



Developing Comprehensive Prevention Strategies Towards Reducing Occupational Disease Among Sulfur Miners in Ijen Crater Eastern Java

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ABSTRACT

Background : High prevalence of occupational disease among sulfur miners in Ijen Crater, Eastern Java has been rising for the last ten years. It has been reported from [8] that there are at about 53,1 % among sulfur miners struck from pharyngitis, and 30% of getting respiratory disease every month caused by working process that contact with sulfur dioxide. Moreover, there were lack of knowledge among sulfur miners and their management especially about the importance of using personal protective equipment (PPE) during their working process [12]. However, comprehensive prevention strategies need to be done to cope with this condition. **Objective**: to develop prevention strategies that consists of primary prevention, secondary prevention and tertiary prevention can be used as an effective program against occupational disease of sulfur miners. **Methods**: This study was conducted in quantitative methodological approach with prospective study design. Sample used were 58 workers out from 280 sulfur miners in PT Candi Ngrimbi Banyuwangi in Ijen Crater Eastern Java. The sampling technique used were simple random technique. It has been done since September 2014 until June 2015. Multivariate analysis were used to assess the effectiveness of comprehensive prevention strategies to reduce the prevalence of occupational disease. **Result** : As a result, there are three prevention strategies were used in this research, namely primary, secondary, and tertiary prevention. Primary prevention consists of giving health promotion program to the workers, and also giving vitamin. Secondary prevention consists of early diagnosis. Then tertiary prevention covering the rehabilitation process. Those strategies were given to the respondents for eight months, and there were an effective effect of those strategies for controlling the occupational disease since those three variables have $p < 0,05$ based on the Paired T test result. **Conclusion**: Thus, from the result it can be recommended that the implementation of comprehensive prevention strategies need an immediate actions to control the occupational disease among workers.

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INTRODUCTION

Sulfur mining in Ijen Crater Eastern Java has been established since 1980, and it has been greatest sulfur mining in Indonesia that located in the active volcano [4]. Inside the crater of the Ijen volcano in East Java, which rises to 2,800m with a crater of over 200 metres deep and nearly one kilometre wide and filled with sulphuric acid, miners hammer out a living in the noxious sulphur fumes which expose them to a high risk of respiratory disease [3]. Also, there a high prevalence of occupational disease among giving health education for them since there are at about 53,1 % among sulfur miners struck from pharyngitis, and 30% of getting respiratory disease every month caused by working process that contact with sulfur dioxide [8]. Sulfur dioxide, even inhaled in low level for long period, can caused inflammation on respiratory tract in which caused higher risk of getting infection on respiratory tract, cardiovascular disorder, and it can leads to death [2]&[5]. It caused by sulfur dioxide inhibit cytochrome oxidase enzyme as a oxygen producer, then the anaerobic metabolism caused the accumulation of lactate acid, that affect on neuron transmitter and respiratory system failed on doing the oxidation process which leads for sudden death [17]. Moreover, lack of knowledge among workers neither their management about the importance of using the personal protective equipment (PPE) during working

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process has been worsening their health conditions. However, with all of those problems, it has not been done any kinds of health preventions to cope with those problems [8]

Health prevention is one of the strategies that has an important role in controlling occupational disease [13]. Preventions includes a wide range of activities known as intervention in which aimed at reducing risks or threats to health. This is done by preventing exposures to hazards that cause disease or injury, altering unhealthy or unsafe behaviors that can lead to occupational disease such as respiratory disease in sulfur miners. It consists of three main action namely primary, secondary and tertiary prevention [3]&[13]. Primary prevention seeks to prevent the onset of specific diseases via risk reduction through giving health education program. While, secondary prevention refers to reduce the impact of a disease or injury that has already occurred, and this is done by detecting and treating disease or injury as soon as possible to halt or slow its progress. Tertiary prevention means softening the impact of an ongoing illness or injury that has lasting effect. Thus, in this study it will develop and assess the effectiveness of prevention strategies towards controlling occupational disease among sulfur miners in Ijen Crater Eastern Java.

Methodology:

Methodological approach and methods:

This is quantitative methodological approach with prospective study design. It has been done since September 2014 until June 2015. Questionnaire methods used in this study in order to identify not only the exposure onto sulfur dioxide, social factor, and occupational disease, but also to develop the prevention strategies. There are two kinds of questionnaire were used in this research. Both were validated questionnaire in which the former identified the exposure onto sulfur dioxide, social factor, and occupational disease, while the latter one identified the effect of preventive strategies for the workers.

Sampling method:

Population of this study were 280 sulfur miner of PT Candi Ngrimbi Banyuwangi Eastern Java. While, sample used were 58 workers with simple random sampling technique.

Identification of Sulfur dioxide, social factor and Occupational disease:

It started with getting letter of acceptance from PT Candi Ngrimbi Banyuwangi to start this research, then it continued with data collecting process for: exposure level of sulfur dioxide (using sulfur dioxide detector), social factor and occupational disease of the worker (both were assessed by questionnaire).

Developing Prevention Strategies Toward reducing occupational disease:

Literature review from journal were used to develop these strategies with key words were prevention strategies (primary, secondary and tertiary prevention) with occupational health nursing approach. Later, it continued to build a model for prevention strategies then applied it for eight month. After that, all of the respondents given questionnaire to assess the effectiveness of these prevention's model.

Data Analysis:

All of data collected were analysed by univariate, bivariate using Paired T Test.

RESULTS AND DISCUSSION

1. Identification of sulfur dioxide exposure level:

Exposure level of sulfur dioxide were arranged based on parameters, namely: time of exposure, frequency, and concentration. Low exposure level were called by time of exposure < 5 years, frequency <8 hours/day, and concentration <10ppm /14.000 $\mu\text{g}/\text{m}^3$. While, high exposure level refers to by time of exposure > 5 years, frequency >8 hours/day, and concentration >10ppm /14.000 $\mu\text{g}/\text{m}^3$ [3].

Table 1: Identification of Sulfur dioxide's exposure for Sulfur Miner Eastern Java 2015.

No.	Exposure Level	Frequency	Percentage
1	Low Exposure Level	24	41.4%
2.	High Exposure Level	34	58.6%
	Summary	58	100%

High exposure level of sulfur dioxide is really dangerous for sulfur miner's health yet it can caused by obstruction and respiratory tract restriction and it can lead to sudden death. Otherwise, workers that expose to low exposure level for longer time still have risk of stricking of shortness of breath and respiratory tract infection. The severity and prognosis level depends on sulfur dioxide's dose that inhaled by workers during their working time and for sure it influences on their respiratory health[14] [15].

Sulfur dioxide (SO₂) is one of a group of highly reactive gasses known as oxides of sulfur. The largest sources of SO₂ emissions are from fossil fuel combustion at power plants (73%) such as sulfur mining industries[17]. Current scientific evidence links short-term exposures to SO₂, ranging from 5 minutes to 24 hours, with an array of adverse respiratory effects including bronchoconstriction and increased asthma symptoms [3]. These effects are particularly important for asthmatics at elevated ventilation rates.

2. Identification of Social Factors:

Identification of workers' social factor were organized based on age, working time, exposure time, and wages.

Table 2: Social factor of Sulfur Miners in Eastern Java 2015 (n=58).

No.	Social Factors component	Score				
		Mean	Median	Standart Deviasi	Minimum	Maximum
1.	Age	40,3	40,5	4,2	32	50
2.	Working period (years)	8	7	6	1	30
3.	Working time (hours /day)	8,5	8	0,9	7	10,5
4	Wages (per month)	40	43		30	55

Based on the result above, it showed that the average age of the workers is 40-yo 3 mo with the youngest is 32 -yo , and the oldest 50-yo. While, most of workest have been working in sulfur mining for 8 years, with the longest period is 30 years and newest is 1 year. Then, most of the worker have been working for 8,5 hour per day and mostly they earn \$40 per month. Age is one of the physiologic factor that affect person's susceptibility against respiratory disorder since a person who aged more than 40-yo have a greater susceptibility of getting lung disease than younger ones[6]. As [16] reported that age have an important influence for lung development, yet as getting older, it impacted on reducing lung capacity. Surely, it will influence on person's capability on doing his job. Person's working period determining how long he exposed into environmental hazard, and it means working period is one of factors that predispose of having occupational disease. The longer working period means higher risk of getting exposed into environmental hazard in which means higher risk of battered from occupational disease[7]. Moreover, the longer time exposure onto environmental hazard (sulfur dioxide) also force on getting respiratory disease such as bronchitis, pharyngitis, emphysema, and lung cancer[11] [9] . Other researcher also informed that normally working time per day is 8 hours, and if there are conditions that make someone working more than normally, it means he gets into higher risk of being exposed into environmental hazards, such as sulfur dioxide, and it can easily leads into occupational disease[1].

On the other hand, people with low economic level tends to work overlimit since they need more money to earn for their life. Thus, they tend to ignore for their health. Therefore, it need special health strategies arranged for them in order to increase their awareness especially about actions need to be done to prevent from occupational disease [10].

Another social factor needs to be examine is related to smoking behavior. Based on the table 3, as mention below, most of the sulfur miner have smoking habitual for 92%. Smoking caused changes in the airway's structure. Smokers, who consumes cigarette two packs a day, are having bigger risk for shortening their life 0,9 years than smoker who consumes 2 cigarette per day [9]. Moreover, sulfur miner who has smoking behavior tend to have respiratory disorder rather than non-smoker [3].

Table 3: Smoking Behavior among Sulfur Miner Eastern Java 2015 (n=58).

No.	Category	Frequency	percentage
1	Smoking	52	92%
2.	Non smoking	6	8%
	total	58	100%

3. Occupational disease:

Occupational disease identification among sulfur miner can be seen from table 4. There are several kinds of occupational disease namely shortness of breath, pharyngitis, bronchitis, and rhinitis.

Table 4: Occupational disease among sulfur miner Eastern Java 2015 (n=58).

No.	Occupational Disease	Frequency	Percentage
1.	Shortness of breath	37	58%
2.	Pharyngitis	31	53%
3.	Bronchitis	22	42%
4.	Rhinitis	16	28%

Most of occupational disease suffered by sulfur miner are related with airway disorder, namely shortness of breath, pharyngitis and bronchitis. It caused by exposure into sulfur dioxide which inhaled by workers during

their working time. said respiratory disorder happened when toxicant gas (sulfur dioxide) breath in by sulfur miner, then it followed by acute symptom that appear within second such as rapid coughing as a response for tracheobronchial effect. If it happened within a days it can leads to contraction of breathing airways that can make shortness of breath, and also pharyngitis[18]. Furthermore, it also reported sulfur dioxide exposure with concentration around 6-12 ppm will make immediate irritation on nose and pharynx [3]. Sometimes they feels “burning sensation” in the respiratory tract when they contact with sulfur dioxide [6].

4. Developing prevention strategies to control occupational disease among sulfur miner:

Developing prevention strategies are based on three kinds of prevention, such as primary prevention, secondary prevention, and tertiary prevention. The details of each strategies to control occupational disease among sulfur miner have been described further below.

Table 5: Comprehensive Prevention Strategies to control occupational disease for Sulfur Miner Eastern Java 2015.

Primary Prevention		Secondary Prevention		Tertiary Prevention		
Health Promotion	Health Protection	Early Diagnosis	Prompt Treatment	Rehabilitation	Primary prevention	
					Health Promotion	Health Protection
Giving occupational health and safety education	Distributing food supplement with vitamin	Doing early screening through General Check Up with Laboratory in Banyuwangi	Giving education for the workers' family through booklet given about the occupational disease	follow up program for diagnosis of occupational disease through reassessing occupational health and safety risk	facilitates Personal Protective equipment (PPE) in coordinations with management	giving vitamin and food supplement
Giving personal protection equipment and socialisation about its importance		Doing referral especially for the worker who has health problem to the primary health care center				
Distributing leaflet that support this health promotion program						

Based on the informations above, primary prevention aims to prevent occupational disease before it occurs [3]. It has been done through two strategies, namely health promotion and health protection program. In the health promotion program, our actions is by giving occupational health and safety education and personal protection equipment (PPE) needed to the workers by coordination with management, and also through distributing leaflet that support with this program. While, health protection program has been implemented through distributing food supplement and vitamin C to the workers every two months.

Then, secondary prevention aims to reduce the impact of a disease or injury that has already occurred. This is done by detecting and treating disease as soon as possible to halt or slow it progress encouraging personal strategies to prevent reinjury or recurrence, and implementing programs to return people to their original health and function to prevent long-term problems [6]. This strategies has been realized through several programs such as: Doing early screening through General Check Up in Laboratory in Banyuwangi, and also giving referral especially for the worker who has health problem to the primary health care center in Ijen. Also, through giving education for the workers' family through booklet given about the occupational disease.

Last, tertiary prevention aims to soften the impact of an ongoing illness or injury that has lasting effect. It could be done through combinating rehabilitation strategies, and also doing primary prevention again [18]. In this program, it has been realized through not only giving follow up program for diagnosis of occupational disease through reassessing occupational health and safety risk, but also again facilitates PPE and give vitamin and food supplement for the workers.

All of these programs has been implemented intensively for eight months with loyalty and commitment from the management and workers as sample. After that, we do the post test to assess the effectiveness of this program with Pearson Correlation Test. The results has been shown below.

Table 6: Identification of Occupational Disease Before and After Prevention strategies being implemented.

Occupational Disease	Before Implementation	After Implementation	Range
Shortness of breath	58%	52%	6%
Pharyngitis	53%	50%	3%
Bronchitis	42%	38%	4%
Rhinitis	28%	26%	2%

Table 7: the Effectiveness of comprehensive prevention strategies towards reducing occupational disease among sulfur miner in Eastern Java 2015.

Paired T Test	p value = 0,035	Conclusion: p<a
	a = 0,05	

Based on both tables above, it shows that the implementation of prevention strategies has been reducing the percentage of occupational disease. Furthermore, it has been supported with the result of Paired T Test, with $p < a$. Thus, it can be concluded that implementation of comprehensive prevention strategies has been successfully reducing the number of occupational disease among sulfur miner in Eastern Java.

Conclusion:

High prevalence of respiratory disease suffered by sulfur miner in Eastern Java caused by several environmental hazard in their working places. Sulfur dioxide can be identified as one of the most risking factor that caused it. On the other hand, comprehensive prevention strategies, which combining primary, secondary, and tertiary prevention in one way, can be seen as one of the solution to solve this problem. Based on the implementation of these program intensively for eight months, there is positive result that it can positively reduce the number of occupational disease among them. However, to maintain its sustainability needs fully commitment from all of management staff and also workers to increase their obedience regarding the implementation of this program [10].

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