

CORRELATION OF METAL FUME AND VAPOR WITH TOTAL IgE SERUM OF THE BLACKSMITH

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ABSTRACT

Blacksmith centers which produce agricultural tools, household appliances, carpentry tools, souvenirs, wheels and other vessels are located in the sub District of Daha Utara and Daha Selatan, and District Hulu Sungai Selatan, South Kalimantan Province. The Blacksmiths during their works did not use personal protective equipment, they were always exposed to metal fume and vapor, and other particles such as Diesel Exhaust Particles (DEP), and compounds resulting from the combustion process in a high temperature with results in total IgE levels. The objective of the investigation was to assess the correlation between exposure of metal fume and vapor with the total IgE levels.

The study was analytic observational, and cross sectional design conducted in the sub Districts of Daha Utara and Daha Selatan. Measuring of metal fume and vapor, Blood sampling were conducted at Kandangan hospital, and Balai Hiperkes and keselamatan Kerja South Kalimantan Province, respectively. Whereas determination of total IgE levels was carried out at Prodia laboratory Jakarta. The population of studies was the entire blacksmiths in sub districts of Daha Utara and Daha Selatan. The sampling procedure was based on purposive sampling predefined by inclusion and exclusion criteria with a sample of 38 units and 38 blacksmiths.

Result were analyzed observational, and cross sectional design using test of Partial Least Square (PLS). The Partial Least Square (PLS) indicated the presence of a significant correlation metal fume, and vapor with the increased of total IgE levels with R^2 : 0.1569.

In conclusion, This study demonstrates the presence of a positive and significant correlation due to exposure of metal fume and vapor leading to as an increased of total IgE levels.

Keywords : metal fume and vapor exposure, total IgE levels.

BACKGROUND

Blacksmith centers is located in the sub District of Daha Utara and Daha Selatan, and District of Hulu Sungai Selatan, South Kalimantan Province. This centers has been producing agricultural tools, household tools, souvenirs, ships wheel, since many years ago. The manufacture process of metal tools began with the metal burning in a furnace with a combustion temperature of around 600°C - 900°C by using fuel from wood and charcoal, while the average temperature is 34°C in the working environment (Fauzi, 2000; Husaini, 2010; Husaini, 2011).

The workers have been doing their job daily without any personal protection, continuously exposed to various pollutants such as metal fume and vapor, and Diesel Exhaust Particles (DEP) (Husaini, 2011). The continuous irritation by those pollutants along the mucosa of the upper respiratory tract produces mucosal inflammations. Consequently, there will be an increased permeability of this layer and enable the antigenic particle and allergens from environment easily enter the mucosa. Exposure of allergenic substances to some people induces allergic reaction (Epler, 2000; Setiono, 2000).

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Repeated antigen or pollutants exposure to the immune system leading to sensitization. Antigens inhalation that will be captured by alveolar macrophages and then presented this peptide in association with Major Histocompatibility Complex (MHC) class II molecule to the T cells. These CD4 T cells will then be activated and secret the cytokines to stimulate B cells producing antibody such as IgG or IgE (Burnet, 1986). Other previous studies were cross sectional studies by looking medical record of the employees at the nickel mining and processing at the site plant. These employees were more likely had experienced on lung disfunction compared to employees outside of the site plant OR=5 times (95%), CI=1.331-17.998, prevalence=39.2% - 73.6% with a risk of 5 times (Syamsurrijal *et al.*, 2009).

Exposure of metal fume and vapor or DEP of exposure to received in a long period of time will affect on lung function and immune response. The immune response is elicited by product ion of total IgE antibodies. Based on the above case studies, we were interested to investigate the correlation of metal fume and vapor exposure with the total IgE levels on the subjects.

HYPOTHESIS RESEARCH AND METHOD

The study hypothesis was that a positive correlation between metal fume and vapor of exposure with total IgE levels. The studies was the analytic observational, with cross sectional study design.

The studies was conducted over the period of 10 months from February - November of 2011. The study was conducted at the unit of blacksmiths, namely in (a) district of Daha Utara, at Desa Panggandingan. (b) District of Daha Selatan, at Desa Sungai Pinang and Desa Tumbukan Banyu. Blood sampling was dose to measure of metal fume and vapor. Examination

by using spirometry was conducted at Balai Hiperkes and Keselamatan Kerja South Kalimantan Province. Determination of total IgE levels was carried out at the Prodia laboratory Jakarta. The inclusion criteria of the subjects were as follow age 25 - 50 years, working period of at least 5 years, had never worked on a similar job before, never smoking. While the exclusion criteria were those who refused to participate in the study, had an allergy, pulmonary tuberculosis and other lung infections. Techniques of sampling in this study was purposive sampling that meet the inclusion and exclusion criteria were 38 units, and 38 blacksmiths.

The independent variables were metal fume and vapor, while the dependent variables were total IgE levels, and the controlled variables were age and year duration of work. Chemicals and equipment used in this study were in the form of a kit comprising: ELISA test. The tools that have been used in this study were water bath, brand hetto oven, pH meter (cyberscan), vortex mixer VM-300, fridge (sharp), glassware (pyrex), gas analyzer (Factory by; USA, Tech).

RESULTS AND DISCUSSION RESEARCH

The results of this study indicated that the mean of air parameters quality at workplace were metal fume=4.479 mg/Nm³, and vapor=5.924 mg/Nm³* (notice:* Above the threshold value by SE Menaker No. 01/Men/1997 with ≤ 5 mg/Nm³).

For total IgE examination, there were 14 (37%) respondents were normal, and there were 24 (63%) respondents were abnormal by the standards of Prodia laboratory Jakarta. Metal fume, and vapor of exposure with total IgE has a significant correlation ($p: 0.043 < \alpha$). Assay system after Partial Least Square (PLS) has a significant correlation ($R^2 = 0.1569$).

Factors contributing to the overall relationship exposure of metal fume and vapor with total IgE levels. Blacksmiths is the source of risk or potential hazards and the characteristics of pollutants that always exposes blacksmiths in the work every day, where they work is always close to the source of danger as well as the high temperatures (mean 34⁰C) as a result of various combustion process that has lasted long enough where exposes blacksmith is also in the works are not using and Occupational Health and Safety principles which adversely affects health, especially the occurrence of various infections and allergies.

Goldsmith *et al.* (1998) dan Groth *et al.* (1989) reported that the gas is distributed in the body especially in the lungs and are stored in a long time. The above factors, combined with the likely reaction of the gas is released into the air and bind with other substances. Devalia *et al.* (1994) also explains that the gas or substances that are released into the air will react with each other and supporting each other in decreasing lung function. Zein *et al.* (2005) suggest that the disease appear due to metal fume exposure, namely metal fume fever leading to the development of respiratory disease. Buerke *et al.* (2002) reported the presence of interstitial pulmonary fibrosis (IPF) after long-term exposure, increasing the prevalence of weight or many in the workplace that has poor ventilation. Erhabor *et al.* (2001) reported that 40.9% were working in the welding industry, many were suffered from restrictive lung disease (interstitial lung disease). Other possible factors were less clean or hygienic work environment and no exhausters available. Consequently, those pollutants exposes intensively to the blacksmiths, and other possibilities for the pollutants of combination in the air, causing a reaction and pollutants become more reactive,

corrosive and toxic if blacksmiths inhaled. This is consistent with the experts of opinion who say that particles or a mixture of composition of organic and inorganic agents to lower lung function in reaction contribute, and increased disorders other, respiratory particularly passages, including transition metals during the combustion process, and Polycyclic Aromatic Hydrocarbons (PAH) derived from combustion processes various kinds of metals combustion, as well as a source of bacterial endotoxin (Mukono, 2005; Diaz-Sanchez *et al.*, 2000b).

Some of the particles and target cells influence each other, such as transition vanadium and copper metals are found capable of mediating cytokine gene expression induced by residual oil and ash that pollutes the air in the work environment of the particle emission sources (Kennedy *et al.*, 1998; Dye *et al.*, 1999). Lipopolysaccharide (LPS) appears to be the main element or part of the Urban Air Pollution (UAP) (Becker, 1996; Osornio *et al.*, 2003). Other aspect possibly influence the blacksmiths was physical exhaustion as indicated by fatigue and pain. This condition also reduced immunity and finally many symptoms appear, such as throat, cough, night fever etc. Mis perception among the blacksmiths on the concept of health and sick for instance, they believe that they are still healthy because they are able to work. Body condition of blacksmith are always forced to work, always adjacent to the source of pollutants and the working environment of heat (34⁰C) due to the burning of materials of various types such as ironwood, charcoal, iron plate, then an entry point for a pollutants of variety that is corrosive and toxic work environment, which is certainly more endurance and the emergence of a variety of pulmonary function abnormalities. This is consistent with studies many suggest the role of fuel due to the blacksmith of

activity capable inflammation of causing. In the particles from the combustion or DEP (Diesel Exhaust Particles) (Barfknecht *et al.*, 1982). Several studies of the pollutants of interaction have been involved either directly or indirectly to immune system cells such as lymphocytes and mastosit (Wang *et al.*, 2003). Thus, if the DEP, metal fume, gas and other pollutants synergize with allergens will affect on mast cells and lymphocytes to produce of IL-4 and IgE, and also induce the secretion of chemokines from epithelial cells. Mononuclear cells will be recruited and activated to molecule in inflammatory reactions (Devalia *et al.*, 1993).

The results of other studies that found a significant correlation with the $p: 0.043$ between a vapor with total IgE. Causing factors total IgE of high levels in the blacksmith pollutants many are likely to be allergenic and also the hypersensitivity reactions possibility in individuals that blacksmiths. Presence of excessive pollutants exceeded the threshold value of the metal fume, and vapour based on SE Menaker No. 01/Men/1997 < 5 mg/Nm^3 , will be corrosive and toxic. Other reaction many occur between metal fume and vapor of pollutants and made worse condition in the working environment. The temperature of a hot working environment (34°C), physical condition also accelerated blacksmith to get tired, so the immune system decreases.

The study showed that there were 24 respondents (63%) of 38 respondents total IgE well above the mean 139.42 IU/mL . Normal standard < 87 IU/mL from Prodia laboratory Jakarta. Stephen *et al.* (1998); Eva *et al.* (2003); Saryono, (2009); Devalia *et al.* (1994) describes the CO, SO₂, NO₂, metal fume, and vapor levels in the work environment is toxic to the every day to exposed for a long time and continuously, and will inflammatory effects, the

increase in cytokine product, and lung injury, this is the main entrance to the disorder or other body reactions including allergies and the various pulmonary infections and other respiratory tract. This is likely due to DEP (Diesel Exhaust Particles) of exposure, and due to incomplete combustion, which uses fuel wood and charcoal ironwood type, and also where iron plate burnt potentially very have toxic effects if burned at a high temperature ($>600^\circ\text{C}$), and will be pneumosiderosis, neutrophilic inflammation, as well as a blacksmith constantly exposed to any work in a long time, providing the potential for interference with the lung function, other infection, and immunoglobulins levels, especially total IgE.

CONCLUSION

In conclusion, this study suggests the presence of a positive and significant correlation due to exposure of metal fume and vapor to the as an increased total IgE levels, with $\alpha = 0.05$.

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