

# Lipid Peroxidation And Respiratory Disorders To The Workers Pool

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**Abstract:** Chlorine gas is a chemical substance produced in the process of disinfection in swimming pool water. Exposure to chlorine causes changes in the body immunology mechanisms that generate oxidants or free radicals and some health complaints. The purpose of this study is analyzing the effect of exposure to chlorine on lipid oxidation measured in malondialdehyde levels (MDA) and respiratory disorders in workers pool in Surabaya.

The method used in this research is analytic observational with cross sectional design. The population of this study is divided into disinfection operator and the administration on the three outdoor pools in Surabaya is selected based on several criteria. Large sample obtained by sampling randomly generated number of 24 people, each of 12 people on the carrier disinfection and administration. Data were analyzed using Mann Whitney test and regression test.

Results of analysis illustrate that MDA levels significantly affected the concentration of chlorine in ambient air ( $p < 0.01$ ) and age ( $p < 0.05$ ) using multiple linear regression. Complaints of respiratory disorders is influenced by the levels of chlorine in the air ( $p < 0.05$ ) using multiple logistic regression. The conclusion of this study is exposure to chlorine can increase the levels of MDA in the exposed group. Moreover the chlorine levels in the ambient air swimming pool are the reason respiratory problems in the disinfection operator. Suggestions for disinfection operators as an early attempt to prevent respiratory problems is by paying attention to wind direction in the process of disinfection and consumption of antioxidant-rich foods as well as the need for air monitoring in particular chlorine levels periodically by the manager of the pool.

**Keywords:** Exposure to Chlorine, Pool, MDA, Respiratory Disorders.

## 1. INTRODUCTION

Activities carried out in the swimming pool in addition to improving health can also cause health problems. The health problems are caused by exposure to one swimming pool disinfectant containing chlorine. Exposure to chlorine continuously for 8 hours of work can improve health, especially respiratory disorders. Research conducted by Thickett explained that exposure to chlorine at  $0.67 \pm 0.17$  mg / m<sup>3</sup> can cause asthma in workers pool.<sup>1</sup>

Chlorine entry point into the body can through three main channels. When there is exposure to chlorine in the form of solutions, the path enters the body is through oral and skin contact. With the direct contact of skin with chlorine is an irritant, and then the effects on the body are skin and eye irritation. When chlorine enters the body through the mouth, then the effects that occur in the body is irritation of the gastrointestinal tract. Whereas, when chlorine direct contact with the body through inhalation due to exposure to the gas, then the effect is irritation of the upper respiratory tract.<sup>2</sup>

Exposure to chlorine can induce formation of Reactive Oxygen Species (ROS), which is an endogenous oxidant that can cause health problems. When chlorine irritates the respiratory tract is acidic, then the chlorine would be transformed into hypochlorite is more irritant. The irritant effects will make inflamed airway epithelium. The body will release the body's defense mechanisms such as the activation of neutrophils, macrophages were invited to fagocyt hypochlorite. Furthermore, macrophages will invite

lipoprotein to issue antioxidant enzyme that functions as an antidote to the damage caused by oxidants (ROS).<sup>3,4</sup>

When a cell or tissue oxidative stress is the amount of free radicals or ROS exceeds the body's defense, it can affect normal oxidation-reduction chain. What happens is the result of oxidative tissue damage. Tissue damage depends by several factors such as the target molecule, the level of stress on the network, the mechanisms involved, and the timing and nature of the molecule target.<sup>5</sup>

Reactivity ROS affect the molecular structure of the cell membrane constituent consisting of cholesterol, phospholipids and glycolipids (both contain unsaturated fatty acids), and the DNA is sensitive to hydroxyl radicals, resulting in cell damage and peroxy fatty acid radicals are formed. The phenomenon of lipid peroxidation in erythrocytes is resulting in lysis. This incident resulted in the release of MDA (Malondialdehyde) hereinafter this compound will cause damage to all the cells.<sup>6,7</sup>

This study aims to determine the effect of exposure to chlorine in the air against MDA levels and respiratory disorders in workers pool in Surabaya.

## 2. RESEARCH METHODS

This type of research is observational research with cross sectional study design. This study involves a pool of workers and clerical workers in the pool. Sampling was done by random study using simple random sampling method. The sample selection criteria based on men, aged 18-60 years, have no history of respiratory disease two weeks prior to the study and are willing to sign informed consent. This study

has also been equipped with the ethical clearance was obtained from the Ethics Committee of the Faculty of Public Health Airlangga University Surabaya.

Measurement of chlorine concentration in ambient air swimming pool using a Midget Impinger with methyl orange method referring to Methods of Air Sampling and analysis. Sampling points are at a height of 150 cm from the floor with the reason this point is breathing zone to measure the effects of exposure to chlorine in swimming pool workers.

Determination of MDA conducted by spectrophotometric examination with a wavelength of 532 nm by measuring the level of Thio Barbituric Acid Reactive Substances (TBARS). Step work is taking a 0.5 ml sample was then added 4.5 ml of cold PBS. After 4 ml of the supernatant was taken and added to 1 ml of 15% TCA solution. Furthermore, given 1 ml of 0.37% TBA solution in 0.25 N HCl and heated in a 80o C water bath for 15 minutes. The next step is carried out cooling at room temperature for 60 minutes further centrifuged at 3000 rpm for 15 minutes. Then measuring the absorbance of the supernatant MDA samples on a spectrophotometer with  $\lambda = 532$  nm and MDA levels were calculated using the equation of the regression line of the standard curve (raw) MDA solution. While respiratory problems complained of by workers measured using standardized questionnaires Thoracic American Society (ATS).

Independent variables include age, antioxidant consumption, smoking habits and nutritional status. The data is processed and analyzed using statistical program. To see the relationship of independent variables and the dependent variable using a multiple linear regression statistical test and multiple logistic with  $\alpha = 0.05$ . Whereas to distinguish the significance of exposure in the group exposed and unexposed groups using the Mann Whitney test.

### 3. RESULTS AND DISCUSSION

Measurement results either chlorine levels in the pool area as well as administrative space in the location of the pool is still below the threshold value required by the Regulation of the Minister of Manpower and Transmigration No. Per.13 / MEN / X / 2011 on the value threshold limits Physical and Chemical Factors Factors at workplace. But who had the highest levels of chlorine is located at point 1 pool A. whereas point 3 in each pool was not detected in the air chlorine administrative space. (Table 1)

Number of subjects in this study as many as 24 people, divided into each of 12 workers pool (exposed) and 12 administrative section (unexposed). Based on the individual characteristics of workers exposed to the majority of age > 40 years (41.7%). Whereas in the group not exposed to the percentage of 50% aged 20-25 years. Consumption habits of antioxidants in the exposed group and 50% of respondents are not exposed to antioxidants to consume a minimum of 3 days. Amounted to 58.3% of the exposed group had a normal category. Similarly, in the unexposed group, 75% of respondents in the normal category. Smoking habits in the group exposed to 66.7% of the respondents were smokers being. Similarly, in the group not exposed got 75% percentage of respondents who have a habit of smoking in the medium category. (Table 2)

Table 1. Chlorine levels in the pool area

No	Pool	Measurement result of chlorin levels			TLV (ppm)
		Pool Area		Administration	
		Point 1 (ppm)	Point 2 (ppm)	Point 3 (ppm)	
1	A	0,0095	0,0081	<0,0047	0,5
2	B	0,0074	0,0078	<0,0047	
3	C	0,0086	0,0091	<0,0047	
Mean		0,0084		<0,0047	

Tabel 2. Characteristic Respondent

Characteristic	Criteria	Exposure		Not Exposure	
		n	%	N	%
Age (Years)	20-25	1	8,3	6	50
	26-30	2	16,7	2	16,7
	31-35	1	8,3	1	8,3
	36-40	3	25	1	8,3
	>40	5	41,7	2	16,7
Antioksidant Consumption	Yes	6	50	6	50
	No	6	50	6	50
Nutritional Status	Thin	0	0	0	0
	Normaly	7	58,3	9	75
	Risk	3	25	3	25
	Obese	2	16,7	0	0
Smoking Habits	Rarely	4	33,3	3	25
	Medium	8	66,7	9	75
	Severe	0	0	0	0

MDA levels on average in the exposed group by 7.42 nmol/mL and the group not exposed to 4.47 nmol/ml. Most (83.3%) exposed group complained of breathing problems while working at the pool.

### 3. DISCUSSION

Threshold Limit Values (TLV) are set Permenakertrans no. 13 / MEN / X / 2011 on Threshold Limit Values Factors Factor Physics and Chemistry at Work which is 0.5 ppm. The results showed that the levels of chlorine in the air pool area (average of 0.0084 ppm) is higher than the administration space (<0.0047 ppm). This means that the chlorine levels in the pool either in the pool area as well as in administration are still under NAB. A similar study was also conducted by Nasli 8 that the concentration of chlorine gas outdoor swimming pool in Cilandak, Jakarta amounted to 0.1004 mg / m<sup>3</sup>; 0.0690 mg / m<sup>3</sup>, and 0.1389 mg / m<sup>3</sup>. This study was similar to the results of research Hutabarat 9, regarding the analysis of the levels of chlorine in rubber glove factory which indicates that there are very striking differences regarding the levels of chlorine gas in the production room (0.0869 ppm) and administration (<0.00001 ppm). From the results of the above study stated that the area exposed to

chlorine will have higher air chlorine than areas that are not exposed to chlorine.

Chlorine levels were measured at study sites categorized as low due to the condition of the pool located in the outdoor dilute the concentration of chlorine which evaporates from the surface of the water. In addition to the wind direction and wind cause the chlorine levels in the lower pool area. This is reinforced by the statement Mukono 10, which states that the factors affecting ambient air pollution is the humidity, temperature and air movement. The movement of the wind on the water surface causes greater air containing chlorine is replaced by fresh air.

Chlorine is inhaled by the worker pool will irritate the airways so that the cells or tissues to be inflamed airways. When the epithelial cells of the airway swelling, the body will form a network defenses to metabolize chlorine. Results metabolism produces Reactive Oxygen Species (ROS) that are oxidants such as HOCl. Endogenous oxidant produced will be addressed by the antioxidants in tubuh.<sup>11</sup>

Malondialdehyde (MDA) can be formed if the hydroxyls free radicals such as Reactive Oxygen Species (ROS) to react with the fatty acid components of cell membranes, causing a chain reaction known as lipid peroxidation. The lipid peroxidation chain will cause the breakdown of fatty acids into a variety of toxic compounds and cause damage to the cell membrane. MDA is a compound that can describe the activity of free radicals in cells that serve as a guide to oxidative stress caused by free radicals <sup>12</sup>.

Results of linear regression analysis to interpret that exposure to chlorine in the air and the age of the respondents significantly affect MDA levels in the blood. Exposure to chlorine in the air ( $\beta = 0.870$ ;  $p = 0.000$ ) with a very significant influence on levels of MDA positive direction of blood. Means that the greater the exposure to chlorine will damage cell lipids were greater. This study is in line with research Fotouh et al<sup>13</sup>, which states that an increase in blood MDA levels after exposure to chlorine for 20 minutes in rats ( $p < 0.01$ ).

The age of respondents also have a significant effect ( $\beta = 0.350$ ;  $p = 0.046$ ) with the positive direction of the MDA blood. It means that the age will increase in the blood levels of MDA. Results of this study are also similar to the research Sayyah et al <sup>14</sup>, which states that the age effect on blood MDA levels with  $p < 0.01$ . The older the person, the content of MDA was also higher compared to someone younger age.

Results of logistic regression analysis suggests that there is the influence of exposure to chlorine in the air against respiratory disorders. Results of this analysis is reinforced by the results of interviews mentioned that most complaints breathing disorders experienced by the exposed group was coughing and shortness of breath. In line with the research Jacobs et al <sup>15</sup>, that cough experienced by many workers who use the swimming pool chlorine as a disinfectant by Odd Ratio (OR) = 2.4. This means that the pool of workers who move around the pool cough risk 2.4 times greater than the other pool workers.

While Hashish Mann Whitney analysis concludes that MDA levels in exposed group differed significantly ( $p=0.000$ ) with the unexposed group. It can be concluded that the exposed group did have elevated levels of MDA caused by exposure to chlorine. Frequency and duration of exposure to chlorine is in the group exposed to the pool area to give effect to the increase in MDA levels. This is proven by the

chlorine levels were measured in the air around the pool (average of 0.0084 ppm) is higher than the chlorine levels in the administration ( $<0.0047$  ppm).

#### 4. CONCLUSION

Workers who are exposed to swimming pool chlorine increased lipid oxidation and respiratory disorders. The condition requiring treatment by consuming foods rich in antioxidants.

#### 5. SUGGESTION

Agencies from the pool need to be monitoring air quality on a regular basis in order to pool chlorine levels in swimming pools can be monitored, checking the dose of chlorine that is mixed in the pool in order to evaporate the chlorine levels are not too big and worker health checks routinely to increase worker productivity.

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