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Dust Exposures, IgE Levels, History of Allergy, and Symptoms of Allergy in Poultry Workers

Yuni Wijayanti[1]✉, Adi Heru Sutomo[2], Indwiani Astuti[2], Widya Asmara[2]

[1]Universitas Negeri Semarang, Indonesia
[2]Universitas Gadjah Mada, Indonesia

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Abstract

Poultry dust exposure may increase workers' health risks, particularly in the form of respiratory allergic reactions. This study aimed to identify mold content of the dust and to analyze the association between dust exposure, IgE level, history of allergy, and symptoms of allergy. This study used cross sectional design with total samples of 33 workers. The data were analyzed using chi-square test and multivariate logistic regression. This study found 93.33% growth of Aspergillus sp., 69.7% work duration > 3 years, 84.8% high IgE levels, 18.2% history of allergy, and 69.7% symptoms of allergy. Dust exposure and history of allergy did not show significant correlation with symptoms of allergy while IgE levels had significant correlation with p-value of 0.036. Workers with high IgE-level were 15.986 times more likely to have symptoms of allergy (p-value 0.028). Aspergillus sp. as dust allergen potentially increased IgE levels and might become the base for facilitation of early and independent preventive and promotive efforts of workers' health.

Introduction

Poultry industry that ignores the proper way of handling waste can cause negative impacts to chicken farm such as pollution and environmental disturbance. A poultry odor nuisance is a kind of air pollution that is generated from microorganism activity in leftovers and livestock manure. The existence of chicken farms also has the potential to disturb the health of surrounding community. Various spores concentrations in working environment could cause decreased level of Pulmonary Function Test (PFT), allergy symptoms, elevated IgE levels, and respiratory disorders of the workers. Exposure to dust and aeroallergens is at risk for respiratory disorders (upper and lower respiratory symptoms) and specific sensitization (IgE) (Cullinan et al., 2001). Alencar et al., (2004) said that workers who worked more than 4 years and more than one chicken farmhouse for 5 hours per day at work showed a risk of respiratory health problems in the form of respiratory allergic reactions.

Based on these background, the main research in this study was "What is the relationship between dust exposure time, subjective allergy complaints, and history of allergy with IgE levels in chicken farm workers at 'X' Farm?". The purpose of this study was to examine the relationship between dust exposure time, subjective allergy complaints, and history of allergy with IgE levels in chicken farm workers at 'X' Farm.

Occupational activities in poultry farm

✉ Correspondence Address:
Universitas Negeri Semarang, Indonesia.
Email : yuniwija@mail.unnes.ac.id

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produce dust particles in which the most common is organic dust. These particles contain allergens, bacteria, lice, fungi/mold spores, endotoxins, food scraps, vaccine residues, fecal matter, and fur/chicken skin (Viegas et al., 2013).

Activities which produce dust which contains litter were chicken care and supervision, chicken vaccination, cage cleaning, litter and feces cleaning, cleaning at the end of production and other similar activities. (Health & Safety Executive, 2009) The bacteria inside bioaerosols may originate from soil, food, cage mats, and chicken feces or skin. Bioaerosols in chicken farms also contain fungi, such as: *Stachybotrys chartarum*, *Alternaria alternata*, *Aspergillus fumigatus*, *Cladosporium herbarum*, *Fusarium* sp., *Penicillium* sp., *Rhizopus* sp., *Mucor* sp., *Trichoderma* sp., and *Trichothecium* sp (Lanc & Plewa, 2010) .

The occupational immune hypersensitivity disorders could manifest as asthma due to allergies or rhinoconjunctivitis, hypersensitivity pneumonitis, and allergic contact dermatitis. These reactions depend on several factors such as host, duration, degree and type of sensitization, and antigen. Dander and excreta of animals, insects, shellfish, and animal enzymes could stimulate IgE antibodies production and type I reactions (Health and Safety Executive, 2009).

Environmental risk factors, including antigen concentration, duration of exposure, particle size, frequency of exposure, particle solubility, respiratory system protection gear use would affect the prevalence, severity, latency and disease pathogenesis. It is generally believed that acute HP (hypersensitivity pneumonitis) is usually the result of intensive but intermittent exposure to inhaled antigens, whereas subacute HP results from less intensive but continuous exposure, although this relationship is not fully understand. Chronic HP may be due to progression from acute or subacute HP, but may also arise from long-term exposure to low levels of antigen (Darya & Rai, 2008).

Methods

This was a descriptive research which used observational with cross sectional and retrospective approach as the method (Mukono, 2008). The study subjects were all workers in chicken farming house 'X' Farm which numbered to 33 people. We used total sampling method. The variables to be studied were duration of dust exposure, IgE levels, history of allergy and subjective complaints of allergies on chicken farm workers at 'X' Farm. This study had passed the ethical review of the Medical and Health Research Ethics Committee (MHREC) Faculty of Medicine, Universitas Gadjah Mada – Dr. Sardjito General Hospital. Respondents which agreed to participate in this study would sign the informed consent form.

The data collection steps were: (1) Identification of fungus in chicken farm dust conducted by Laboratory of Microbiology Faculty of Veterinary Medicine, Universitas Gadjah Mada, (2) Measurement of IgE levels from the subjects conducted by CITO Clinical Laboratory Semarang (3) The interview was conducted to obtain data about dust exposure time, the history of allergies, subjective complaints of respiratory and allergic disorders on chicken farm workers at 'X' Farm. We used a modified questionnaire from ATS-DLD-78-A.

Descriptive quantitative analysis was performed by description of all variables and analysis of independent and dependent variables relationship. Variables time of dust exposure, IgE levels, history of allergies and subjective complaints of allergies in chicken farm workers in 'X' Farm were shown in the form of tables and graphs. Chi-square test (cross tab 2x2) and multivariate logistic regression with 95% significance level (error α 5%) were used to analyze the relationship between variables.

Results and Discussion

'X' Farm is a farm which raises egg layer chicken. This chicken farm has 16 house cages, eight support rooms, and five bathrooms. The eight support rooms consist of: two rooms for chicken food processing and storage, a room for weight measurement and egg storage, an office, a generator room, two-bedroom for worker, a kitchen, and a dining room. Each cage sized 6x15 meters is used to raise around fifteen hundred chickens. The operator worker's duties are to clean the cage, feed the chicken, and take their eggs from two house cages. The chicken feeding schedule are three times a day (morning, afternoon, and evening) and the schedule to take their eggs are twice a day

(morning and afternoon). The chicken cage model is stage shaped. The height is about 2 meters from the ground. It does not have a closed wall. The feces of the chicken will fall to the ground. The chicken feces cleaning schedule are 4 times a day. Each operator also tasked to maintain the cleanliness of the chicken cage environment.

The 'X' Farm produces their chicken feed by grinding some ingredients. Basic ingredients of these feed are corn, bran, and added with chicken food. At the time of grinding activities, there is dust flying inside the room. The feed that has been grilled are then put in the sack and stored in the storage warehouse. In this storage warehouse there is also a lot of dust flying around. When chicken feed is ready, it will be distributed to the chicken cage. A worker as an operator will feed the chicken regularly. Chicken are fed three times a day, in the morning, noon, and afternoon. When the chicken are eating, the atmosphere of the cage looks crowded and the chickens move a lot. There would be numerous dust flying around especially the dust that come from powder chicken food. Other dust come from waste and cage environment.

Identification of *Aspergillus* sp mold on environmental dust around 'X' farm was performed by catching farm dust using 15 SDA (Sabaroud Dextrose Agar) petri dishes. There were two SDA petri dishes placed in weighing and egg storage room, two dishes in grinding room and chicken food storage, and 11 dishes in 6 chicken cage. The petri dishes were placed for 24 hours. After that, the dishes were taken to Laboratory of Microbiology, Faculty of Veterinary Medicine, Universitas Gadjah Mada in order to identify the growth of *Aspergillus sp*. From 15 petri dishes, there were 14 dishes which showed growth of *Aspergillus* sp. mold and 1 petri which was placed in the chicken cage did not show any growth of *Aspergillus* sp. The growth of *Aspergillus* sp. mold are shown below.

Dust which contained above molds could come from chicken feed or from chicken farm waste that fly in the air. The contaminants consisted of several types of mold such as *Aspergillus* sp., *Fusarium* sp., and *Mucor* sp. Those molds could be found in feed and its ingredients, especially corn. Such contamination could cause health problems in the form of mycosis in animals. Health disturbances or diseases were not only caused by mold, but also by the toxin which was produced by the mold. The economic burden due to contamination of fungi on feed and its ingredients was quite real. Some of the factors which supported the occurrence of mold contamination and toxins in mold were mainly moisture and temperature. In Indonesia, *Aspergillus* sp., Especially *Aspergillus flavus* is the most common mold which could contaminate feed and its ingredients (Ahmad R Z., 2009).

A study by Tyasningsih (2010) on the potential of feed as source of *Aspergillus* sp. contamination found several species of *Aspergillus* sp. which could be growth on Sabouraud's Dextrose agar (SDA) culture medium, namely *Aspergillus fumigatus*, *Aspergillus flavus,* and *Aspergillus niger*. From examination of 30 samples of feeds, positive growth of *A. fumigatus* were found in 16 samples, *A flavus* were found in 10 samples, and *A. niger* were found in 3 samples.

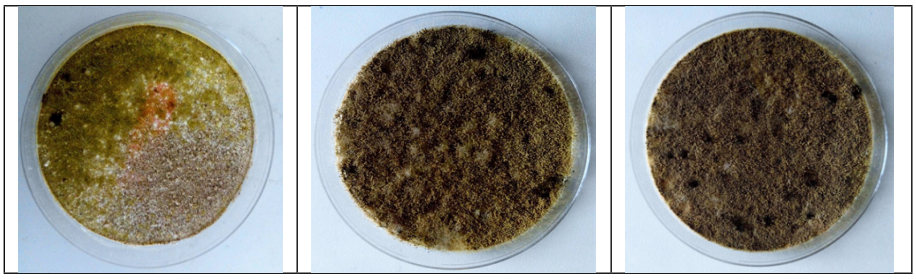

Figure 1. Results of *Aspergillus* sp. culture on *Sabouraud Dextrose Agar* (SDA)

Fungal diseases which was caused by *Aspergillus* species could be present with various clinical syndromes. In patients with chronic lung disease (especially asthma, chronic lung diseases or cystic fibrosis) and patients allergic to these fungi, bronchial damage and intermittent bronchial blockage could happened. This condition is called Allergic Bronchopulmonary Aspergillosis (ABPA). Aspergillosis is a group of diseases which is caused by *Aspergillus* fungus. There are 2 types of aspergillosis. One is Allergic Bronchopulmonary Aspergillosis (ABPA), a condition in which the fungus causes symptoms of allergy in the respiratory system but does not invade and destroy tissue. Another type of aspergillosis is invasive aspergillosis which affects human immune system. In this condition, the fungus invades throughout the body and damages the body tissues (Ahmad, 2009).

Chicken farm workers may be exposed to dust which contains *Aspergillus* sp. One of the factors that could worsen it is long term exposure while working in chicken farms. In this study, the data about the duration of exposure to dust were taken from the work duration of workers in the 'X' Farm. Duration of exposure to dust on workers was divided into two categories, namely > 3 years and <3 years. Most of the chicken farm workers (69.7%) at 'X' Farm had been exposed to dust for more than 3 years. Workers who have worked for three years or more had experienced chronic exposure. This condition may cause interruption of the respiratory tract and the occurrence of allergic processes. This is relevant to research from Kirychuk et al., (2006) and Rimac et al., (2010) which found that exposure to chicken farm dust was associated with increased incidence of upper and lower respiratory tract symptoms.

Level of IgE of chicken farm workers from 'X' Farm was obtained from the results of blood tests which were conducted by CITO Clinical Laboratories Semarang. The data on IgE levels in workers largely exceeded the normal IgE levels (>100 IU/ml). The respondent were asked about their history of food allergy, dust allergy, and weather allergy. They were also asked about clinical symptoms of allergy which appear, such as itch, skin irritation, rash, sneeze, runny nose, itchy eye, and eye irritation. From interview results, it was found that most workers on 'X' chicken farm experienced symptoms of allergy, such as sneezing, runny nose, itchy skin, and eyes feel hot, red, and itchy. The univariate profile of the research data (duration of dust exposure, IgE level, history of allergy, and subjective complaints of allergy) are presented in Table 1. Visualization of graphs in the form of bar charts from the data in Table 1 is shown below.

The data analysis showed no significant relationship between dust exposure times and subjective complaints of allergy in workers in 'X' Farm. The p-value was 0.226 (95% CI 0.736-17.599). It was possible because there were 5 workers who work >3 years but did not have subjective complaints of allergy, and there were 5 workers who work <3 years and had subjective complaints of allergy. Factors which might affect this condition include history of allergy, health condition, healthy behavior at work, use of personal protective equipment, and past medical history.

Exposure to allergens in chicken farms

Table 1. Research Data Profile

No.	Variables	Categories	Total (%)
1	Duration of exposure	> 3 years	23 (69.7)
		< 3 years	10 (30.3)
2	IgE levels	High	28 (84.8)
		Normal	5 (15.2)
3	History of allergy	Yes	6 (18.2)
		No	27 (81.2)
4	Subjective complaints of allergy	Yes	23 (69.7)
		No	10 (30.3)

Source : Primary Data

could occur from contact with dust mites, chicken dust which contains allergens from grains and animal foods, and fungi which contains allergenic substances (mostly from *Aspergillus* sp.) (Health and Safety Executive, 2009; Prester et al., 2010). Other sources include chicken feathers, dander, serum, *rabuk* that chicken farm workers might be exposed while treating chickens closely (Health and Safety Executive, 2009). The most prevalent work-related symptoms in chicken farm workers were symptoms of the eyes, nose, and skin (Rimac *et al*., 2010).

Air pollution (measured in PM10 concentration) in Indonesia caused an economic cost of around Rp 373.1 trillion or equivalent to 5.03% of Gross Domestic Product (GDP) in 2011. The economic cost consisted of early mortality cost of Rp 227.1 trillion (60.9% of total cost) and morbidity cost of 146 trillion (39.1% of total cost) in which the largest component (about 50%) of the morbidity cost was hospital treatment due to respiratory diseases. The economic cost of pollution was a burden that must be borne by the community with an average of about Rp 1.53 million or about 6.7% of per capita income per year (Mursinto & Kusumawardani, 2016).

In this study most workers had high IgE levels as many as 28 people (84.8%). According to Ahn et al., (2011), allergic reactions occur when immune system misinterprets a normally harmless substance as an agent of the disease and produces a type of antibody, namely immunoglobulin E (IgE). House dust mites are a common cause of asthma and common allergic diseases. IgE responses to allergens caused by house dust mites are important in the development of atopic asthma and rhinitis.

History of allergy with subjective allergy complaints did not show any significant correlation with p-value of 0.503 (95% CI 0.057-2.154). IgE levels with subjective allergic complaints showed a significant correlation. Bivariate analysis in this study showed p-value of 0.036 (95% CI 1.371-156.888). This happened

Table 2. Correlation between Variables and Subjective Allergy Complaint

No.	Variables	Category	Subjective Allergy Complaint		p-value
			Yes (%)	No (%)	
1	Exposure time	> 3 years	18 (78.3%)	5 (21.7 %)	0,226
		< 3 years	5 (50.0 %)	5 (50.0 %)	
2	IgE levels	High	22 (78.6 %)	6 (21.4 %)	0,036
		Normal	1 (20.20 %)	4 (80.0 %)	
3	History of allergy	Yes	3 (50.0 %)	3 (50.0 %)	0,503
		No	20 (68.7 %)	27 (30.3 %)	

Source : Primary Data

Table 3. Inclusion of Independent Variables for Multivariate Analysis

No	Independent Variables	p-value	Note
1	Length of work (*cut-off value*: 3 years)	0.114	Included
2	IgE level	0.026	Included
3	History of allergy	0.257	Not included

Source : Primary Data

Tabel 4. Variables in Regression Analysis

		B	Wald	Sig.	Exp(B)	95% CI for EXP(B)	
						Lower	Upper
Step 1[a]	Length of work	1.385	2.294	0.130	3.996	0.666	23.991
	IgE level	2.772	4.815	0.028	15.986	1.344	190.083
	Constant	-1.804	8.285	0.004	0.165		

Source : Primary Data

because there were 22 people who had blood test results of high IgE levels and subjective complaints of allergies.

Air pollution is a trigger for asthma attacks. Pollutants as extrinsic antigens stimulate plasma cells and lymphoid tissues to produce IgE. IgE would bind to mast cell and antigen-antibody reaction occurs. These reaction produce histamine, bradykinin, and slow reacting substance mediators that cause narrowing of respiratory tract, swelling and thickening of mucosa, and increased mucosal secretion (Mukono, 2008). Increased serum IgE levels is correlated with lower FEV_1 values, which means that elevated serum IgE levels might increase the degree of obstruction in more severe directions (Kusuma et al., 2004).

The results of analysis of correlation between duration of dust exposure, IgE levels, history of allergy, and subjective allergy complaints are presented in Table 2.

Multivariate analysis in this study began with determination of candidates of independent variables into multivariate model performed by SPSS using the "Enter" method in simple logistic regression. The independent variables were determined as candidate to be included in multivariate analysis if it has significance level or p-value <0.25 (Bursac et al., 2008). Checks were done by simple regression between each independent variable with dependent variable whose analysis results are presented in Table 3.

Based on the result above, it was found that the independent variables which were suitable to be included were the length of work with cut-off value of 3 years and IgE level. Multivariate analysis results are presented in Table 4.

The result of variable selection shows that the OR for IgE is 15.986 with p-value from Wald test is 0.028 with 95% confidence interval of 1.344-190.083. This information indicated that workers with high IgE levels had 15.986 times greater chance of having a subjective allergy complaint event with a significance level of 0.028.

Conclusions

In dust from chicken farm environment in 'X' Farm which was caught in SDA (Saboraud Dextrose Agar) petri dish, growth of *Aspergillus* sp. mold were identified in 93.33% samples. Most workers (69.7%) have worked for three years or more. Exposure to dust which were experienced by workers in 'X' farm was classified as chronic exposure. The description of IgE levels in the blood of workers in 'X' Farm indicated abnormal condition. 84.8% of workers had high IgE level. The percentage of workers who had history of allergy was 18.2%. A total of 69.7% had subjective complaints of allergies such as sneezing, runny nose, itchy skin, and sensation of hot, red, and itchy eyes. Duration of exposure with subjective complaint did not show significant correlation (p-value 0.226). Correlation between IgE level with subjective allergy complaint showed significant (p-value 0.036), history of allergy with subjective allergy complaint did not show a significant correlation (p-value 0.503). People with high IgE level were 15.986 times more likely to have a subjective allergy complaint with significance level of 0.028 and 95% confidence interval of 1.344-190.083.

This research is expected to provide information to the government (District Health Office, Primary Health Care) that chicken farm dust can contain *Aspergillus* sp. which can affect public health especially for workers. Health problems that can be caused include an allergic process that can increase IgE levels and some clinical symptoms (subjective complaints) of allergies. For that purpose, government can make health prevention for healthy workers and workers who already sick. Prevention and promotion programs such as health care insurance, education/health training in the workplace, periodic health examination can improve health status of workers so that work capacity can be maintained. It is expected that other researchers will do the same research to add variables, sample quantities and use other statistical tests.

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