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RISK OF AIR POLLUTION EXPOSURE ON RESPIRATORY ORGAN OF TRAFFIC POLICE: AN OBSERVATIONAL STUDY WITH AN EXAMINATION OF Ig E TOTAL SERUM LEVEL AND LUNG PHYSIOLOGY

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Abstract

***Background**: Exposure of air pollution on the highway may cause respiratory problems, especially in the traffic police. IgE total serum examination and pulmonary function become a marker of lung health.*

***Aim**: This study aims to examine the correlation between air pollution and IgE total serum and lung function in the traffic police.*

***Method**: This was an observational study by means of a cross-sectional design. A total of two groups that consists of 30 people (police who were exposed to air pollution directly) and 30 people (police who were not directly exposed), IgE total serum and pulmonary function of both groups will be measured. The level of air pollution is measured by the Standard Air Pollution Index method. Characteristic differences were tested through unpaired t-test and Mann-Whitney test while correlation and strength between variables were tested through the Spearman test.*

***Result**: The examination of IgE total serum levels in the two groups showed that there were no significant differences (p = 0.301). Significant differences occurred in pulmonary function tests between the exposed groups compared to controls in the FEV1 variable (% p) (p = 0.015), FVC (% p) (p = 0.000) and spirometry results (p = 0.001). There was no significant difference in the FEV1 / FVC variable ratio (p = 0.395). There was no correlation between air pollution and IgE total serum levels (r = 0.080; p = 0.544). There is a weak negative correlation between air pollution and FEV1 (% p) (r = -0.298; p = 0.021) and between air pollution with spirometry results (r = -0.380; p = 0.003). There is a moderate negative correlation between air pollution and FVC (% p) (r = -0.409; p = 0.001). There is no correlation between air pollution and the FEV1 / FVC ratio (r = 0.058; p = 0.662).*

***Conclusion**: There is a significant correlation between air pollution and pulmonary function disorders, but there is no significant correlation between air pollution andIgE total serum levels.*

***Keywords:** Air Pollution, Air Quality Index, traffic police, total serum IgE, pulmonary function.*

Introduction

Air pollution is one of the environmental problems faced by urban areas. The air quality of urban areas in Indonesia has shown a declining trend in the past decade. The rapid development of the city of Surabaya in addition to producing a positive impact as well as a negative impact, one of which is a decrease in air quality. The main source of air pollutants in big cities is transportation and industry. The most common air pollutants are carbon monoxide, PM10 (particulate matter), SOx, NOx and ozone. Air pollutants can enter the respiratory tract in the form of volatile gases (eg carbon monoxide, ozone, and benzene), liquid droplets (eg sulfuric and nitrogen oxides) and particulate matter (eg diesel exhaust particles / DEP and polyaromatic hydrocarbons) [*Romieu I et al., 2008*].

Allergic diseases are now a worldwide health problem in both developing and industrialized countries. In the past few decades, clinicians have been confronted with the fact that there is an in-

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creased incidence of atopy and allergic diseases. The underlying factors of this phenomenon are very complex and it seems that the increase is in parallel with the increase of industrialization and urbanization in various parts of the world, especially in developing countries that experience severe pollution, including air pollution, causing health problems [*Ebtekar M, 2006*]. Some diseases associated with air pollution include cardiovascular disease, asthma, allergies, immunological disorders, and cancer. The respiratory disease itself can cause health problems ranging from mild respiratory problems to the onset of death that have an impact on social and economic life [*Ebtekar M, 2006; Jerrett, M. et al., 2009*].

Allergies or allergic diseases are diseases that occur due to hypersensitivity reactions that begin with an immunological mechanism. This happens because of exposure to the antigen, then dysregulation occurs and uncontrolled immune response causes tissue damage. About 20% of the world population suffers from allergic diseases mediated by Immunoglobulin E (IgE), such as allergic rhinitis, allergic asthma, atopic dermatitis, and anaphylaxis. The prevalence of allergic diseases shows an increasing tendency in the last three decades [*Effendi C, 2006; Pawankar R et al., 2011*]. In principle there are 3 important factors underlying the occurrence of allergic diseases, namely genetic, allergen exposure and various kinds of environmental factors (viruses, atypical bacteria, pollutants, etc.). An allergic disease which is a type I hypersensitivity reaction can cause a variety of clinical manifestations, depending on the target organ involved (asthma, allergic rhinitis, dermatitis, etc.) [*Baskoro A, Konthen PG, 2008*].

Examination of pulmonary physiology is useful for early detection of respiratory disorders, although clinically and radiologically the condition of these patients is still normal. Pulmonary physiological status is a state of pulmonary function based on the results of measurements or examination of the lung with a spirometer. The spirometer can measure forced vital capacity (FVC) and forced expiratory volume in 1 second (FEV1) which is the initial indicator of inflammation and breathing disorders that are often associated with chronic effects on exposure to environmental air pollution [*Götschi T et al., 2008*]. From this examination can also assess whether a person has normal pulmonary physiology, obstruction abnormalities, restriction abnormalities or mixed forms [*Pierce R, Johns D.P.2004*].

People who are at risk of air pollution are the people who use the highway, people who live on the edge of the highway, and people who work on highways such as traffic police (traffic police), street sweepers, street vendors, or street children. Traffic police who work along Surabaya road with heavy traffic is one of the groups that are considered at risk of being exposed to air pollution [*Mukono HJ, 2009*]. The National Police are on the field with a minimum of 8 hours per day [*Head of Indonesian Police.2014*].

The results of this study can be used as material for further policy consideration and prevention of further risks in the community and health services if air pollution is found not to increase IgE total serum but can cause pulmonary physiological disorders. Pollutant gas can cause airway hypersensitivity and fibrosis in the lungs. So this study aims to determine the effect of air pollution on the increasing IgE total serum levels and the decreasing of pulmonary physiology in the traffic police.

MATERIAL AND METHOD

This study was an observational analytic study with a cross-sectional design for 4 weeks. This study was conducted in several places. Retrieval of pulmonary physiological test data and blood samples of exposed groups was carried out on the traffic police stationed in five outposts than in the Surabaya area, namely in western Surabaya, east Surabaya, northern Surabaya, south Surabaya, and central Surabaya. Data collection for the control

To overcome it is possible, due to the uniting the knowledge and will of all doctors in the world

group was carried out in the Polrestabes Surabaya. A sampling of outdoor air quality for exposed groups was also carried out in five regions of Surabaya city, according to the location of the post. The process of examining blood samples and analyzing the results and pulmonary physiological tests were carried out in a private laboratory (Ultra Medika) Surabaya. Air quality measurements were carried out with the help of automatic air quality measuring devices belonging to the Surabaya City Government Environmental Agency.

Traffic police and police staff members (administration officers) involved in the study were obtained by cluster random sampling with six subjects in each outpost location. There are 2 groups of 30 people, namely traffic police (police working in the field as exposed groups), 30 people compared to police staff (administrative police who work indoors as a control group) as many as 30 people. Traffic police and police staff serving in the Polrestabes Surabaya are represented by police who meet the inclusion criteria, namely aged 20-58 years, have served at least 3 years, and are willing to take part in this study by signing the consent sheet. Police who have a history of chronic diseases that interfere with respiratory function, smoking, history of history and physical examination are suspected of having a disease that can increase IgE total serum levels other than because pollutant factors were not included in the study. Disruptive variables in this study are wind, rain, humidity, temperature, sunlight, genetics, worm infestation, aspergillosis, several types of immunodeficiencies and neoplasms.

Pulmonary physiological examinations were carried out by a trained professional using the American-made Maestros spirometer POP-10 model made in America in 2009 by one of the private laboratories (Ultra Medika Laboratory) in Surabaya. The parameters examined were Forced Vital Capacity / FVC (% p), Forced Expiratory Volume in 1 second / FEV1 (% p) and FEV1 / FVC ratio and IgE Total Serum. The data obtained were analyzed descriptively and statistically. The normality test was carried out by the Kolmogorov-Smirnov test. If the normal distribution is obtained, the data will be analyzed further by using unpaired t-test and Mann-Whitney test for differences in characteristics while the correlation and strength between variables are tested through the Spearman test. Analysis of differences in the characteristics of respondents between exposed groups and the control group in the categorical data was calculated by the Chi-Square test and Fisher's test (if it did not meet the Chi-Square test requirements). Analysis of correlations and strengths between data scale variables was carried out by the Spearman test. A p value of <0.05 was considered a significant result. Data processing and statistical analysis were carried out by using SPSS version 17.0.

Result

The entire sample in this study were men with different age distribution even though the statistical results were not significant in the results of the T-test both in the age and BMI categories (p> 0.05). The average age of the police in the exposed group was 42.67 ± 9.93 years while the average age in the control group was 41.07± 8.28 years. The mean Body Mass Index (BMI) in the exposed group was 25.95 ± 2.83 kg/m^2while the BMI average in the police staff group was 25.00 ± 2.67 kg/m^2. In the exposed group of a total of 30 respondents, 25 (83.3%) respondents always use masks on duty and 5 (16.7%) respondents only occasionally use masks while on duty. In the control group, 30 (100%) respondents did not use masks on duty. Fisher's exact test results show that there are significant differences in the characteristics of mask use when on duty between the two groups (exact p = 0,000). Table 1 shows the sample characteristics of the study.

The Air Pollution Index (API) shows different results in several regions, including 67.38 for the North Surabaya area, 69.88 for the East Surabaya area, 69.67 for the South Surabaya area, 64.94 for the West Surabaya area and 64.97 for the Central Surabaya. The five regions have the same category, namely the moderate category, while the level of air pollution in the police staff group (control) has an API score of 21.00, which is included in the good category. The Mann-Whitney test results

show that there is a significant difference between air pollution inside the building with outside buildings (p = 0,000). The results of the air pollution level test are presented in table 2.

TABLE 1.

Characteristics of traffic police based on age, BMI and use of masks.

Characteristics	Category	Group		Comparison	Details
		Exposed	Control		
Age (years)		42.67 ± 9.93	41.07 ± 8.28	p=0.501	NS
BMI (kg/m^2)		25.95 ± 2.83	25.00 ± 2.67	p=0.179	NS
Mask Usage	Yes	25 (83.3%)	0 (0.0%)	Exact p=0.000	S
	Occasionally	5 (16.7%)	0 (0.0%)		
	No	0 (0.0%)	30 (100.0%)		

Descriptions : S means there were significant differences (p <0.05); NS means there was no significant differences (p> 0.05), data in mean + SD or%.

The median value of IgE total serum in the exposed group was 34.75 *IU/ml* with a minimum value of 13.59 *IU/ml* and the maximum value was 171.36 *IU / ml*. In the control group, the median value of IgE total serum level was 50.29 *IU/ml* with a minimum value of 7.44 *IU/ml* and the maximum value was 136.79 *IU/ml*. The Mann-Whitney test results showed that there was no significant difference in IgE total serum levels of respondents between the two (p = 0.301).The mean value of test results for IgE (*IU/ml*) in total serum levels of the exposed group (n=30) was 34.75, with a minimum of 13.59 and a maximum of 171.59. In the control group (n=30), the average was 50.29 with a minimum value of 7.44 and the maximum - 136.79. The results of unpaired t-test showed that there were significant differences in the IgE of respondents between the two groups (p = 0.301).

The pulmonary function test results showed different results. The mean FEV1 (% p) in the exposed group was 82.33 + 14.20% with a minimum value of 62% and a maximum value of 119%. In the control group, the average FEV1 (% p) was 90.90 + 12.28% with a minimum value of 57% and the maximum value was 111%. The results of unpaired t-test showed that there were significant differences in the FEV1 (% p) of respondents between the two groups (p = 0.015). The mean FVC (% p) in the exposed group is 74.40 + 11.04% with a minimum value of 58% and the maximum value is 99%. In the control group, the average FVC (% p) was 85.50 + 10.11% with a minimum value of 60% and the maximum value was 103%. The results of the unpaired t-test showed that there were significant differences in FVC (% p) of respondents between the two groups (p = 0.000). The mean FEV1 / FVC ratio in the exposed group is 88.23 + 10.58 with a minimum value of 73.70 and the maximum value is 100.20. In the control group, the average FEV1 / FVC ratio was 86.40 +8.11 with a minimum value of 72.79 and the maximum value was 100.10. The results of unpaired t-test showed that there was no significant difference in the respondent's FEV1 / FVC ratio between the two (p = 0.395). Table 3 shows FEV1 (% p), FVC (% p) and FEV1 / FVC ratios.

In the exposed group it was obtained that 10

TABLE 2.

Air pollution levels.

Group	Location	Air Pollution Index (API)		Mann-Whitney test
		Value	Category	
Exposed	North Surabaya	67.38	Moderate	Z=-7.132 p=0.000
	East Surabaya	69.88	Moderate	
	South Surabaya	69.67	Moderate	
	West Surabaya	64.94	Moderate	
	Central Surabaya	64.97	Moderate	
	Mean	67.37	Moderate	
Control	In the building of Mapolrestabes Surabaya	21.00	Good	

(33.3%) respondents with normal spirometry results, 10 (33.3%) experienced mild restriction, 8 (26.7%) had a moderate restriction, 2 (6.7%) experienced severe restriction and no one has an obstruction or mixed abnormalities. In the control group, 24 (80.0%) respondents with normal spirometry results, 5 (16.7%) respondents experienced mild restriction, 1 (3.3%) respondents had moderate restriction and no one experienced severe restriction abnormalities, obstruction or mixed abnormalities. Fisher's exact test results show that there were significant differences in the spirometry results of respondents between the two groups (exact p = 0.001). Table 4 shows the results of spirometry examination.

Table 3.

FEV1 (% p), FVC (% p) value and FEV1 / FVC Ratios.

Group	N	FEV_1*(%p)*				T test
		Σx	SD	Min	Maks	
FEV_1*(%p)*						
Exposed	30	82.33	14.20	62	119	t=-2.500 p=0.015
Control	30	90.90	12.28	57	111	
FVC *(%p)*						
Exposed	30	74.40	11.04	58	99	t=-4.474 p=0.000
Control	30	85.50	10.11	60	103	
FEV_1/FVC Ratio						
Exposed	30	89.47	5.47	73.70	100.20	t=0.858 p=0.395
Control	30	88.22	5.76	72.70	100.10	

Table 4.

Results of spirometry examination.

Pulmonary Function Test	Group		Total
	Exposed	Control	
Normal	10 (33.3%)	24 (80.0%)	34 (56.7%)
Mild Restriction	10 (33.3%)	5 (16.7%)	15 (25.0%)
Moderate Restriction	8 (26.7%)	1 (3.3%)	9 (15.0%)
Severe Restriction	2 (6.7%)	0 (0.0%)	2 (3.3%)
Mild Obstruction	0 (0.0%)	0 (0.0%)	0 (0.0%)
Moderate Obstruction	0 (0.0%)	0 (0.0%)	0 (0.0%)
Severe Obstruction	0 (0.0%)	0 (0.0%)	0 (0.0%)
Mixed	0 (0.0%)	0 (0.0%)	0 (0.0%)
Total	30 (100%)	30 (100%)	60 (100%)

Note: *p = 0.001*

Statistical analysis using the Spearman correlation test showed varied results. There was no significant correlation between air pollution and IgE total serum levels (r = -0.080; p = 0.544). There is a weak negative correlation between air pollution and pulmonary function (FEV1 parameter (% p) (r = -0.298; p = 0.021)) and air pollution with spirometry results (r = -0.380; p = 0.003). There is a moderate negative correlation between air pollution and lung function (FVC parameter (% p) (r = -0.409; p = 0.001)). There is no significant correlation between air pollution and pulmonary function (parameter FEV1 / FVC ratio (r = 0.058; p = 0.662)). There was no significant correlation between IgE total serum and pulmonary function (FEV1 parameter (% p) r = 0.047; p = 0.723; FVC parameter (% p) r = 0.042; p = 0.750; parameter FEV1 / FVCr ratio = -0.004; p = 0.974; spirometry result parameters r = 0.142; p = 0.279). Table 5 shows the correlation of air pollution with IgE total serum levels and pulmonary physiology.

Discussion

This study shows that even though there are differences in the group directly and indirectly exposed, there is no correlation between air pollution with total serum IgE levels. Different results on the correlation between air pollution and pulmonary function test results. Significant differences occurred in pulmonary function tests between ex-

posed groups compared to controls seen in FEV1, FVC and spirometry results while there were no differences in FEV1 / FVC ratio variables. There is a weak negative correlation between air pollution and FEV1 and between air pollution and spirometry results. There is a moderate negative correlation between air pollution and FVC. There is no correlation between air pollution and the FEV1 / FVC ratio. This is caused by several factors, genetics, the disease in individuals, age and smoking habits. Other factors that play a role are the process of ventilation in different pulmonary compartments and deposition of particles of pollutants in the lungs and exposure to allergens, especially at a young age [*Brunekreef B, Holgate ST, 2002; Ebtekar M, 2006; Baskoro A, Konthen PG, 2008*]. Several studies examining the correlation between air pollution and immunological responses have different results. There was an increase in IgE total serum levels in subjects exposed to air pollution compared to non-exposed subjects [*Rage E et al., 2009*].[13] This could be due to the study conducted in asthma patients who in theory did have relatively high IgEtotal serum levels [*Baratawidjaja K, 2009*]. In addition, Other studies conducted on children showed changes in pulmonary function due to air pollution in groups of children attending school in areas that exposed to pollution compared to those not exposed to pollution [*Linares B et al., 2010*]. Smoking habits has became one factor that causes differences in pulmonary function outcomes as a result from the cumulative dose of cigarettes [*Sandra C.,2008*].

TABLE 5.

Correlation of air pollution with IgE total serum levels and pulmonary function.

Variable	Correlation coefficient	Significance	Details
API - Total serum IgE	r=-0.080	p=0.544	NS
API – FEV1(%p)	r=-0.298	p=0.021	S
API –FVC(%p)	r=-0.409	p=0.001	S
API – Rasio FEV1/FVC	r=0.058	p=0.662	NS
API – Hasilspirometri	r=-0.380	p=0.003	S
IgE total serum –FEV1(%p)	r=0.047	p=0.723	NS
IgE total serum –FVC (%p)	r=0.042	p=0.750	NS
IgE total serum – FEV1/FVC Ratio	r=-0.004	p=0.974	NS
IgE total serum – Spirometry results	r=0.142	p=0.279	NS

NOTE: *r means the correlation coefficient between variables; S means significant (p <0.05); NS means non significant (p> 0.05).*

The results of the API assessment showed different results in the group that directly exposed and not directly exposed. The study conducted in a closed room can indeed explain the mechanism of an individual's response to air pollution, but the mechanism is relatively difficult to prove if the study is carried out in an open space with a variety of environmental variations and exposure to air pollution naturally [*Brunekreef B, Holgate ST, 2002*].If adapted to government decisions through PP no.41 of 1999 and East Java Governor's Regulation No. 10 of 2009 where the API vale expected for the work environment is at maximum of 50 or included in the medium category, then the level of air pollution in the working environment of the exposed group with an average of 67.37 (medium category) turns out to exceed the air quality threshold, while in the controls group with mean value of 21.00 (good category) are still below the air quality threshold. Some studies on air pollution generally do not use API or PSI (Pollutant Standard Index) as air quality parameters but instead, concentrations of measured air pollutant gases are used [*Sandra C,2008; Rage E et al., 2009; Linares B et al., 2010*].

The spirometry examination results showed varied types of restriction abnormalities although the Air Pollution Standard Index cate-

gory was still within safe threshold. The higher the API value, the lower the pulmonary function test results. Restriction abnormalities describe the development of pulmonary disorders due to lung elasticity obstruction. This can be caused by air pollutants, especially the dust particles that accumulate and cause fibrosis in the alveolar wall so that the alveolar wall cannot expand properly [*Pierce R. Johns DP 2004*]. Exposure to pollutant gases, especially Ozone (O_3) and SO_2, will cause oxidation if the pollutant contacst with the surface airway mucosa. This condition will cause irritation and the increase in respiratory problems [*Linares B. et al., 2010*]. Although there is a link between air pollution and pulmonary function, an increase in total IgE levels is not related to pulmonary function. However, an increase in IgE levels can aggravate existing pulmonary function disorders [*Lapperre TS et al., 2004; Peck P, 2004*].

The behavior to prevent air pollution exposure has been applied by most traffic police in this study. Basically, fossil fuel transportation will produce various kinds of air pollutant gases and particles that play a major role in air pollution in large cities and can endanger human health. The density of traffic in the city of Surabaya is one of the factors that contribute to the burden of air pollution around the region [*Jerrett, M. et al., 2009; Mukono HJ, 2009*]. The effect of air pollution on the highway-related to respiratory function concludes that the closer the residence to the highway, the greater the air pollution that occurs and the more severe respiratory problems experienced by the subjects [*Gauderman, WJ et al., 2007*]. The level of air pollution in the city center is dense with vehicles larger than those on the outskirts of the city [*Nowak D et al., 1996*].The level of air pollution in industrial areas is greater than in non-industrial areas and concludes that children those who live in industrial areas are experiencing respiratory problems compared to children who live in non-industrial areas [*Kleinhappl B et al., 1996*].

A similar study was carried out by Nowak et al in Germany, namely in the cities of Erfurt and Hamburg. Erfurt is an industrial city where the levels of pollutant gases namely SO2 and particulate matter in Erfurt show higher results than in Hamburg. It turns out that the level of IgE in the adult population in the city of Hamburg is higher than in Erfurt ($p = <0.05$). Results of FEV1 (% p) population in Hamburg were lower than in Erfurt ($p = <0,0001$). The results of the study support the hypothesis that genetic factors and exposure to allergens have more influence on serum IgE levels than exposure to SO2 and particulate matter [*Nowak D et al., 1996; Baratawidjaja K, 2009*].

This study has several weaknesses. Indoor air quality control group data uses secondary data from previous research conducted by Sandra (2008) because technical constraints, namely the air quality monitoring equipment owned by the Surabaya City are fixed in place so it is not possible to take indoor air samples. This study does not analyze other factors, among others: subject activities outside official hours, subject activities if there are emergency conditions that cause subjects to work in the field for example there are demonstrations and residence of the subjects that may be adjacent to sources of air pollution, types of masks that used by exposed group when on duty, using drugs or vitamins, such as vitamins that contain antioxidants. Data on the atopic allergy history of the subjects are based on history and physical examination only. Researchers did not carry out skin prick tests because of technical constraints, because in these examinations there could be severe side effects, namely allergic reactions so that skin prick tests should be carried out in a place that has complete health facilities. Further research is recommended to identify factors that cause a decrease in pulmonary function in addition to genetic factors in the traffic police group. Similar research needs to be done in several cities with different levels of air pollution and a larger number of samples. Further research is needed by considering confounding factors which are the main obstacles in research related to the environment.

CONCLUSION

The results of this study indicate that there is no correlation between air pollution with IgE total serum and IgEtotal serum levels with pulmonary function. Air pollution shows a correlation with pulmonary physiology including a weak negative correlation between air pollution and pulmonary function in FEV1 (% p) and air pollution parameters with spirometry results, a moderate negative correlation between air pollution and pulmonary function (FVC parameter (% p)) and there is no correlation between air pollution and pulmonary function (FEV1 / FVC ratio parameter).

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