THE ANALYSIS OF FORMALIN VAPOR EXPOSURE EFFECT ON THE DECREASING OF LUNG FUNCTION
(Study on formalin factory production workers)

Nikens Kristina Raharjo[1], Noeroel Widajati[2] and Soedjajadi Keman[3]

[1,2,3]Departement of Occupational Health and Safety, Airlangga University, Surabaya Indonesia

Abstract-Formalin is the most dangerous chemical in the form of steam and has irritant and carcinogenic effects. Malignancy is often referred to as a result of exposure to this substance is nasopharyngeal carcinoma and respiratory disorders. Exposure to formalin vapors in working environments is related to work environment conditions and individual characteristics. The purpose of this study was to analyze the effect of formalin vapor exposure on the decreasing of lung function before and after work (cross shift). This research was an observational analytic research. The subjects were 16 people with morning shift. The independent variable of this research is the formalin content in the air, while the dependent variable is the decrease of lung function with the parameter of FVC, FEV1 done before and after work (Cross shift) as well as the annoying variable that is individual characteristic consisting of age, work period, smoking habit and sport habit Result based on lung function measurements resulted in 56.28% decreased lung function both FVC and FEV_1 after work compared with before work, but only significant FEV_1 ($p < 0.05$ paired t-test) whereas FVC was not significant. Influence of worker characteristic on significant decrease of lung function that is age and work period ($p < 0.05$ multiple linear regression). The conclusion of research needs to optimize air ventilation by adding local exhaust ventilation (LEV), adhere to and use appropriate personal protective equipment (respirator) during work, and perform regular health checks.

Keywords- formalin vapour, lung function, worker characteristics.

I. INTRODUCTION

Chemical industry is specially processing, producing and marketing chemicals. The chemical industry is a specialization in industrial activities where materials or chemicals are the subject and the main object. Chemical industry included in high risk category should be paid attention to the safety and safety of the workers[1].

Formalin is a chemical that provides quite a lot of benefits. However, at doses exceeding the Threshold Limit (NAB) may cause toxic effects in the human body. In addition formalin became one of the chemicals that can cause carcinogenic to be a public health concern and health work[2].

Formalin can enter through the body through several paths such as inhalation, orally, skin and eyes. The primary route of exposure is primarily through inhalation because the respiratory system is the main organ targeted by exposure to gas and steam. The nature of the formalin gas is irritant when exposure to the gas in the mucosa of the inhalation can cause both acute and chronic health effects[3].

According to Permenakertrans No. Per.13 / MEN / X / 2011 Year 2011 on the Threshold Value of Physical Factor and Chemical Factors in the Workplace, exactly on appendix II d sheet stating that the permissible formalin concentration at work is 0.30 ppm[4].

Berdasarkan laporan ILO tentang penyakit paru akibat kerja memperkirakan rerata insiden dari penyakit paru akibat kerja adalah sekitar satu kasus per 1000 pekerja setiap tahun. Diantaranya semua penyakit akibat kerja 30% adalah penyakit paru.[5]

Exposure to the main concern in chronic lung disease is the presence of recurrent formalin exposure. Repeated exposure to formaldehyde may lead to chronic effects such as reduced sensitization and cancer. Inhalation of low-level long-term formalin causes chronic pulmonary trauma. Long term formalin exposure will be followed by an increased risk of nasal and nasal cancer[6].

The industry in this research is an industry engaged in chemistry. The products of this industry are formalin and glue / glue plywood and use formalin as main raw material and product.

In the production area is where the main exposure of formalin for workers. This formalin has a carcinogenic and irritant and volatile nature in the air because of its low boiling point. In this company has never done the measurement of formalin levels in a closed production room only on the outside of the production that is part of 2F absorber with the measurement of 0.03 ppm and in the Flare Stack with the measurement of 0.63 ppm. According to Permenakertrans Number Per 13 / Men / X / 2011 indoor formalin levels include above the highest level of permissible (KTD) that is above 0.30 ppm (KTD). According to observations made by company researchers are still using general ventilation that is a door measuring ± 6 meters to get in and out of workers so the air becomes not diluted properly. In addition, based on research in the results obtained at the level of formalin in the air by 0.21 ppm and as many as 12.5% of respondents have irritation in the eyes[7].

Formalin is the most dangerous chemical in the form of steam, so researchers are interested to analyze the effect of formalin exposure to sub-chronic effects by examining lung function by workers at Formalin Factories.

II. MATERIAL AND METHODS

The type of research used is observational analytic. The research design is a longitudinal study cohort, where the study begins with measurement of baseline exposure, followed by the predetermined time course before and after work (cross shift) or for 8 hours of work..

The population in this study there are 37 workers but the researchers only took a sample of 16 workers. Sampling in this study is the total population of workers exposed to formalin by selecting samples among the population in accordance with the desired by the researchers.

Independent variable in this research is formalin vapour in air of production area, whereas in dependent variable that is decrease of lung function, and The confounding variables were individual characters, such as age, length of works,smoking habit and exercise habit

Sources of data used in the study are primary and secondary data sources. Primary data obtained from the observation, perform lung physiology examination with spirometry tool conducted by UPT K3 Surabaya. The researcher explains the purpose of the research to the respondent, then if the respondent understands and agrees to sign the informed consent.

Data analysis is done The data processing in this study include data editing, coding data and entering data. The collected data is presented in the form of tables, graphs and narratives then analyzed using the statistical program used

III. FINDING

Measurement of Formalin Level in Production Section in table 1 below:

Table 1. Formalin Vapour Concentration

Measurement Point	Formalin Vapour Concentration (ppm)
1st floor front production area	0,19

1st floor Rear production area	1,28
Control room	0,31
2nd floor production area	0,79

In the measurement of formaalin vapour in the production section at 4 points, it was found that there were 3 points of measurement location exceeding the maximum permissible level (> 0.30), at the location of the 1st floor Rear production area, control room and 2nd floor production area.

The results of the distribution of lung function measurements before and after work (Cross Shift) with parameters (FVC and FEV_1) can be described in table 2 below:

Table 2. Distribution of lung function measurements

Lung Function	FVC		FEV_1	
	n	%	n	%
Decreased	9	56,28	9	56,28
Not Decreased	7	43,72	7	43,72
Total	16	100.0	16	100.0

Based on Table 2 it is known that 56.28% of workers experience decreased lung function both FVC and FEV1 after work compared with before work. This is in accordance with previous research which states that the occurrence of decreased lung function both FVC and FEV1 after exposure formalin 2 hours every 6 days / week for 1 month on medical students in the anatomy section[8]. Similarly, Binarawa (2010) pointed out the decreased in FVC and FEV_1 in medical students exposed to formalin gases in anatomical laboratories. The study showed that formalin exposure in two hours will cause FVC and FEV_1 to decrease, then return to normal after 24 hours[9].

Results of Differential Test Analysis Before and After Work (Cross Shift) Lung Function with Parameters (FVC and FEV1) can be described in table 3 below:

Table 3. Results of Differential Test Analysis Lung Function with Parameters (FVC and FEV1)

Indikator Analisis	FVC		FEV_1	
	Pre	Post	Pre	Post
Mean ± SD	3,55± 0,45	3,37± 0,71	3,03± 0,42	2,86± 0,68
Paired t-test	p=0,06		p=0,04	

Based on Table 3 it is known that FVC before work obtained an average score of 3.55 and after work obtained an average value of 3.37. The result of Paired sample t-test FVC test obtained significance value of (p = 0,06)> (p = 0,05) hence can be concluded there is no difference of FVC before and after work. In parameter FEV_1 obtained result of mean value before work that is 3.03 and after work that is 2,86. Paired sample t-test FEV_1 obtained significance value of (p = 0,04) <(p = 0,05) hence can be concluded there is difference of FEV_1 before and after work.

According to Alexanderson et al. (1989) in his study evaluating lung function and immunoglobulin, 34 plywood workers exposed to formalin had a significant decrease in both FVC and FEV_1[10].

In this study although lung function decreased but only FEV_1 alone was significant, whereas FVC was not significant. This is according to the research of Chia et al. (1992) reported that there was no significant difference before and after formalin exposure with FVC parameters but there was a difference in the parameter FEV_1[11].

Although in this study is not statistically significant but seen from the average of both parameters have decreased lung function both FVC and FEV_1. This is in accordance with the research of Farah Khaliq et al., (2009) which states there is a decrease in FVC and FEV_1 after exposure to formaldehyde for 2 hours but not statistically significant[12].

The insignificant results in this study may be due to the chronic effects of formalin exposure due to differences in prolonged exposure and continuity of exposure occurring

Result of characteristic distribution of workers in the production department of formalin factory can be described in table 4 below:

Table 4.Characeristic of Workers

Worker's Characteristic	Category	Amount	
		N	%
Age	21-30	8	50,00
	31-40	7	43,75
	>40	1	6,25
	Total	16	100
Length of works	1-5	7	43,75
	6-10	4	25,00
	>10	5	31,25
	Total	16	100
Smoking habit	non-smoking workers	8	50,00
	1-10 stem / day	6	37,50
	11-12 stem / day	2	12,50
	>20 stem / day	0	0
	Total	16	100
Exercise habit	Never exercise at all	3	18,75
	Exercise 1-2 times a week	10	62,50
	Sports more than 3 times a week	3	18,75
	Total	16	100

(Source: Production Data Worker PT X, 2018)

The results of the characteristics of workers in the production of formalin factory which includes age, length of works, smoking habits and sports habits were obtained through interviews with 16 respondents as workers in Formalin Production department.

Based on table 4 there are 50.00% aged between 21-30 years old, 43.75% have a working period of 1-5 years, 50.00% of non-smoking workers and 10 respondents 62.50% who exercise 1-2 times a week.

Results of data Test Results Statistics Influence Respondent Characteristics Against Lung function decreased At Workers In Production Formalin Factory are displayed in the following tables:

Table 5 Results of data Test Results Statistics Influence Respondent Characteristics Against Lung function decreased

Variabel	Multiple Linier Regresion (p-value)	
	FVC	FEV$_1$
Age	0,00	0,00
Length of works	0,00	0,00
Smoking habit	0,88	0,75
Exercise habit	0,58	0,90

Based on the result of table 5 the characteristics of respondents consisting of age, Length of works, smoking habits and exercise habits that have significant effect (p <0,05) on the decreased of both FVC and FEV$_1$ lung physiology is age (p = 0,00) and years of service (p = 0, 00)

The analysis of age with decreased of lung function that shows a relationship between age with pulmonary function decrease where maximal muscle strength at the age of 20-40 years and will be reduced by 20% after the age of 40 years. The need for power substance continues to increase until it declines after the age of 40 years. The reduced power demand is due to the decrease of physical strength[13].

The result Length of works analysis in this research is known there is influence between the working period with the decrease of lung physiology, where the worker's work is proved to affect the lung physiologic disorder. Working periods are important to see how long a person is exposed to dust, aerosols and irritant gases a meaningful effect between length of service and respiratory distress, the longer a person's working period is exposed to dust, aerosols and irritant gases, thus further disrupting lung health. Influence is happening is known that the higher the work time it will increasingly increase the risk of lung impaired phenomenon[14].

IV. CONCLUSION

1. There are 3 work location with high formalin vapour content
2. There is a greater decreased in lung function after exposure than before exposure formalin vapour.
3. There is 1 significant measurement parameter that is FEV$_1$(p<0,05).
4. There are characteristic influence that is age and length of works to decrease of lung function.

- **CONFLICT OF INTEREST**

None

- **SOURCE OF FUNDING**

- **ETHICAL CLEARANCE**

The study was approved by the institutional Etichal Board of Public Health, Airlangga University. All information concerns about the study and the subject matter of the study signed an informed consent form.

REFERENCES

[1] Suma'mur. 2014. Higiene Perusahaan dan Kesehatan Kerja. Jakarta: PT Toko Gunung Agung.
[2] National Industrial Chemicals Notification and Assessment Scheme. 2006 Formaldehide. Australia: Departement of Health and Ageing. www.nicnas.gov (diakses 9 November 2017).
[3] RAIS. 2013. Formaldehide. rais.ornl.gov/ (diakses tanggal 8 November 2017).

[4] Peraturan Menteri Tenaga Kerja dan Transmigrasi Nomor Per.13/MEN/X/2011 Tahun 2011 tentang Nilai Ambang Batas Faktor Fisika dan Faktor Kimia di Tempat Kerja.

[5] ILO. 2005. A global alliance against forced labour.Global report under the follow-up to the ILO Declaration on Fundamental Principles and Rights at Work. Report of the Director-General. Geneva: ILO.

[6] Amirudin R. 2006. Fisiologi dan Biokimia Jakarta: EGC.

[7] Mustika A. 2017. Air Formaldehyde Level, Eye Irradiation and Throat Occurrence at Workers In Production Unit of PT X. Thesis. Surabaya: Universitas Airlangga.

[8] Shrivastava .A, and Saxena .Y 2012. Effect Of Formalin Vapours On Pulmonary Functions Of Medical Students In Anatomy Dissection Hall Over A Period Of One Year. Jurnal. Indian J Physiol Pharmacol 57(3):255-256.

[9] BK Binawara, Rajnee, S Choudhary, KC Mathur, H Sharma, K Goyal. 2013. Acute effect of formalin on pulmonary function tests in medical students. Indian Pak J Physiol. 6(2):8–10.

[10] Alexandersson R, Hedenstierna G. 1986. Pulmonary function in wood workers exposed to formaldehyde: a prospective study. Jurnal Arch Environ Health. 44(1):5–11.

[11] Chia SE, Ong CN, Foo SC, Lee HP. 1992. Medical students' exposure to formaldehyde in a gross anatomy dissection laboratory. Jurnal. J Am Coll Health. 41(3):115–119.

[12] Khaliq F, dan Tripathi P. 2009. Acute effect of formalin on Pulmonary function in Gross Anatomy Laboratory. Indian J Physiol Pharmacol. 53(1):93–96.

[13] Sanusi, Rahayu. 2003. Perilaku Penderita TB paru di Kabupaten Merangin. Makalah Seminar Health Environment and Behaviour. Indonesia.

[14] Rosbinawati. 2002. Relationship of Rice Dust With Respiratory Pressure on Rice Mill Workers at Desa Tanjung Selamat Medan Tahun 2005. Thesis. Medan: FKM-USU