ppb, 20 ppb, 50 ppb, 100 ppb and 300 ppb to build the calibration curve. Lastly, the standard solution and a blank were analysed with ICP-MS to obtain the standard curve value of ±0.999 prior to the sample analysis. The food standard reference material, SRM 1640a for lead, cadmium and arsenic element were analysed to obtain the standard curve prior to the samples analysis and good recoveries were observed. The value of heavy metals concentration in instant noodle was applied into following equation to obtain the actual concentration of heavy metals present in the samples:

$$\text{Heavy metal concentration in instant noodle, mg/kg} = \frac{[(A \times B)]}{W} \times C$$

Where, A = Volume of extraction (digested sample, g); B = Dilution factor (volume of diluted sample/volume of extract); C = Heavy metal concentration in instant noodle (µg/mL); W = weight of sample (g).

## RESULTS

Table I shows the concentration of heavy metals in all seven instant noodle samples and maximum permitted level in certain food types according to Malaysian Food Act and Regulations (10) and Codex Alimentarius (11). The Pb concentrations in instant noodles were ranged between 0.27 to 2.94 mg/kg. Cd was detected which

**Table I: Mean heavy metals concentration (mg/kg) in instant noodle samples (N = 7)**

Instant Noodle Sample and flavour	Pb	Cd	As
A - Curry	2.94*#	0.37#	0.81
B - Tom Yam	1.53#	0.16	0.81
C - Original Fried noodle	2.52*#	0.26#	0.56
D - Tom Yam	0.27#	0.10	0.69
E - Chicken	0.47#	0.22#	0.75
F - Original seafood	0.98#	0.10	0.44
G - Curry	0.58#	0.03	0.25
<b>Maximum permitted proportion by Malaysian Food Act (10)</b>	2 <sup>a</sup>	1 <sup>a</sup>	1 <sup>a</sup>
<b>Permitted level by Codex Alimentarius (11)</b>	0.2 <sup>c</sup>	0.2 <sup>b</sup>	n.a

\*Exceed the maximum permitted level for Malaysia (10)

#Exceed the maximum permitted level of Codex Alimentarius (11)

<sup>a</sup>Maximum permitted level in all food, preserved and salted except pickles

<sup>b</sup>Maximum permitted level in wheat

<sup>c</sup>Maximum permitted level in cereal grain

n.a = not available

ranged between 0.03 to 0.37 mg/kg and As ranged between 0.25 to 0.81 mg/kg. Sample A, which is the most popular brand, showed the highest concentration of Pb, Cd and As. Overall, Pb concentration was highest in 5 out of 7 samples as compared to Cd and As. Based on Malaysian Food Regulation 1985 (10), two samples, A and C, exceeded the maximum permitted level for Pb while Cd and As were not exceeded the permitted level in all samples. However, if referred to Codex Alimentarius standard (11), all seven samples were exceeded the maximum permitted level for Pb, and three samples exceeded the limit for Cd. There was no maximum permitted level available for As for the related type of food.

## DISCUSSION AND CONCLUSION

Previous studies reported that heavy metals were detected in instant noodle samples from Bangladesh, N=5 (3), Nigeria, N=7 (4); N=8 (5), and Iran, N=27 (6). In this recent study, we found the Pb concentration detected in instant noodles was in the range of 0.27 to 2.94 mg/kg, is higher than previous studies. In Bangladesh, Johti and Uddin (3) found that Pb concentration was between 1.17 to 1.67 mg/kg, lower than the maximum permissible levels for lead in noodles in Bangladesh national legislation but higher than Codex Alimentarius standard (11) level of 0.2 mg/kg. Onyema et al, (4) reported a study done in Nigeria where the Pb concentration ranged from 0.025 to 0.106 mg/kg in which surpassed the international standard limit (11). Another study in Nigeria revealed Pb level between n.d. to 0.55 mg/kg (5) also exceeded the international standard. A recent study in Iran found that Pb in instant noodles was in the range of 1.004 to 1.57 mg/kg (6), also exceeding the permitted limit of Codex Alimentarius (11) in several samples of instant noodles. In this study, Cd was detected in instant noodles which ranged between 0.03 to 0.37 mg/kg. The maximum concentration found in this study is comparable to an Iranian study (6) which reported the

Cd concentration in their samples ranged from n.d. to 0.34 mg/kg. Besides that, the concentration of Cd in this study was higher than Onyema et al (4) (0.001 to 0.008 mg/kg) and Emujejaye et al., (5) (nd to 0.01) but lower than Jothi and Uddin (3) (0.53 to 0.82 mg/kg). The As concentration in instant noodles in this study was ranged between 0.25 to 0.81 mg/kg which was higher than previous studies (3,5). Jothi and Uddin (3) found that the As level found in their samples ranged from 0.17 to 0.41 mg/kg while Emumejaye, et al (5) reported the As level ranged from n.d. to 0.14 mg/kg.

The heavy metals found in instant noodle might come from the raw or processed ingredients used in the making of instant noodles. Wheat flour is the main raw materials in making and processing of noodles. Studies pointed out that legumes and cereals were contaminated with different levels of heavy metals (12). Wheat flour can be contaminated with Pb, Cd and As from the environment due to industrial and traffic emission, agriculture activities through irrigation with contaminated water, application of fertilizer and metal based pesticides, as well as method of harvesting and storage (13). Since instant noodle is highly processed food, heavy metals might be introduced into the food from the added flavours or ingredients during the preparation of instant noodle and its seasoning. In food industry, As was widely used as food preservative while Cd was used as colour pigment. This might contribute as one of the contamination sources of heavy metals in instant noodle consumption. Adding of water during instant noodle preparation also can be the source of contamination (14). While this current study did not analyse the heavy metals content in the noodle and in the seasoning separately, there is a need to do so in the future researches. Therefore, proper prevention plan can be suggested to lower the risk of heavy metals exposure through instant noodle intake.

In order to ensure food safety and quality, the Malaysian authority has enacted the Malaysian Food Act 1983 and Food Regulation 1985 to protect the public against health hazards and fraud in the preparation, sale and use of food, and for matters incidental thereto or connected therewith (10). Under the Malaysian Food Regulation 1985, a maximum permitted level in all food was set at 2, 1 and 1mg/kg for Pb, Cd and As respectively (10). This local permitted level is higher than the international standard by Codex Alimentarius (11) which are 0.2 mg/kg for Pb and Cd. Since there is no standard limit specifically for instant noodle in Codex Alimentarius (11), a permitted level for Pb in cereal grains, and for Cd in wheat, is used as the reference. No permissible level is available for As in Codex Alimentarius for the related food type.

This study conclude that Pb, Cd and As were detected in all instant noodle samples. Based on Malaysian Food Act (10), only Pb exceeded the permitted level of 2mg/

kg. However, from the international standard of Codex Alimentarius standard (11), all samples surpassed the permitted level for Pb, while 3 samples exceeded the permitted limit for Cd. These findings indicated that instant noodle can be one the sources of chronic exposure to heavy metals through food consumption which later might cause health effects related to heavy metals toxicity. Further steps should be considered to prevent the continuous intake of heavy metals from food particularly instant noodles. Regular monitoring of heavy metals in food samples conveniently available to public followed by withdrawal of affected food from the market need to be done by the authority to assure only high quality and safe foods reach the public. Public awareness should be increased to educate them to wisely choose only quality foods for consumption for the own health benefits. Further studies which focuses on the specific sources of contamination as well as the health risk of consuming this contaminated food is strongly recommended.

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## EXTENDED ABSTRACT

# Risk Factors Associated with Mental Health of Primary School Teachers in the Klang Valley, Malaysia

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### SUMMARY

Mental health outcome among teachers has become an escalating problems in many countries. Mental health nowadays has becoming a public health issue. Teachers were not an exclusion from this issue. Several studies did point out teachers with poor mental health status has become an increasing problems in many countries. A total of 272 teachers from the urban, rural and industrial areas participated in this cross sectional study in the Klang Valley. The objective was to determine the risk factors associated with mental health among primary school teachers. The teachers' mental and physical health status were measured using questionnaires. Respondents were given a set of questionnaire which consisted 5 parts, namely socio-demographic and background status, occupational information and medical history obtained from the first part of questionnaire. The other part consisted of the General Health Questionnaire, Teachers' Stress Inventory, Modified Nordic Questionnaire and American Thoracic Society for Adult. There was no difference in the background of the groups of teachers except for the educational level ( $p < 0.05$ ). The urban teachers were more highly qualified than the other 2 groups. The majority of teachers showed good mental health and respiratory health status. Less than 50% of the respondents developed one-year prevalence of low back pain. Respiratory symptoms showed a significant relationship with poor mental health status (OR 8.12, 95% CI 2.80–23.56). Respiratory problems were the significant risk factor for poor mental health status ( $p < 0.001$ ) of teachers in schools.

**Keywords:** Risk Factors, Mental Health, School Teachers

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### INTRODUCTION

World Health Organization (WHO) defined mental health as "a state of well-being in which an individual realizes his/ her own abilities, can cope with the normal stresses of life, can work productively and effectively and is able to make contributions to his or her own community" [1]. A few studies [2-5,6] reported that teachers' mental health could affect their performance in classroom, as well as changed in methods of teaching. Premature retirement and sick leave have been identified as the effects of poor mental health status among school teachers [4-6]. Several studies reported mental health to be an influencing factor to musculoskeletal problems and respiratory symptoms [7,8,9,10,11]. Other risk factors were job responsibility, gender, physical strenuous

activity and work stressors, including interpersonal relationship, student misbehaviour and job satisfaction [9-11]. This study proposed to assess if physical health could be the risk factor for poor mental health among school teachers. The said physical health status in this study was low back pain and respiratory health. Therefore, this study aimed to determine the influencing factors for the poor mental health status among primary school teachers.

### MATERIALS AND METHODS

This study was conducted in the Klang Valley. For the study locations, schools in Klang Valley were divided into three areas, which were urban, industrial and rural. List of Grade A (more than 100 student population) national primary schools were obtained through the Malaysia Ministry of Education (MOE) website. Schools in Cheras and Sri Petaling were chosen to represent urban area; schools in Klang represented the industrial area while schools in Hulu Langat and Kuala Langat

represented the rural area. Written consent was obtained from the Ministry of Education, the state and the districts where the schools are located. Teacher's name lists were obtained from the school administrators. The inclusive criteria for teachers to participate were: had at least one-year teaching experience, not diagnosed with any chronic medical problem or under alcohol and drug influence. Two hundred and seventy two teachers agreed to participate in the study and written consent were obtained. Short briefing about the study was given to the respondents. Respondents were given a set of questionnaire which consisted 5 parts: the first part of questionnaire consisted on questions on the respondents' socio-demographic background, occupational information and medical history, the General Health Questionnaire, Teachers' Stress Inventory, Modified Nordic Questionnaire and American Thoracic Society for Adult. The General Health Questionnaire was used to determine the common mental health problems such as depression and anxiety. It was universally used as a screening tool to detect those likely to be at risk of developing psychiatric disorders. The score was based on Likert Scale with 0 for "not at all", 1 for "sometimes", 2 for "more than sometimes" and 3 for "often". Teachers' Stress Inventory was used to measure the stress levels and its stressors. The identified stressors at school include student misbehaviour, workload, and recognition from school administrators, interpersonal relationship with colleagues and insufficient time and resources. Likert Scale was used for the scoring system, which ranged from 1 for 'No or less stress', 2 for 'Medium stress', 3 for 'High stress' and 4 for 'Extreme stress'. Modified Nordic questionnaire was used to determine the prevalence of one-year low back pain and teachers' perception on health risks at workplace. Respiratory symptoms were assessed using the American Thoracic Questionnaire for Adult. Respondents who had more than 3 symptoms were categorized as poor respiratory health system and while below less than 3 symptoms were considered as good respiratory health system.

## RESULTS

Table I shows the respondents' background according to the study locations. Female teachers were the majority in this study, with more than 60% in each area. Ninety three percent of the respondents were Malay teachers, followed by 4.6% Indian teachers.

Table II shows the prevalence of mental and physical health status among the respondents. About 87.9% of the respondents had good mental health and majority of them experienced medium stress level. On the other hand, 40.4% of the respondents developed one-year prevalence of low back pain and 91.2% have good respiratory health.

Mental health status among the respondents can be divided into two categories, which were good and poor

**Table I: Respondents' background**

Variables	Frequency n (%)			F	P
	Urban (n=121)	Industrial (n=84)	Rural (n=67)		
Gender					
Male	44 (36.4)	31 (36.9)	16 (23.9)	0.009	0.926
Female	77 (63.6)	53 (63.1)	51 (76.1)		
Race					
Malay	110 (90.9)	77 (91.7)	64 (95.5)	1.386	0.247
Chinese	3 (2.5)	0 (0.0)	0 (0.0)		
Indian	4 (3.3)	5 (6.0)	3 (4.5)		
Others	4 (3.3)	2 (2.4)	0 (0.0)		
Job responsibility					
Subject teacher	48 (39.7)	32 (38.1)	22 (32.8)	2.463	0.087
Classroom teacher	71 (58.7)	45 (53.6)	40 (59.7)		
Administrator	2 (1.6)	7 (8.3)	5 (7.5)		
Smoking					
Yes	15 (12.4)	13 (15.5)	8 (11.9)	0.363	0.547
No	106 (87.6)	71 (84.5)	59 (88.1)		
Disease status					
Hypertension	11 (9.1)	9 (10.7)	3 (4.5)	0.549	0.649
Diabetes	3 (2.5)	1 (1.2)	1 (1.5)		
Both (hypertension & diabetes)	3 (2.5)	0 (0.0)	3 (4.5)		
None	104 (85.9)	74 (88.1)	60 (89.5)		
Educational background					
Certificate	56 (46.3)	44 (52.4)	53 (79.1)	3.902	0.021*
Diploma	20 (16.5)	5 (6.0)	1 (1.5)		
Bachelor	45 (37.2)	35 (41.6)	13 (19.4)		
Marital status					
Single	24 (19.8)	15 (17.9)	3 (4.5)	0.548	0.579
Married	96 (79.3)	67 (79.8)	58 (86.6)		
Widowed	1 (0.8)	2 (2.3)	6 (8.9)		

N=272

\* Significant at p<0.05

**Table II: Prevalence of mental and physical health status among respondents**

Main Variables	Variables	Frequency (%)
Mental health status	Good	<b>239 (87.9)</b>
	Poor	33 (12.1)
Work stress levels	Low	56 (20.6)
	Medium	<b>195 (71.7)</b>
	High	21(7.7)
Low back pain	Yes	110 (40.4)
	No	<b>162 (59.2)</b>
Respiratory health	Good	<b>248 (91.2)</b>
	Poor	24 (8.8)

N=272

mental health status. Table III shows the variables that influenced respondents to experience poor mental health. Respiratory symptoms showed a significant relationship

with poor mental health status (OR 8.12, 95% CI 2.80–23.56). Increased risk trend was shown in low back pain (OR 1.24, 95% CI 0.54–2.84), interpersonal relationship (OR 1.09, 95% CI 0.89–1.34), female (OR 1.57, 95% CI 0.58–4.24) and married teachers (OR 3.06, 95% CI 0.12–75.67) who teaches in rural schools area (OR 1.01, 95% CI 0.35–2 .80).

**Table III: Mental health status and its influencing factors**

Variable	Odd Ratio	95% C.I	p value
Low back pain			
No	1 <sup>a</sup>		
Yes	1.24	0.54 – 2.84	0.609
Respiratory symptoms			
No	1 <sup>a</sup>		
Yes	8.12	2.80 – 23.56	0.001***
Student misbehaviour	0.97	0.84 – 1.12	0.745
Recognition	0.96	0.73 – 1.25	0.766
Insufficient time and resources	0.92	0.76 – 1.11	0.430
Interpersonal relationship	1.09	0.89 – 1.34	0.381
Workload	0.91	0.79 – 1.05	0.211
Marital status			
Single	1 <sup>a</sup>		
Married	3.06	0.12 – 75.67	0.493
Divorced	0.51	0.04 – 5.97	0.595

N= 272

Binary Logistic regression  
\* Reference category

\*\*\* Significant at p<0.001

## DISCUSSION AND CONCLUSION

This study was intended to determine the risk factors for poor mental health status among primary school teachers. The respondents were divided into three areas, namely urban, industrial and rural areas. The result showed that there was a significant difference between school location with the educational background of the respondents ( $p < 0.05$ ) [12]. Post hoc test showed that teachers in the urban areas had higher educational qualification with diploma and degrees as compared to the industrial and rural schools groups. There was no significant difference in other variables such as gender, marital status and job responsibility between the urban, rural and industrial groups. The results from Table 2 was supported by [13] which showed the similar prevalence of low back pain among the Chinese school teachers. Poor respiratory symptoms was defined as having more than 3 symptoms, either asthma, cough, chest pain, wheezing and phlegm. Teachers, who usually stay indoors, have been associated with increased risk of non-specific, flu-like symptoms, such as headache, nausea, dizziness and general respiratory disorders. Effect of the indoor air pollutants exposure was shown to associate with impaired performance among teachers [14, 15]. Meanwhile, studies [16, 17] showed teachers were prone to develop wheezing, asthma, chest pain and cough due to teaching in schools. Classroom conditions showed

significant association with respiratory symptoms such as asthma or colds in teachers where the classrooms had no windows or had windows that did not open. Thus, job task of teachers and the indoor and ambient air pollutants in the school contributed to the risk of developing respiratory symptoms. The results of this study showed that respiratory problems were the significant risk factor for poor mental health status. A study [16] also reported the same finding which indicated a significant relationship between psychological depression and stress with respiratory problems. Findings from previous studies [18, 19] also showed the significant association between depression and asthma. The findings proved that poor physical health were associated with poor mental health status. This study results showed that there was an increased trend for that situation. Teachers with low back pain was also prone to experience poor mental health status. Other risk factors for poor mental health were interpersonal relationship, and married teachers. Marriage is associated with enhanced mental health despite it provides social support and social integration, the economic burden is heavier. Being married required great commitment and the role of housewife is relatively unstructured and invisible. For example, if a working woman finds her family role unsatisfactory, there is no major alternative source of gratification as she must maintain both house and work chores equally. On contrary, previous study showed that married men and women gave the lowest rates of admission to mental hospitals, compared to divorced and single patients [20]. Interpersonal relationship showed trend to develop poor mental health status. Poor relationship with colleagues might lead to poor mental health status since supportive relationship in the workplace is crucial in minimizing the effect of work stress. In conclusion, this study showed that most of the teachers experienced good mental health status with majority of them with medium stress level [21]. The teachers were also reported to have good respiratory health and almost half of them experienced low back pain. Increased risk trends were shown in factors such as low back pain, interpersonal relationship and marriage to contribute to poor mental health. In conclusion, this study showed that the respiratory symptoms were the significant risk factor for poor mental health among the teachers.

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## EXTENDED ABSTRACT

# The Evaluation of Exposure to Benzene among Children in Indoor Environments: A Review

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### SUMMARY

Benzene has been measured in indoor environments for many decades and has been identified to cause variety of health effects. Children spend most of their time indoors such as daycare centre, preschool and school, they are more likely to be exposed to indoor air pollutants. This paper was aimed to review the exposure to benzene among children within indoor environments from worldwide studies from 2003 to 2018. Based on 24 papers evaluated, 54% were conducted in primary schools. The highest concentration of benzene was found in preschools in China at 148.0 µg/m<sup>3</sup>. The benzene levels were found higher in indoors than outdoors for most of the studies. Active sampling techniques were used in 42% of studies that enable the determination of acute health effects on children during short-period of exposure time. Differences in sampling techniques and durations make it hard to compare the outcomes of the studies with health-effect guidelines. This review indicated a diversity of sampling approaches and techniques, pointing to the importance of establishment of standard method for collecting and reporting data.

**Keywords:** Benzene, Children, Indoor Environments, Daycare Centres, Preschools

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### INTRODUCTION

Children spend most of their time in indoor environments, mainly at daycare centre, preschool and school. They are more likely to be exposed to indoor air pollutants as they spend most of their time indoors and indoor pollutants are found to be two to five times higher than outdoors [1]. The levels of indoor pollution and the duration of the exposure might have a considerable impact on children's health for the rest of their lives [2]. Benzene has been classified as Group 1 to cause carcinogenic effects in humans and there is no safe exposure level of benzene can be recommended [3]. It has been measured in indoor environments for many decades and few studies on exposure to benzene among children have been reported [4-8] and variety of health effects associated with benzene have been identified includes possible childhood leukemia [9]. This paper aims to review on 24 papers that related to the studies of benzene in daycare centres, preschools and primary schools. Finally, this paper offers recommendations that can help to improve the indoor air quality study.

### MATERIALS AND METHODS

A comprehensive literature search was conducted to

identify any studies on children of exposure to benzene within indoor environments conducted worldwide. Original research papers published in English language academic journals were obtained by searching electronic databases including from ScienceDirect, Scopus, ProQuest and Google Scholar. The keywords used in these searches were: 'benzene', 'exposure to benzene among children', 'school', 'daycare centre', 'indoor air quality', 'benzene in indoor environments', 'health effects benzene' and 'benzene guidelines'. The results were refined to identify the studies conducted from 2003 until 2018.

### RESULTS

A total of 24 papers were evaluated in this study. Based on Table 1 on the sampling approaches, there were 15 countries that reported on the studies of benzene in indoors. 54% were conducted in primary schools, followed by daycare centres (31%) and preschools (15%). The exposure duration and sampling methods were varied among the studies. There were two sampling approaches that being used; active sampling (42%) and passive sampling (58%). Meanwhile, the shortest and longest exposure duration were from 30 minutes [10] to 7 days per week [11-13]. For the analytical methods, most of the studies cited US EPA Compendium Method TO-17 for the analysis of benzene [6-7]. All of studies reported to use gas chromatography/mass spectrometry (GC/MS) as the principal method of analysis. Meanwhile, automated thermal desorption GC/MS and flame

**Table I: Sampling approaches in determination of benzene in indoor environments**

Ref	Year of study	Study Area	No of Study Site	Exposure Duration	Flow Rate	Sampling Method	Location (Month/Season)
[13]	2013	School	Urban = 6 Rural = 6 Industrial = 6	2 weeks	n/a	Radiello passive sampler (RAD 130, activated charcoal)	Spain (Feb-Apr)
[6]	2007	School	8	4 h/7 days	0.2 L/min	Anasorb 747 charcoal tubes	Malaysia (n/a)
[17]	2011-2012	School	2	5 days/week	n/a	Radiello passive samplers	Greece (Sept-Oct/ non-heating; Jan-Feb/ heating period)
[5]	2011-2013	School	20	24 h/5 days	n/a	Tenax TA thermal desorption tubes	Portugal (Nov-March/ winter)
[4]	2009	School	Urban = 1 Suburban = 1	24 hours	n/a	3M OVM 3500 organic vapor monitors	Turkey (March/winter)
[18]	2010	School	Urban = 1 Suburban = 1	5 days/week	n/a	Radiello passive samplers	Portugal (April-June)
[2]	2011	School	2	24 h/5 days	n/a	Tenax TA thermal desorption tubes	Portugal (Nov/summer)
[12]	2003-2008	School	22	7 d/week	n/a	Radiello passive samplers (RAD 130, activated charcoal)	European cities (summer, winter)
[19]	n/a	School	Urban = 2 Suburban = 1	5 hours	66.7 ml/min	Tenax TA sorbent tubes active sampler	Turkey (winter, spring, fall)
[14]	2006-2007	School	3	24 hours	n/a	Radiello passive samplers activated charcoal (Carbograph 4)	Turkey (May-June/summer; Dec-Jan/winter)
[11]	2007	School	Urban = 1 Suburban = 1	1 week	n/a	Radiello passive sampler (RAD 130, activated charcoal)	Mediterranean cities (winter)
[20]	2003	School	Suburban = 9	4.5-day	n/a	Tenax GR thermal desorption adsorbents	USA (March-June/ spring, early summer)
[21]	2000	School	Urban = 2	31 h/5 days	n/a	3M OVM 3520 organic vapor monitors	USA (Jan-Feb/winter; Apr-May/spring)
[22]	n/a	School	6	1 hour; 8 hours	0.0931; 0.0121 L/min	Summa™ canister passive samplers	Hong Kong (n/a)
[17]	2011-2012	Preschool	1	5 days/week	n/a	Radiello passive samplers	Greece (Sept-Oct/ non-heating; Jan-Feb/ heating period)
[15]	2011	Preschool	8	24 hours	n/a	Passive sampler	China (March-April)
[23]	n/a	Preschool	Urban = 13 Suburban = 4	60 - 100 min	0.07 ~ 0.1 L/min	Tenax TA thermal desorption tube	Korea (n/a)
[12]	2003-2008	Preschool	22	7 days/week	n/a	Radiello passive sampler (RAD 130, activated charcoal)	European cities (n/a)
[24]	2012	Daycare centre	25	7 hours	100 ml/min	2,4-DNPH coated Florisil thermal desorption cartridge	Korea (May-July)
[25]	n/a	Daycare centre	1	1 hour	100 mL/min <sup>-1</sup>	Tenax TA thermal desorption tube and Carboxen 1000 60/80	Japan (Dec, March)
[7]	2013	Daycare centre	14	10 hours	1 L/min	SKC Anasorb Coconut Shell Charcoal tubes	Columbia (Autumn)
[8]	2008	Daycare centre	21	6 hours	13.5 ml/min	Summa™ canister passive samplers	Canada (Jan-Feb/winter)
[26]	n/a	Daycare centre	28	5 days/week	n/a	Radiello passive sampler (RAD 130, activated charcoal)	France (Oct-Mar/winter; Apr-Sept/summer)
[16]	n/a	Daycare centre	104	9 hours	5 and 10 mL/min <sup>-1</sup>	Tenax TA thermal desorption tube	Singapore (n/a)
[10]	2006	Daycare centre	29	30 min	n/a	Tenax TA thermal desorption tube	Korea (Jan-Dec)
[27]	2013-2014	Daycare centre	Urban = 2	n/a	n/a	Tenax TA thermal desorption tube	Poland (Dec-Jan/winter)

n/a: not available

ionization detector were used as the principal mode of detection, however they were not uniformly specified in every study.

Based on Table II, the maximum level of benzene in school was found at 19.77 µg/m<sup>3</sup> during winter season. The study found that indoor activity, ventilation and duration of human occupancy have influenced the air quality in the buildings [14]. Benzene was found highest in preschool in China at 148.0 µg/m<sup>3</sup> [15], meanwhile 32.7 µg/m<sup>3</sup> was found in daycare center in Singapore due to the traffic emissions from outdoor and human

activities [16]. The evaluation of indoor to outdoor (I/O) ratios found that majority were higher in indoors (> 1.0) compared to outdoors. High levels of benzene in indoors were related to poor ventilation, consumer products and human activities. Motor vehicle emission was found to be significant with outdoor benzene sources.

## DISCUSSION AND CONCLUSION

This evaluation revealed that there is no specific regulation and standard for indoor air quality that have been reported. Comparisons among the studies

Table II: Concentrations of benzene in indoor environments ( $\mu\text{g}/\text{m}^3$ )

Ref.	No. of sample	Benzene ( $\mu\text{g}/\text{m}^3$ )				I/O Ratio
		AM	Median	Min	Max	
[13]	54	S1: 0.5 S2: 0.3 S3: 0.7	S1: 0.48 S2: 0.27 S3: 0.66	S1: 0.4 S2: 0.2 S3: 0.6	S1: 0.5 S2: 0.4 S3: 0.9	S1: 0.9 S2: 1.0 S3: 0.8
[6]	32	7.2	4.6	n/a	31.7	0.93
[17]	n/a	S1: 1.5 <sup>a</sup> ; 3.7 <sup>b</sup> S2: 1.5 <sup>a</sup> ; 4.0 <sup>b</sup>	n/a	n/a	n/a	S1: 1.7 <sup>a</sup> ; 1.2 <sup>b</sup> S2: 1.5 <sup>a</sup> ; 1.7 <sup>b</sup>
[5]	73	n/a	2.5	1.5	2.7	0.84
[4]	S1: 26 S2: 24	S1: 1.91 S2: 2.71	S1: 0.92 S2: 2.50	S1: 0.39 S2: 1.54	S1: 13.2 S2: 4.74	S1: 1.10 S2: 0.70
[18]	n/a	0.31	n/a	n/a	n/a	0.84
[2]	n/a	S1: <1.0 S2: 1.63	n/a	n/a	n/a	n/a
[19]	n/a	10.4	n/a	n/a	n/a	n/a
[14]	n/a	7.5 <sup>a</sup> 19.77 <sup>b</sup>	n/a	n/a	n/a	1.57 <sup>a</sup> 1.20 <sup>b</sup>
[11]	n/a	S1: 2.4 S2: 4.5	n/a	n/a	n/a	n/d
[20]	64	0.09	n/a	n/a	1.6	1.4
[21]	113	n/a	0.6 <sup>b</sup> 0.6 <sup>c</sup>	n/a	n/a	n/a
[22]	24	3.04	0.86	0.68	12.22	0.61
[17]	n/a	1.4 <sup>a</sup> ; 3.7 <sup>b</sup>	n/a	n/a	n/a	3.3 <sup>a</sup> ; 2.0 <sup>b</sup>
[15]	n/a	P1: 2.5 P2: 6.0 P3: 148.0 P4: 2.5 P5: 3.5 P6: 30.0 P7: 22.5 P8: 11.5	n/a	n/a	n/a	n/a
[23]	P1: 54 P2: 17	P1: 9.24 P2: 4.98	n/a	P1: 2.0 P2: 2.0	P1: 33.18 P2: 12.71	P1: 1.18 P2: 0.83
[12]	188	4.4	2.6	0.5	63.7	1.2
[24]	n/a	1.2 <sup>d</sup> 1.7 <sup>e</sup>	1.2 <sup>d</sup> 1.7 <sup>e</sup>	0.4 <sup>d</sup> 0.8 <sup>e</sup>	6.8 <sup>d</sup> 7.9 <sup>e</sup>	1.09
[25]	n/a	A: 10.3; 1.29 B: 8.2; <0.2 C: 6.2; <0.2	n/a	n/a	n/a	n/a
[7]	35	2.0	n/a	<LOD	4.4	n/a
[8]	21	1.8	n/a	0.9	6.3	n/a
[26]	n/a	1.4; 1.6 <sup>a</sup> 2.0; 2.1 <sup>b</sup>	1.4; 1.6 <sup>b</sup> 2.1; 2.1 <sup>c</sup>	0.5; 0.9 <sup>b</sup> 0.5; 0.9 <sup>c</sup>	3.7; 3.9 <sup>b</sup> 4.4; 4.5 <sup>c</sup>	n/a
[16]	123	NV: 25.4 HB: 17.5 ACMV: 24.2 AC: 17.9	NV: 32.7 HB: 30.5 ACMV: 28.4 AC: 21.2	n/a	n/a	n/a
[10]	183	4.2	3.6	n/d	13.1	2.2
[27]	24	S1: 1.63; 2.93 S2: 2.59; 2.11	n/a	n/a	n/a	n/a

AM: Arithmetic mean; I/O ratio: Indoor/Outdoor ratio; S: school; n/a: not available; n/d: not detectable; <sup>a</sup> summer; <sup>b</sup> winter; <sup>c</sup> spring; <sup>d</sup> day; <sup>e</sup> night; P: preschool; LOD: limit of detection; NV: natural ventilation; HB: hybrid ventilation; ACMV: air-conditioned and mechanically ventilated; AC: air-conditioned

were made without the consideration of the sampling methods. In general, the sampling durations were found to be different in most of the studies. This is rarely being acknowledged and is a problem for researchers globally who wish to compare their findings with previous studies. This paper indicated the need for a standard approach especially in data collection, sampling method and the correct way on how to report data.

This review showed the levels of benzene [14, 15, 16,

25, 27] were found to be higher as compared to US EPA (RfC: 0.009 ppm) [28], OSHA (1 ppm for 8-hour/5 ppm for 15-minute) [29] and WHO health-based guidelines (no safe level) [3]. However, the used of passive sampling in 58% of studies limits the determination of concentrations relevant to short-term exposure and guidelines for acute effects. Meanwhile, another 42% of studies used active sampling in their assessments. This may indicated a better support on determination of acute health effects on exposure to benzene in

children. Sampling methods and sampling durations which consistent with the exposure and pollutant exposure guidelines, compatible with sampling patterns and occupant behavior, would enable a more rigorous assessment. Besides, comparison of potential health risks also can be made.

This paper also found most of the studies were conducted in school environments and only 15% were conducted in preschools and 31% for daycare centres. The highest concentration of benzene was found in preschools at 143.0 µg/m<sup>3</sup> [15]. This finding indicated that some preschool environments may be a significant source of benzene exposure. Thus, it is important to increase the number of studies in preschool in the future. Furthermore, children in preschools and daycare centres may be more vulnerable to the effects of benzene exposures as compared to the children in schools. Thus, determination of exposure to air pollutants in these environments is especially important to the children.

The most recent study was conducted in schools located in different spatial characteristics [13]. Based on the evaluated studies, high significant levels of benzene have been related to the study areas in urban and industrial, compared to in rural area. Overall, only few studies that reported on the locations of the sampling sites. Thus it is important to acknowledge that difference in the spatial variation also can influence the benzene concentrations in indoor environments.

In summary, study related to benzene exposure in educational environments has evolved from the early year of 2000 up until recent study in 2018. Concentrations of benzene were found to be higher indoors than outdoors, especially in buildings located in urban and industrial areas, and during cold season. In some cases, these concentrations were exceeded the exposure guidelines. To enable more valid comparison among studies with exposure guidelines, a standard approach for sampling and correct way on reporting data should be introduced. Finally, greater attention should be focused on indoor air quality studies that related to air pollutants which are underreported and with vulnerable populations.

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## EXTENDED ABSTRACT

# Relationship between Occupational Stress and Excessive Daytime Sleepiness (EDS) with Commuting Driving Behavior among Workers

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### SUMMARY

The number of commuting accidents in Malaysia is increasing every year and therefore it is essential to understand the underlying factors that influence the drivers' way of driving among Malaysian workers. This study aims to determine the risk factors of driving behaviour among workers through a cross-sectional study involving 153 manufacturing workers in Petaling Jaya, Selangor. Self-administered survey consisting standardized questionnaire were used to collect information on sociodemographic, working background, driving experience, job strain (JCQ) and EDS (ESS) among respondents. The most reported risky driving behaviour was lapses followed by ordinary violation, errors and aggressive violation. There were 36.6% of respondents reported to have job strain and 53.6% reported to have EDS. In bivariate analyses, younger age, higher education level, job tenure, longer years of having driving license and positive EDS were significantly correlated with more risky driving behaviour but after all inter-relationship between these factors were controlled, only EDS was found significant.

**Keywords:** Occupational Stress, Excessive Daytime Sleepiness, Commuting behaviour

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### INTRODUCTION

Globally, the number of annual road traffic deaths is 1.35 million and is recognized as the leading killer for people aged 5-29 years [1]. In Malaysia transport accidents (4.6%) is reported to be the fourth leading cause of death [2] and the number of commuting accidents (CA) is increasing from 17682 cases in 2007 to 33319 in 2017 [3]. CA refers to the accidents occur on the route between a worker's residence and his work site, from the work site to other places as well as the route between work sites to worker's residence [3]. Sleepiness was identified in several studies to be one of the important cause of road accidents [4,5]. Sleepiness while driving may happens due to various reasons including insufficient sleep quality and duration and sleep disorders. Excessive daytime sleepiness (EDS) is one of the most common indicators of sleep disorders. Those who suffer from EDS usually has frequent complain of compulsory sleepiness, or an urge to take naps or tendency to fall

asleep [6]. The effect of EDS to driving behaviour in commuting can be aggravated by work-related stress which is now becoming one of the main occupational health issues among workers worldwide. Higher level of stress can change the perceived risk among drivers [7] and influence drivers' road safety attitude [8]. Exploring the inter-relationship between EDS and work-related mental health in predicting driving behaviour will help employers and employees to determine workplace strategies in reducing commuting accidents.

### MATERIALS AND METHODS

This cross-sectional study involved 153 manufacturing workers in an industrial area in Selangor from January 2017 to June 2017. Simple random sampling was applied to choose factory. The study location was purposely selected as Petaling Jaya is one of the main industrial areas in Selangor which provides employment to large population and it is surrounded by congested city streets, which exposed the workers to road crash risk. Respondents in the selected factory were chosen randomly including only those who were Malaysian and having driving license and excluding those who had problem with drug and alcohol addiction and

who was previously diagnosed with sleeping disorders. Self-administered survey consisting three standardised questionnaire was used. These included Driving Behaviour Questionnaire (DBQ) [9], Job Content Questionnaire (JCQ) [10] and Epworth Sleepiness Scale (ESS) [11]. The DBQ assess the drivers' behavior into 4 main categories such as errors, lapses (temporary loss of concentration), violations and aggressive violations. The ESS survey assess the degree of sleeping in different circumstances including sitting and reading and watching television. In ESS, respondents described their level of sleepiness either to be would never doze, slight chance of dozing, moderate chance of dozing or high chance of dozing. The JCQ has been proven as a reliable and valid instrument to access job strain and psychosocial factors of job stress. There are 27 questions in JCQ, comprises of three major scales to be assessed: decision latitude, psychological job demands and social support. Reliability test was done and all scales was proven reliable. The designed questionnaire was translated to *Bahasa Melayu* (BM) and double checked by back-translation. Data were analysed by using IBM SPSS statistical software version 22.

## RESULTS

### Socio-demographical factors and work characteristics

The average age of respondents was 36 years old and majority of respondents were males (86.3%), married (64.1%), Malays (86.3%), obtained tertiary education (64.8%). In term of work characteristics, most respondents has been working for more than 10 years (46.7%), daily working hours of 5 to 8 (34%) and non-shifts (62.7%).

### Driving experience

In commuting, most of them has been travelling about more than 20km to the workplace (37.6%), followed by a group of less than 10km (37.4%) and the remaining was from a group of within 11km to 20km (25.0%). Majority of the respondents have driving license for more than 10 years ( $f=95$ , 55.3%). A large percentage of respondents (71.9%) reported that they involved with road crash in the past 5 years (Table I). The respondents were asked on the type of car that they used daily to and back from work. The findings found that majority of the respondents (53.0%) use sedan car and about 40 respondents (26.2%) used compact car, 25 respondents (16.4%) use MPV/SUV, and only 19 respondents (12.4%) use motorcycle to work. It was reported that on average the respondents' daily commuting duration was  $1.80 \pm 0.67$  hours. More than half of the respondents commuted for about 1-2 hours per day ( $f=87$ , 56.9%) and minority of the respondents commuted for more than 3 hours per day ( $f=16$ , 10.4%).

### Prevalence of Excessive Daytime Sleepiness (EDS) and Job Strain

In this study, it was reported that about 82 respondents

**Table I: Driving Experience among Respondents (N=153)**

Variable	f (%)	Median (IQR)/ *Mean
<b>Traffic Condition</b>		2.0 (0.0)
Smooth	27 (17.6)	
Heavy but still moving	109 (71.2)	
Very heavy	17 (11.1)	
<b>Road Accident History in 5 years</b>		0.0 (1.0)
Yes	110 (71.9)	
No	43 (28.1)	
<b>Years of Driving License Obtained</b>		*14.83±9.86
Less than a year	5 (3.3)	
2 – 5 years	15 (16.5)	
6 – 10 years	38 (24.9)	
More than 10 years	95 (55.3)	
<b>Type of Vehicle Used</b>		2.0 (2.0)
Sedan	81 (53.0)	
Compact	40 (26.2)	
MPV/SUV	25(16.4)	
Motorcycle	19 (12.4)	
<b>Duration of Driving (/day)</b>	1.0-4.0	*1.80±0.67
Less than 0.5 hours	50 (32.7)	
1-2 hours	87 (56.9)	
3- 5 hours	12 (7.8)	
5 hours and above	4 (2.6)	

(53.6%) were normal. Seventy-one respondents (46.4%) were classified as cases which indicated that they had problems of EDS. Most of the symptoms of EDS were experienced while lying down to rest in afternoon when circumstances permit, sitting quietly after a lunch without alcohol, sitting inactive in public place, watching TV and sitting and reading. Based on the surveys conducted, results showed that majority of the respondents do not have job strain or considered as normal ( $f=97$ , 63.4%). Only 56 respondents (36.6%) are classified as cases or positively having job strain.

### Driving Behavior

Based on the total mean scores of the scale in ESS the most reported behaviour while commuting was lapses followed by ordinary violation, errors and aggressive violation (Table II). For the lapses, the highest frequency reported was "Hit something when reversing that you had not previously seen" followed by "Switch one thing, such as headlights, when you meant to switch on something else such as wipers". For ordinary violation, the highest frequency reported was "Race away from traffic lights with the intention of beating the driver next to you". Furthermore, for the aggressive violation, the highest frequency reported among respondents was "Become angered by another driver and give chase with the intention of giving him/her piece of your mind". For errors, the highest frequency reported was "Attempt

**Table II: Driving behaviour among respondents (N = 153)**

	N	Mean	Std. Deviation
Aggressive Violation	153	7.34	2.71
Ordinary Violation	153	17.77	6.06
Errors	153	16.73	6.54
Lapses	153	19.29	6.55
Total Score DBQ	153	61.13	18.63

to overtake someone that you had not noticed to be signalling a right turn”.

### Analyses the relationship between socio-demographical characteristics, work characteristics, EDS and Job strain with driving behaviour

Based on the statistical test results, younger age ( $r_s = -0.16$ ,  $p = 0.04$ ), higher educational level ( $r_s = 0.23$ ,  $p = 0.01$ ), shorter job tenure ( $r_s = -0.20$ ,  $p = 0.01$ ) and shorter years of obtaining driving licence ( $r_s = -0.16$ ,  $p = 0.04$ ) were significantly correlated with more risky driving behavior. EDS was significantly correlated with all the domains of driving behaviour; aggressive violations ( $r_s = 0.24$ ,  $p < 0.01$ ), ordinary violation ( $r_s = 0.22$ ,  $p < 0.01$ ), errors ( $r_s = 0.21$ ,  $p < 0.01$ ), lapses ( $r_s = 0.34$ ,  $p < 0.01$ ) among respondents. However, none of the variables of occupational stressors was significantly correlated with driving behaviour among respondents. All variables which were found significantly correlated with driving behavior was included in the multiple regression analyses. Several variables which were not significant but were found significant in previous study was also included and analysed and only the best model is presented. Results showed that the total variance of driving behaviour explained by the model as a whole was only 15.8% after controlling for age, education level, job tenure, years of having license, EDS and job strain. In this model, only EDS was found significant ( $\beta = 0.37$ ,  $p < 0.01$ ) (Table III).

**Table III: Multiple regression predicting driving behaviour**

	B	SE	Beta	t	p-value
(Constant)	54.98	9.81		5.61	<0.001
Age	0.08	0.32	0.05	0.26	0.79
Education	-0.58	1.20	-0.04	-0.48	0.63
Job tenure	-0.02	0.28	-0.01	-0.08	0.94
Having license	-0.35	0.29	-0.18	-1.20	0.23
EDS	1.29	0.27	0.37	4.76	<0.01*
Job Strain	-5.11	3.02	-0.13	-1.69	0.09

## DISCUSSION AND CONCLUSION

Findings of the present study found that majority of respondents tend to have lapses while driving which is consistent with those of previous findings [12]. In this study, EDS is the only significant factor predicting driving behaviour even after controlling for socio-demographic factors, work factors, driving experience

and work-related mental health. EDS mainly influences attention and driving behavioural capacities [13]. More than half of the respondents claimed that they were having symptoms of EDS which is a great concern found in this research. There are many factors that led to EDS such as insufficient sleep, poor sleep quality, insomnia, sleep-related breathing disorders, circadian rhythm and disorders [14] psychological factors including depression and anxiety, and obesity [15]. The factor of EDS including both workplace and personal appears to be substantial to be explored in future study to understand more on the underlying contributors of commuting risky behaviour among drivers. Similar studies involving different occupational groups will provide a better view of the causes and effects of commuting accident.

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## EXTENDED ABSTRACT

# Nitrate Pollution in Groundwater: A Cross-sectional Study in Three Villages in Bachok District, Kelantan, Malaysia During the Paddy Pre-planting Season

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### SUMMARY

Nitrate fertilizer is extensively used to produce healthy crops on a wide scale, and paddy planting is no exception. Nitrate that is not used by plants is able to penetrate the soil and end up in groundwater. This, if not checked, can give rise to health problems including infant methemoglobinemia, a disease where hemoglobin in erythrocytes are changed into methemoglobin by nitrite which, in turn, makes it unable to transport oxygen to body cells. Nitrite is formed from ingested nitrate that is altered by bacteria present in the infant's stomach. This cross-sectional study was conducted in February 2019 for 2 weeks' observation during the paddy pre-planting season, and a total of 149 wells across three villages were sampled for nitrate. Readings were compared to the Drinking Water Quality Standard stated by the Ministry of Health, Malaysia. The maximum acceptable value for nitrate in drinking water is 45 mg/L nitrate ( $\text{NO}_3^-$ ). The three villages, namely Keting, Kuchelong and Telaga Ara, were chosen as they are located near paddy fields and water from wells were used for drinking and cooking without filtration. It was found that only one (0.67%) of the wells had nitrate above the maximum acceptable value (56.85 mg/L  $\text{NO}_3^-$ ). This highest value was found in Telaga Ara village and the location of the well was 50m from the nearest paddy fields. In Kuchelong village, the mean nitrate level was 5.10 +0.85 mg/L with a range of 0.73 to 27.10 mg/L. While in Telaga Ara village, the mean nitrate levels was 10.52 +1.24 mg/L with a range of 1.67 to 56.85 mg/L. Mean nitrate level in Keting village was 5.34 + 4.94 mg/L with a range of 0.40 -23.65 mg/L. In general, nitrate levels were found to be below the maximum acceptable value in the villages concerned and therefore did not pose any health risks to users. Periodic assessment of nitrate in groundwater is still important as to ensure the levels remain below the acceptable value, and in turn, safeguard the health of its users.

**Keywords:** Nitrate, Groundwater, Paddy, Bachok

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### INTRODUCTION

Nitrate ( $\text{NO}_3^-$ ), an organic compound made up of one nitrogen atom and three oxygen atoms, is negatively-charged and readily soluble in water. In the nitrogen cycle, a process called nitrogen fixation begins where atmospheric nitrogen ( $\text{N}_2$ ) from the atmosphere is split and the atoms are combined with hydrogen to produce ammonia ( $\text{NH}_3$ ) or ammonium ( $\text{NH}_4^+$ ). Nitrate is then formed in a process called nitrification by soil bacteria, where at first, ammonia or ammonium is converted into nitrite ( $\text{NO}_2^-$ ), and then to nitrate by the oxidation process. This is then absorbed by plants and used to produce plant proteins [1].

Nitrate and ammonium is continuously produced in

the soil, depending on the amount of waste, nitrogen content, temperature, soil type and water content [2]. It is added into soil as fertilizer to produce better crop yield but misuse such as extreme application may exacerbate problems involving nitrate and farming and eventually the pollution of groundwater. The intensity of farming and increased levels of nitrate in streams, rivers and groundwater can therefore be linked, even though not explicit [3].

Contamination of nitrate in both surface and groundwater is of utmost importance as the problem is getting worse by the day. This world-wide problem is caused mostly by agricultural practices, usage of nitrogen-based fertilizers, improper discharge of wastewater and failure of septic tank systems [4]. Places related with animal production, slurry tank and barns may also have the potential to pollute soil and groundwater [5]. Excessive rainfall may also play an important role in influencing nitrate migration from the soil and ultimately into groundwater. This is because rainfall that exceed

potential evapotranspiration ability from the soil and plants over a long period of time and by assistance of bare paddy land may result in nitrate leaching [6].

The problems with high content of nitrogen compounds in shallow groundwater are associated with uncontrolled agricultural activities and improper water management [7]. In the Netherlands, nitrate is present in low concentrations in shallow groundwater of clayey and peat soils, but absent in deeper groundwater in eight out of twelve provinces in the country. However, in shallow groundwater with sandy soil in agricultural areas, nitrates have been found to exceed 50mg/L [8].

Usage of nitrogen-based fertilizers are in the increase in order to produce more rice for the growing population. Fertilizer management is important to ensure minimum loss of applied nitrogen [9]. The effects of nitrate pollution in groundwater can be seen after one week fertilizers are applied. After the second and third dose, concentration of nitrate was elevated five-fold in shallow groundwater compared to existing nitrate nitrogen concentrations [10].

Nitrate that is not absorbed by plants is able to penetrate the soil and end up in groundwater. This, if not checked, can give rise to health problems such as methemoglobinaemia, a disease occurring among children less than 1 year old. It happens when microbes in the stomach convert ingested nitrate into nitrite. This, when absorbed into the bloodstream, will react with hemoglobin in erythrocytes and changes into methemoglobin which, in turn, making it less able to transport oxygen to body cells [11]. By using organic manure that is able to increase nitrogen retention capacity and reduce nitrate loss by leaching in sandy soils, groundwater pollution can be reduced. Crops can therefore use the applied fertilizer efficiently [12].

According to the Drinking Water Quality Standard by the Ministry of Health, Malaysia, the maximum allowable levels for nitrate in both raw and drinking water must not exceed 10 mg/L of NO<sub>3</sub>-N [13].

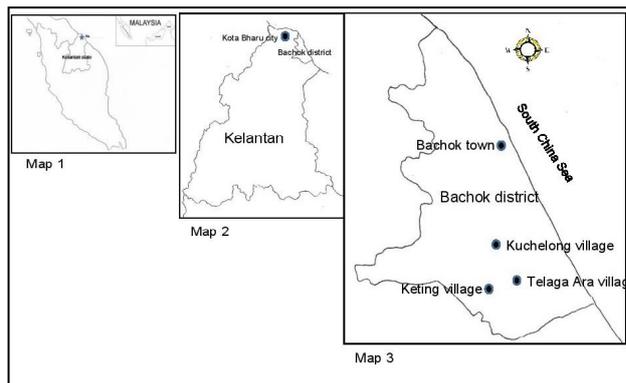
In soils with finer texture, such as clay and silt, nitrate levels are higher than in soils with rough textures, such as sand. The soil profile with alluvial deposit (consist of gravel, sand, silt and clay) is fragile and porous due to overuse of groundwater and man-made activities at the surface thus make Bachok as a potential district in this study [14].

Agricultural activities nearby can potentially contaminate the groundwater, therefore, there were high nitrate in the well less than 50 meters from the livestock area in the farmland were consistent with these findings. Generally, a short distance to a point source may led to a higher level of nitrate [15].  
The aim of this study were to determine nitrate levels

in groundwater used for domestic purposes such as cooking and drinking, and to compare these values to the a standard for drinking water quality to ensure it is safe for human consumption.

**MATERIALS AND METHODS**

This study was conducted in February 2019 during the paddy pre-planting season. Bachok district is one of the ten districts (“jajahan” in the Malay language) in the state of Kelantan, located north-east of Peninsular Malaysia (Figure 1). This state is one of the important producers of rice in Malaysia; other states are Kedah and Selangor.



**Figure 1: Map 1 showing the location of Kelantan state in Peninsular Malaysia. Map 2 showing the location of Bachok district in Kelantan state. Map 3 showing the location of villages studied**

Three villages were chosen as they are located near paddy fields, and most homes have groundwater supply. The villages are Keting, Kuchelong and Telaga Ara, located approximately 14kms south-west from Bachok town and 26kms south-east from Kota Bharu city, the state capital of Kelantan.

**RESULTS**

The total number of wells sampled was 149, with the breakdown as follows: Keting village with 47 wells; Kuchelong village with 47 wells and Telaga Ara village with 55 wells (Table I and Figure 2).

Mean and range of nitrate level in all three villages can be seen in Table II. In Keting village, the mean nitrate level was 5.34 +4.94 mg/L with a range of 0.40 -23.65 mg/L (Figure 3). In Kuchelong village, the mean nitrate level was 5.10 + 0.85 mg/L with a range of 0.73 to 27.10 mg/L (Figure 4). While in Telaga Ara village, the mean

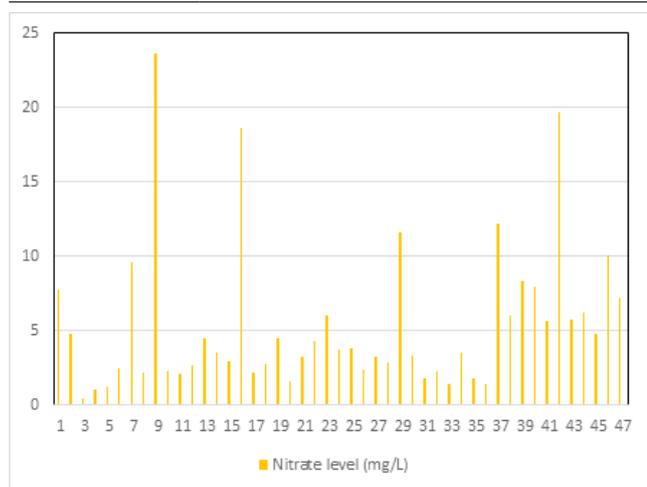
**Table I: Villages and number of wells**

Village	Number of wells
Keting	47
Kuchelong	47
Telaga Ara	55

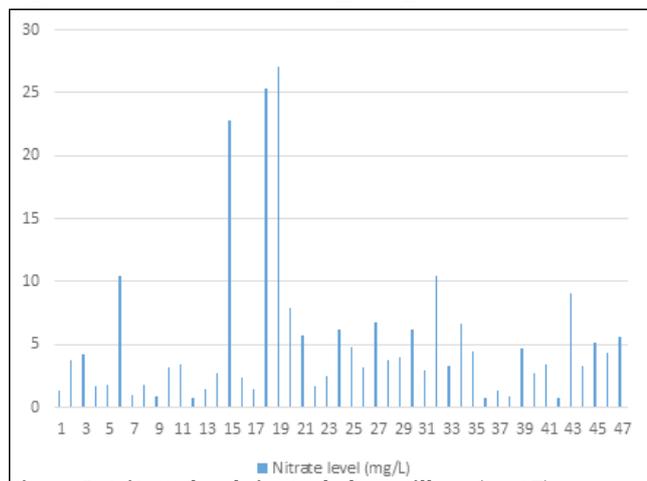
N = 149

**Table II: Mean and range of nitrate based on villages**

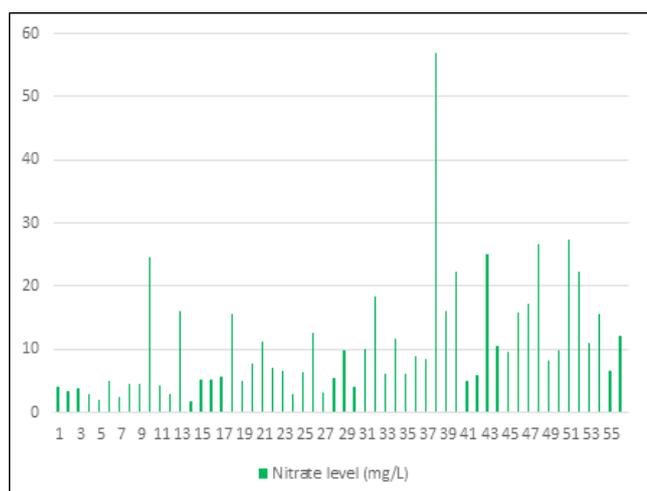
Village	Mean (mg/L)	Range (mg/L)
Keting	5.34 ±4.94	0.40 -23.65
Kuchelong	5.10 ±0.85	0.73 to 27.10
Telaga Ara	10.52 ±1. 24	1.67 to 56.85



**Figure 2: Nitrate levels in Keting village (N=47)**



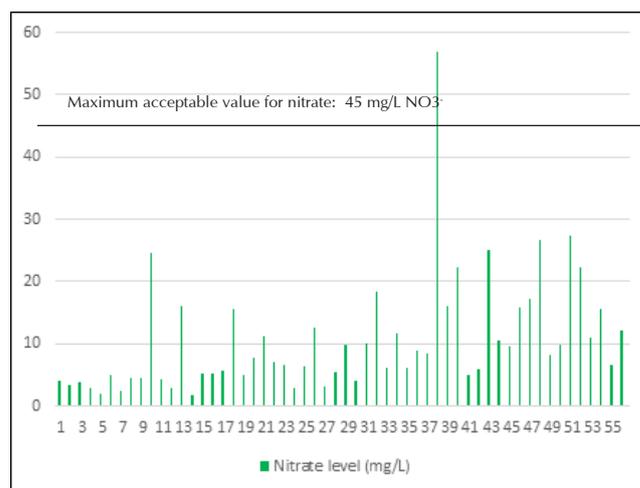
**Figure 3: Nitrate levels in Kuchelong village (N=47)**



**Figure 4: Nitrate levels in Telaga Ara village (N=55)**

nitrate levels was 10.52 +1. 24 mg/L with a range of 1.67 to 56.85 mg/L (Figure 5).

It was found that only one (0.67%) of the wells had nitrate above the maximum acceptable value (56.85



**Figure 5: Nitrate levels in Telaga Ara village (N=55)**

mg/L NO<sub>3</sub><sup>-</sup>). This value was present from a well found in Telaga Ara village and located 50m from the nearest paddy fields.

All nitrate readings except one were below the maximum acceptable value of 45 mg/L NO<sub>3</sub>-N. This may be caused by two reasons, namely sampling was conducted after the rainy season where dilution may have played a factor in reducing the concentration of nitrate in groundwater. The other reason was that fertilizers have not been applied to the paddy fields as it was the start of the pre-planting season. A study on groundwater nitrate pollution in an agricultural area in North-east China found that the range of nitrate was from 0.02 to 497 mg/L with an average of 39.46 mg/L. The authors mentioned that 32% of samples exceeded 20 mg/L of N, above the Grade III value used in that country. The reason behind this could be attributed to dispersal and translocation of nitrate in three dimensions after leaching into groundwater [16].

As for the one well which registered nitrate level higher than the maximum value allowed, the most rational reason is that the well is located 50m from the nearest paddy field, while the others were located further away. When wells are located close to one type of point source pollution (for example agricultural origin or septic tank), there is an increase in nitrate pollution, but when considering both sources, the resulting water becomes unfit for human consumption [17]. Very high levels of nitrate (>350mg/L) was found to be present at a few urban areas in India, and this may be caused by dumping of animal manure, organic wastes from industries and sewage on to the soil. The same author, however, stated that in agricultural areas where the soils were very low in N content, there were very few cases of nitrate contamination caused by fertilizers in groundwater, e.g. in Punjab where the levels was about 4 – 5 mg/L [18].

**DISCUSSION AND CONCLUSION**

This study found that nitrate levels in the villages

concerned were below the maximum acceptable value and, thus, did not bring any health risk to the users. That being said, periodic assessment of nitrate is still important as to ensure the levels remain low. Groundwater sources used primarily for drinking and cooking purposes should be located as far away as possible from nitrate-polluting sources such as septic tanks, animal farms and intensive agricultural areas as to limit the pollution that may give rise to human health problems. Seasonal variations of rainfall and period of agricultural activity may also play a role in the concentration of nitrate in groundwater.

The limitation in this study is the information obtained from the respondents could not be determined to be valid 100% valid. This is due to recall bias may contribute in this study. Then, there is lack of geological data was conducted in the study area. This is because, the type of aquifer and soil should be known in order to get the clear flow of nitrate in groundwater.

Another thing to ponder is that data for this study was collected at one point of time only and further studies are recommended where the data can be collected at different point of time.

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