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Original Research Article

Respiratory symptom and disorder characteristic of farmer who exposed by pesticide

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ABSTRACT

Background: Pesticide is related to respiratory diseases; thus, personal protective equipment is very important as a preventive equipment while using pesticide. However, farmers in Indonesia still rarely use PPE when farming for reasons of inconvenience and availability problems.
Methods: This study was an analytic observational study with cross-sectional design. Sampling technique was consecutive sampling. Subject was 62 residents of Sukawana Village, Kintamani, Bangli who work as farmers and used pesticides.
Results: Dominant subject never experienced chronic respiratory symptom. The spirometry results showed mean of FVC (L) was 3.50 liters, FVC% was 93.31%, FEV1 (L) was 3.09, FEV1% was 97.64%, FEV1/FVC was 88.72, FEF 25-75% (L/s) was 4.07 liters/second, and FEF 25-75% was 106.95%. Age was significantly related to the occurrence of wheezing but not significantly related to another. Older people have significantly lower mean of FVC (L), FEV 1 (L), and FEF 25-75% (L/s) than younger. Smokers have significantly higher mean of FVC (L) and FEF 25-75% (L/s) than non-smokers.
Conclusions: The dominant subject never experienced chronic respiratory symptom with spirometry mean values within normal limits. Age was significantly related to the occurrence of wheezing. Older age has significantly lower mean of FVC (L), FEV 1(L), and FEF 25-75% (L/s).

Keywords: Pesticide, Farmer, Chronic respiratory symptom, Lung function, Spirometry

INTRODUCTION

Pesticides used in agricultural export commodities has increased in developing countries. Ninety-nine percent of deaths due to pesticides used occur in developing countries. This was caused by excessive use of pesticides, sub-optimal policies, and health systems in developing countries.[1] Pesticides are generally divided into five types, they are herbicides, insecticides, fungicides, bactericides and rodenticides. Based on chemical elements, pesticides

are also categorized into Organochlorines (OC), Organophosphates (OP), Carbamates, Dithiocarbamates, Pyrethroids, Phenoxyl, Triazine, Amida and Koumadin.[2] Pesticides exposure to workers occurs in the process of production, transportation, preparation and use of pesticides. The level of pesticides exposure is influenced by the intensity, frequency, duration, method and behavior for safety, physiochemical factors, and the toxic effects of the pesticides. In agricultural sector workers, about 10% of total pesticides exposure occurs through inhalation and also from skin or digestive tract absorption.[3]

The acute toxic effects of pesticides can be recognized on the basis of toxicology and clinical studies. Neurological and immunological effects on the respiratory system are associated with a local or systemic toxic action. Development of respiratory problems occurs due to excessive toxic effects interfering with cell regeneration. Those caused airway inflammation which can induce coughing and shortness of breath.[4] A study on workers in pesticide packaging showed, workers who were exposed to pesticides had a significantly higher risk of developing respiratory disorders.[5]

Meanwhile, chronic exposure of pesticides such as OP and Carbamate has a risk of progressive decrease in lung function to become chronic obstructive pulmonary disease (COPD).[6] Various studies showed the use of pesticides was associated with chronic respiratory diseases. That was indicated by abnormal spirometry results in workers with chronic exposure to pesticides.[4,5] A study conducted by Mekonnen consisting of 102 pesticiden exposured workers and 69 non-workers showed that pesticide workers aged 15-24 years had significant reduction in forced expiratory volume 1 second (FEV1) coupled with decreased forced vital capacity (FVC).[7]

Airborne exposure often occurs when using volatile pesticide products, especially in workers without standart PPE. There are still many farmers who are reluctant to use PPE for reasons of inconvenience, disturbing work, lack of knowledge about its benefits, and its availability. Therefore, it is important to conduct research on clinical characteristics and respiratory function in farmer exposed to pesticides. Sukawana Village is one of the villages in Bali with the dominance of the population working as farmers and using pesticides. This study aims to determine the profile of respiratory symptoms and disorders of farmer exposed to pesticides in Sukawana Village, Kintamani District, Bangli.

METHODS

Study design

This study was observational analytical with cross-sectional research design. The study was conducted in Sukawana Village, Kintamani, Bangli from July 1 to July 30, 2022. The subject was resident of Sukawana Village, Kintamani, Bangli who worked as farmers and used pesticides.

Study participants and data collection

Subjects were determined through a consecutive sampling. The inclusion criteria were farmers who were cooperative and willing to be included as study participants. Farmers who have contraindications in performing spirometry were excluded by researchers. Data collection was carried out by using questionnaires consisting of five parts; demography characteristics (gender, date of birth, and comorbiditie); Anthropometry (height); smoking status (smoker and non-smoker); Job description (length of work using pesticides and the use of PPE while using pesticide); and chronic respiratory symptom for 12 months. Information's regarding respiratory symptoms in 12 months were evaluated by using A modified European community respiratory health survey questionnaire.

Data analysis

Data analysis were carried out by statistical software. Descriptive analysis was done to figuring out demographic characteristics. Median was used to determine cut off value of Ages. The differences chronic respiration symptoms distribution among age group, and smoking status was analyzed by using Chi-square or Fisher's exact analysis. The differences distribution of chronic respiration symptoms among length of work group was analyzed by using Kruskal-Wallis. Test of normality among FVC, FEV1, and FEV1/FVC data used Kolmogorov- Smirnov. Differences in the mean of FVC (L), FEV1%, FEV1 (L), FEV1/FVC, and FEF 25-75% among age group, smoking status and length of work were analyzed using independent T-Test and Chi-square tests (for the length of working group) due to data showed normal distribution after serial of normality tested. Difference regarding mean value of FVC% were analyzed by using Mann-Whitney and Chi-square (for the length of working group) because the data showed different with normal data.

RESULTS

Demographic characteristics

Total number of subjects was 62 people. The characteristics demography can be seen in table 1. We found that our subjects were dominant male, smoker, used good precaution, and no comorbid.

Characteristics of chronic respiratory symptom and pulmonary function

Characteristics of respiratory symptom and pulmonary function can be seen in (Table 2-3). Our subjects dominant did not have chronic respiratory symptom with good spirometry result.

Table 1: Characteristics of the study participants.

Variables	N	(%)
Age (Years)		
≤42	32	(51.6)
>42	30	(48.4)
Gender		
Man	58	(93.5)
Woman	4	(6.5)
Smoking Status		
Smoking	50	(80.6)
No smoking	12	(19.4)
Personal protective equipment used		
Yes	56	(90.3)
No	6	(9.7)
Comorbid diseases		
Yes	11	(17.7)
No	51	(82.3)

Table 2: Characteristics of chronic respiratory symptom.

Questions	N (%)
Have you ever experienced wheezing or "ngik-ngik" sounds on the chest for the last 12 months?	
Yes	10 (16.1)
No	52 (83.9)
Have you ever experienced chest tightness in the last 12 months?	
Yes	12 (19.4)
No	50 (80.6)
Have you ever experienced coughing with or without sputum almost every day during minimum 3 months in a year at least 2 years consecutively?	
Yes	3 (4.8)
No	59 (95.2)
Have you ever experienced chest pains such as sharp and penetrated pain into the back in the last 12 months?	
Yes	6 (9.7)
No	56 (90.3)

Table 3: Characteristics of pulmonary function.

Variable	Mean±SD
FVC (L)	3.50±0.68
FVC (%)	93.31±15.52
FEV1 (L)	3.09±0.59
FEV1 (%)	97.64±14.6
FEV1/FVC	88.72±8.00
FEF 25-75 (L/s)	4.07±1.17
FEF 25-75 (%)	106.95±26.33

Chronic respiratory symptom characteristic by age, smoking status, and length of work

Bivariate analysis of respiratory symptoms by age, smoking status, and length of work, can be seen in (Table 4-6).

Table 4: Chronic respiratory symptom characteristic by age group.

Questions	≤ 42 years old	>42 years old	P value
Have you ever experienced wheezing or "ngik-ngik" sounds on the chest for the last 12 months?			0.029
Yes	2	8	
No	30	22	
Have you ever experienced chest tightness in the last 12 months?			0.158
Yes	4	8	
No	28	22	
Have you ever experienced coughing with or without sputum almost every day during minimum 3 months in a year at least 2 years consecutively?			1.0
Yes	2	1	
No	30	29	
Have you ever experienced chest pains such as sharp and penetrated pain into the back in the last 12 months?			0.41
Yes	2	4	
No	30	26	

Table 5: Chronic respiratory symptom characteristic by smoking status.

Questions	Smoking status		P value
	Smoker	Non-smoker	
Have you ever experienced wheezing or "ngik-ngik" sounds on the chest for the last 12 months?			0.18
Yes	10	0	
No	40	12	
Have you ever experienced chest tightness in the last 12 months?			1.0
Yes	10	2	
No	40	10	
Have you ever experienced coughing with or without sputum almost every day during minimum 3 months in a year at least 2 years consecutively?			1.0
Yes	3	0	
No	47	12	
Have you ever experienced coughing with or without sputum almost every day during minimum 3 months in a year at least 2 years consecutively?			1.0
Yes	5	1	
No	45	11	

Subjects with age >42 years, had more experience of wheezing significantly than subjects with age ≤42 years.

Table 6: Chronic respiratory symptom characteristic by length of work.

Question	Length of work (years)		P value
	≤10	>10	
Have you ever experienced wheezing or "ngik-ngik" sounds on the chest for the last 12 months?			0.30
Yes	4	6	
No	31	21	
Have you ever experienced chest tightness in the last 12 months?			0.42
Yes	8	4	
No	27	23	
Have you ever experienced coughing with or without sputum almost every day during minimum 3 months in a year at least 2 years consecutively?			1.0
Yes	2	1	
No	30	29	
Have you ever experienced coughing with or without sputum almost every day during minimum 3 months in a year at least 2 years consecutively?			0.52
Yes	3	3	
No	32	24	

Table 7: Mean differences in pulmonary function by age.

Parameters	Age		P value
	≤42	>42	
FVC (L)	3.76	3.23	0.002
FVC (%)	95.57	90.9	0.21
FEV1 (L)	3.31	2.85	0.002
FEV1(%)	98.36	96.86	0.690
FEV1/FVC	88.24	89.22	0.632
FEF 25-75 (L/s)	4.36	3.77	0.047
FEF 25-75 (%)	105.78	108.2	0.72

Table 8: Mean differences in pulmonary function by length of work.

Parameters	Length of work		P value
	≤10	>10	
FVC (L)	3.54	3.46	0.678
FVC (%)	94.35	91.96	0.94
FEV1 (L)	3.11	3.07	0.789
FEV1(%)	97.85	97.37	0.899
FEV1/FVC	88.17	89.42	0.547
FEF 25-75 (L/s)	4.02	4.15	0.657
FEF 25-75 (%)	104.23	110. 48	0.359

Lung function based on age groups, smoking status, and length of work

Lung function based on age groups, smoking status, and length of work can be seen in (Table 7-9). It was found that FVC (L), FEV1 (L), and FEF 25-75 (L/s) significantly lower in >45 years old subjects but FVC (L) and FEF 25-75 (L/s) significantly lower in non-smoker subjects.

Table 9: Mean differences in pulmonary function by smoking status.

Parameters	Smoking status		P value
	Smoker	Non smoker	
FVC (L)	3.59	3.15	0.045
FVC (%)	92.99	94.66	0.94
FEV1 (L)	3.15	2.84	0.10
FEV1(%)	97.15	99.66	0.59
FEV1/FVC	88.28	90.54	0.38
FEF 25-75 (L/s)	4.19	3.57	0.032

DISCUSSION

The (Table 2-3) show the characteristics of respiratory symptoms and pulmonary function of respondents. Other studies have shown various results. A study conducted by Stoleski et al on vegetable farmers in the Republic of Macedonia found that chronic respiratory symptoms predominantly felt by farmers were cough, phlegm, and chest tightness with prevalence respectively 20%, 10.7%, and 12%. The mean of FVC and FEV1 in that study was also normal, 84.2±8.6% and 82.7±8.3%.[8] Another study conducted by Khane on farmers aged 32 years found the dominant symptoms of respiratory were chest tightness (33.3%), cough (20%), wheezing (15.2%), and phlegm (8%).[9] Research by Arisanti et al in Bali showed similar results. A research that was conducted on farmers in Utu Village, Bali found that chest tightness (13.1%), wheezing (7.1%), coughing (15.5%), phlegm (13.1%), and chest pain (2.4%) were found. Lung function results were obtained on mean FEV1 (83.75%±34.24), FVC (81.63%±34.30), and FEV1 / FVC (104.9±13.90).[10] Noxious exposure in farming activities does not only come from pesticides, but also exposure from other organic dust, an-organic dust, and noxious gas. Each of those components will cause different pathological reactions and create variations in clinical respiratory symptoms. Exposure to pesticides is one of the risk factors for lung disease in farmers. Various studies have shown an association between chronic respiratory symptoms and abnormal outcomes on spirometry tests with a history of pesticide exposure. The effect of exposure on the respiratory system is associated with local and systemic toxic reactions. Most pesticides have a small molecular weight which can undergo a hapten mechanism to cause airway inflammatory reactions. Exposure to pesticides can cause local and systemic toxicity reactions that induce exacerbation of the patient's atopy symptoms, exacerbation of asthma, and contact dermatitis. Respiratory disorders by pesticides can go through the mechanisms of type 1 hypersensitivity, type IV hypersensitivity, and oxidative stress. The toxicity of organophosphate insecticides occurs through a decrease in the function of muscarinic 2 receptors on the nerves leading to the loss of inhibition of acetylcholinesterase which causes airway hyperreactivity. Because of that, in

acute exposure, there will be a decrease of FEV1 in chronic process. Fibrosis can occur in the parenchyma and small airways which can cause abnormalities in FVC, FEV1/FVC, and FEF 25%-75%.[11,12] In this study, it was found that there was a relationship between age and wheezing. This was in accordance with previous studies that examined the relationship between age and the incidence of COPD in farmers, obtained results for farmers aged more than >70 years (35.56%) at risk of 1.12 times experiencing COPD.[13] The results of this study was also in line with the results of Yunus' research, which shows a relationship between the age of workers and the onset of workers' respiratory disorders.[14] There was no relationship between working periods with respiratory symptoms. This is similar to research on the relationship between pesticide use and respiratory symptoms in horticultural farmers in Buleleng, Bali, who did not find a relationship between working period with symptoms (p=0.96).[15] Working period was defined as how long the farmer starts doing his job as a farmer and using pesticides. The more often farmers spray pesticides, the greater the risk of pesticide toxicity. The most dangerous problem in pesticide exposure is that the inhalation of residual dust, vapors, and gases released by pesticides during mixing and spraying process can cause pneumonitis, and pulmonary edema. The more pesticide-toxic substances inhaled by a person, the higher content of these particles in the body. The high content of noxius particles in the body can also cause disorders of the nervus system such as chronic neuropathy. Pesticide toxicity is irreversible, but the risk of toxicity can be avoided by using PPE.[13] The use of PPE can prevent and reduce the occurrence of pesticide toxicity by reducing the risk of direct contact with pesticides so that the risk of pesticide toxins entering the body through the respiratory, digestive, and skin can be avoided.[16] The absence of a relationship between the length of work and symptoms of respiratory in farmers in Sukawana Village was possible because most farmers (90.3% respondent) have used PPE while working. In addition, other contributing factors such as age, type of pesticide, number of pesticides used, and frequency of different pesticides used also contributed to the results of this study. In this study, there was also no relationship between smoking status and respiratory symptoms. This is similar to previous studies that did not find an association between smoking status with the incidence of COPD in farmers in North Sumatra (p=0.29).[13] Smoking is one of the bad habits that can damage respiratory function. One cigarette contains 4000 types of substances that are harmful to the body. Toxins in cigarettes will accumulate in the body, especially in the lungs. The presence of this toxin substance will inhibit the exchange process of O2 gas with CO2 in the alveolus. This will certainly reduce the number of functional alveoli that play a role in the respiration process. Chronic exposure to cigarette smoke will cause inflammation in the airways and make pathological changes in the airways. Pathological changes are an increase in smooth muscle and connective tissue in the proximal airway, bronchiolitis obliterans and peribronchial fibrosis of the peripheral airway, luminal and inflammatory exudate of the peripheral airway, damage to the walls of the alveolus, and in vascular intimal thickening and endothelial dysfunction occur. As a result, there will be a decrease in the functioning of the pulmonary organs. This condition will geting worse as the number of cigarettes smoked increases.[17] The discrepancy between the results of this study and literature can be caused by the data obtained from interviews with respondents which were subjective, and the lack of accuracy of the data regarding the number of cigarettes smoked in a day. Researchers also did not consider other aspects of smoking habits such as the type of cigarette smoked, how to smoke cigarettes, and the length of time respondents had a smoking habit. In this study, there were differences in the mean of lung function (FVC (L/s), FEV1 (L) and FEF 25%-75% (L/s)) based on age. There were significant differences in the mean of FVC (L) for ages <42 years and >42 years (p=0.002). FVC was higher at the age <42 years. This is the same as previous studies, the relationship between age and the FVC of parking attendants on Jalan Pandanaran, which was obtained a significant negative relationship between age and the FVC.[13] The theory said that as a person ages, there will be a decrease in the function of the body's organs. This study also found a significant relationship between age and FEV1 and FEF values of 25% -75%. In this study, the FEV1 (L) and FEF values of 25%-75% (L/s) were better at ages ≤42 years than those at ≥42 years. VC (Vital Capacity), FVC, FEV1, FEV1/FVC, PEF (Peak Expiratory Flow), FEF25, FEF50, TLC (Total Lung Capacity), DLCO (Diffusing Capacity of Lung for Carbon Monoxide), and KCO (Carbon Monoxide Transfer coefficient) decreases with age.[18] RV (Residual Volume) and RV/TLC increase with age in both men and women, but FRC (Functional Residual Capacity) does not change. FEV1 and FVC values increase until age 20 in women and 27 years in men, then decrease in old age. The decline can occur more rapidly over 60 year old and remains stable throughout 60-90 year old.[18,19] The absence of a relationship between age and mean of FVC (%), FEV1 (%), FEV1/FVC and FEF 25-75 (%) can be caused by one of the less optimal maneuvers during spirometry examination. In addition, demographic factors and other biases must also be considered, such as a history of other exposures which did not assess in this study. We found that there was no relationship between lung function and length of work. Previous research who research about relation of length of work and the FVC of parking attendants on Jalan Pandanaran shows a significant relationship between the length of work and FVC with a strong and negative correlation.[17] A study of workers in pesticide packaging showed that compared with controls, workers exposed to pesticides had a significantly higher risk of developing respiratory disorders. Meanwhile, chronic exposure to pesticides such as organophosphates and carbamate has a risk of progressive decline in lung function to chronic obstructive pulmonary disease (COPD).[13,20] A study by Hernandez in Spain also showed that the FEV1/FVC ratio decreased in pesticide sprayers, indicating obstructive disorder. In a study by Beseler concerning the relationship between pesticide exposure and respiratory problems in

agricultural operators and their partners in Colorado, that pesticide exposure was associated with a decrease in FVC and FEV1, indicating a restrictive disorder, the risk of progressive decline in lung function to become COPD.[21] Each pesticide has a different pathological risk of respiratory disorders through specific mechanisms that are influenced by biochemical processes.[20] It can be one factor that influences this study's results. The difference between the results of this study and the theory was thought to be caused by several things, the spirometry maneuvers of the respondents who were not optimal, the presence of other confounding factors, such as exposure history, which were not taken into account in this study, and ethnic and environmental factors also had an effect. We did not found a difference in the lung function with smoking status; it can be seen that the FVC (L) and FEF 25-75 (L/s) values were higher in smokers compared to non-smokers. The results of a similar study were also shown in Thailand in 2014; the average FVC value in the smoker group was 3.07±0.68, and non-smokers were 2.68±0.62 litres.[21] In theory, smoking can affect lung function. Smoking has a detrimental effect on the respiratory and cardiovascular systems. A cross-sectional study by researchers Nadeem et al on 400 male subjects in India, showed a very significant decrease in the FEV1 value correlated with the length of the smoking habit.[22] The result of this study was not following the theory, possibly due to bias in the subjective assessment of the respondents; besides that, it is likely due to differences in age, exercise habits, duration and type of cigarettes consumed, as well as the respondent's BMI which was not carried out during data collection. This research was a series of studies that describe the characteristics of respiratory symptoms and lung function based on specific exposures in Bali, thus later, it is hoped that it can become one of the primary studies for others. There were several weaknesses in this study; the data obtained from the subjective statements of respondents so that the potential for information bias can occur; farming activities that are not only related to a single exposure in the form of pesticides that can affect research results.

Limitations

There were several limitations of this study. First, we used subjective data in this research for several information, such as, history of chronic respiratory symptom, smoking history, and general precaution used while working, thus it would give potential information bias from data resource. Second, multiple exposure sources of farmer beside pesticide also could be influenced this study result.

CONCLUSION

It can be concluded farmers who exposed to pesticides in Sukawana Village, Kintamani District, Bangli, dominant never experienced chronic respiratory symptom such as wheezing, chest thighnest when breathing, coughing, and chest pain for the last 12 months. Spirometry results showed normal values of FEV1, FVC, FEV1/FVC, and FEF 25% -75%. Age is significantly related to wheezing. Older people have significantly lower mean of FVC (L), FEV 1(L), and FEF 25-75% (L/s) than younger people.

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