



## Risk Factors Analysis of Lime Dust Exposure with ARI Incidence on workers: Study in Limestone Burning Industry Margasari District, Tegal Regency, Central Java

Mirza Fathan Fuadi<sup>1\*</sup>; Onny Setiani<sup>2</sup>; Yusniar Hanani Darundiati<sup>3</sup>

<sup>1\*)2,3</sup>Master of Environmental Health, Faculty of Public Health, Diponegoro University, Indonesia

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### ABSTRACT

Limestone burning industrial activities have the potential to cause air pollution in the workplace in the form of lime dust. Limestone burning industry with a high level of limestone dust particles exposure could be risk factor for acute respiratory infections (ARI) on workers. Based on the preliminary study, it was found that 7 out of 10 workers were exposed to ARI felt symptoms such as coughing, shortness of breath, and sneezing during their work activities and supported by data from the Tegal Regency Environmental Service where the dust content around the industrial area exceeded the standard quality of 284  $\mu\text{g}/\text{Nm}^3$ . This study aimed to determine risk factors and analyze the relationship between lime dust exposure with the incidence of ARI in limestone burning workers in Margasari District, Tegal Regency, Central Java. This study used an observational method with a cross-sectional approach. The population of this study were 160 respondents with a sample of 60 respondents, were taken random sampling technique. Data analysis in this study used the Chi-Square test. The results of the analysis showed significant variables, namely total dust particulate content ( $p=0.048$ ), exposure to inhaled dust ( $p=0.031$ ), working period ( $p=0.046$ ), and use of personal protective equipment ( $p=0.034$ ). Variables that were not significant were length of work ( $p=0.906$ ) and smoking habits ( $p=0.319$ ). From this study, it can be concluded that respondents with exposure to inhaled dust above NAV ( $\geq 1 \text{ mg}/\text{m}^3$ ) high risk of experiencing acute respiratory infections (ARI). To prevent the occurrence of ARI, it is recommended to use complete personal protective equipment during the work process.

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#### Kata kunci:

Faktor Risiko  
Industri Pembakaran Batu Kapur  
Debu Kapur  
Debu Terhirup  
ISPA

#### \* ) corresponding author

Department of Environmental Health,  
Faculty of Public Health, Diponegoro  
University  
Jl. Prof. Soedarto No.1269, Tembalang,  
Kecamatan Tembalang, Kota Semarang, Jawa  
Tengah - Indonesia 50275

Email: mirzaff@gmail.com

### ABSTRAK

Kegiatan industri pembakaran batu kapur berpotensi menimbulkan pencemaran udara di tempat kerja berupa debu kapur. Industri pembakaran batu kapur dengan tingkat paparan partikel debu kapur yang tinggi dapat menjadi faktor risiko terjadinya Infeksi Saluran Pernapasan Akut (ISPA) pada pekerja. Berdasarkan studi pendahuluan diperoleh hasil bahwa 7 dari 10 pekerja terkena ISPA dengan gejala seperti batuk-batuk, sesak, dan bersin selama melakukan aktivitas pekerjaannya dan didukung data dari Dinas Lingkungan Hidup Kabupaten Tegal dimana kadar debu di sekitar area industri melebihi baku mutu sebesar 284  $\mu\text{g}/\text{Nm}^3$ . Penelitian ini bertujuan untuk mengetahui faktor risiko dan menganalisis hubungan antara paparan debu kapur dengan kejadian ISPA pada pekerja pembakaran batu kapur Kecamatan Margasari Kabupaten Tegal Jawa Tengah. Penelitian ini menggunakan metode observasional dengan pendekatan cross-sectional. Populasi penelitian ini sebanyak 160 responden dengan jumlah sampel 60 responden, menggunakan teknik random sampling. Analisis data dalam penelitian ini menggunakan uji Chi-Square. Hasil analisis

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menunjukkan variabel yang bermakna yaitu kadar partikulat debu total ( $p=0,048$ ), paparan debu terhirup ( $p=0,031$ ), masa kerja ( $p=0,046$ ), dan penggunaan APD ( $p=0,034$ ). Variabel yang tidak bermakna yaitu lama kerja ( $p=0,906$ ) dan kebiasaan merokok ( $p=0,319$ ). Dari penelitian ini dapat disimpulkan, bahwa responden yang memiliki paparan debu terhirup diatas NAB ( $\geq 1 \text{ mg/m}^3$ ) berisiko tinggi terkena gangguan saluran pernapasan akut (ISPA). Untuk mencegah terjadinya ISPA disarankan untuk menggunakan alat pelindung diri secara lengkap saat proses bekerja.

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## INTRODUCTION

Air pollution is currently considered the most serious environmental health risk in the world (Hassen et al., 2020). Data from World Health Organization shows as many as 4.2 million deaths each year occur due to exposure to ambient air pollution (World Health Organization, 2019). One of the causes of an increase in pollutants in the air is the increasing number of industries (Prabowo K, 2018). The progress of the industrial sector has many positive impacts. But on the other hand, the existence of industrial activities raises various problems. One of the resulting problems is air pollution (Baur et al., 2019).

Tegal Regency is one of the regencies in Central Java which has various kinds of industries. One of the industries in Tegal Regency is the limestone burning industry. The fuel used in burning limestone industry is in the form of firewood, oil sludge, plastic waste and others. From the process of burning limestone, it can produce smoke, where the dust particles in the smoke will produce various air pollutants. (Rohmawati & Andriyani, 2018).

The impact of exposure to hazardous materials such as dust pollutants in the limestone burning industry cause acute respiratory tract infections (ARI) (Hartanto & Fevria, 2017). According to World Health Organization, there are about 200,000 deaths annually due to air pollution in the workplace, of which 93% of cases are experienced by developing countries (Iyogun et al., 2019). The results of another study of the health problem profile of workers in Indonesia in 2014, found 40.5% of workers had health problems related to respiratory disorders. Then the number of cases of ARI every year in Indonesia is 15,000 cases or it can be said that someone dies every 5 minutes. (Fitriah & Juniati, 2010).

ARI is a disease that is commonly found in the Margasari District, Tegal Regency. Based on data obtained from the Margasari Health Center, Margasari District, Tegal Regency, in 2020 it shows that ARI was ranked second in the top 10 diseases in Margasari District, Tegal Regency with a total of 3,068 cases and in 2021 from January to February there were 342 cases of ARI in Margasari District, Tegal Regency (Dinas Kesehatan Kabupaten Tegal, 2020).

This study was conducted on the subject of limestone burning workers because stone burning workers are the population most vulnerable to the incidence of ARI. From the data on environmental quality monitoring activities by the Tegal Regency Environmental Service in Margasari District, Tegal Regency, it was obtained based on the Air Pollution Standard Index (ISPU) which was included in the category of very unhealthy pollution with a dust content of  $284 \mu\text{g}/\text{Nm}^3$  (Dinas Lingkungan Hidup Kabupaten Tegal, 2019). It is proven from the results of a preliminary study by conducting physical examinations and interviews with 10

limestone burning workers, found that 7 out of 10 (70%) workers were exposed to ARI felt symptoms such as coughing, shortness of breath, and sneezing during their work activities.

Seeing the increase in the incidence of ARI which is thought to be triggered by exposure to lime dust and considering the importance of health and the role of limestone burning workers, it is necessary to describe and analyze the practice of involvement in limestone burning activities and risk factors for limestone burning workers in the limestone industry in Margasari District, Tegal Regency. Therefore, the purpose of this study was to determine risk factors and analyze the relationship between lime dust exposure with the incidence of ARI in limestone burning workers in Margasari District, Tegal Regency, Central Java.

## METHOD

This study was a quantitative study using an analytical observational method with a cross-sectional approach. Cross-sectional study that measured the independent variables (total dust particulate content, exposure to inhaled dust, years of service, length of work, use of personal protective equipment (PPE), and smoking habits) and the dependent variable is the incidence of concurrent acute respiratory infections (ARI). The data collected are data from measurements of total dust particulate levels, temperature and humidity in the limestone burning industry, measurement data on inhalation of dust exposure and other variables, namely age, years of service, length of work, use of personal protective equipment (PPE) and smoking habits. ARI data collection by interview and physical examination by medical personnel. This design was chosen because the data was collected at one time.

The population in this study were workers in the limestone burning industry in Margasari District, Tegal Regency, Central Java, namely 160 people. The number of samples in this study was determined using the Lameshow formula, obtained as many as 60 people with inclusion criteria: willing to be research subjects and willing to do a physical examination related to ARI, male, limestone burning workers, respondent age between 20–45 years, and willing to participate in the research by filling out an informed concern. The sampling method in the study used random sampling technique.

Data analysis was performed using SPSS24 software. There are two stages of analysis, namely univariate and bivariate analysis. Univariate analysis was conducted to describe the distribution and frequency of the studied variables. These variables include total dust particulate content, exposure to inhaled dust, years of service, length of work, use of personal protective equipment (PPE), and smoking habits. In the bivariate analysis by conducting the

Chi-Square (X<sup>2</sup>) test which was carried out to analyze the relationship between the independent variable and the incidence of ARI with a value of = 0.05. The interpretation of the analysis is that if the p-value < 0.05 is obtained, it is concluded that there is a significant relationship between the variables, but if the p-value > 0.05 is concluded there is no significant relationship between the variables (95% confidence level).

## RESULTS AND DISCUSSION

The research location is in the limestone burning industry. This limestone burning industry is located in Margasari District, Tegal Regency, Central Java. This industry

has been operating since 1990. The area of land used in this industry is about 567 m<sup>2</sup>. This industry has several sections, namely the mining section, the burning section, the packaging section and the marketing section. The total number of workers working in this industry is around 200 workers. Every day the limestone burning industry can produce 2000 quicklime.

### Respondent Characteristics

Data Table 1 shows the characteristics of workers examined in this study were exposure to inhaled dust, working period, length of work, use of personal protective equipment (PPE) and smoking habits.

**Table 1.**  
**Distribution Frequency of Respondent Characteristic**

VARIABLES	F (Person)	Percentage%
Inhalation of Dust		
≥1 mg/m <sup>3</sup>	41	68.3
<1 mg/m <sup>3</sup>	19	31.7
Years of Service		
≥10 Years	47	78.3
<10 Years	13	21.7
Length of Working		
>8 Hours per day	21	35.0
≤8 Hours per day	39	65.0
Use of Personal Protective Equipment (PPE)		
Incomplete	43	71.7
Complete	17	38.3
Smoking Habits		
Yes	46	76.7
No	14	23.3

Source: primary data

The results from table 1 show that the respondents who had exposure to inhaled dust were above the NAV (>1 mg/m<sup>3</sup>) as many as 41 workers with a percentage (68.3%). Meanwhile, exposure to inhaled dust was below the NAV (<1 mg/m<sup>3</sup>) as many as 19 workers with a percentage (31.7%). Most of the respondents had exposure to inhaled dust above the NAV (>1 mg/m<sup>3</sup>), according to Putra in 2018, exposure to dust is dust particles that are inhaled by the public outdoors or indoors, exposure to dust can interfere with the respiratory tract of workers (Putra & Afriani, 2018).

In the variable period of service, 47 (78.3%) respondents have worked as new limestone kiln workers for 10 years and 13 (21.7%) have worked as limestone kilns for <10 years. The majority of workers have worked 10 years. The working period of limestone burning workers is related to the amount of accumulated dust exposure that enters the worker's body, the longer you are a limestone burning worker, the higher the risk of respiratory disorders due to dust exposure (Akili et al., 2017).

In the variable length of work, 21 (35.0%) respondents worked >8 hours per day and 39 (65.0%) respondents worked 8 hours per day. The length of exposure of workers in working every day includes the length of work that is at risk because the length of work recommended by the World Health Organization is no more than 5 hours a day (Hu et al., 2019).

In the variable of the use of personal protective equipment (PPE), 43 respondents (71.1%) did not fully use personal protective equipment (PPE). While as many as 17 respondents (28.3%) were fully equipped with personal

protective equipment (PPE). Personal protective equipment (PPE) is used by a person in carrying out his work, which is intended to protect himself from certain sources of danger both from work and from the work environment. This personal protective equipment is not perfectly able to protect the body but will be able to reduce the severity that may occur (Christina, 2017).

In the smoking habit variable, 46 respondents (76.7%) have a smoking habit. Meanwhile, as many as 14 respondents (23.3%) have a habit of not smoking. Most workers have a smoking habit, according to the theory of smoking habits can cause changes in the anatomy of the respiratory tract in smokers and can cause changes in lung function with all kinds of clinical symptoms (Milner, 2012).

### The Incidence of ARI in Workers

Physical examination of acute respiratory infections (ARI) in workers was assisted by doctors from the Tegal District Health Office. Based on Table 2, it can be seen that the results of the physical examination of Acute Respiratory Infections (ARI) in workers in the limestone burning industry. On physical examination of ARI, 42 workers (70.0%) were diagnosed with acute respiratory infection (ARI) and 18 workers (30.0%) were diagnosed not to have acute respiratory infection (ARI). The most common complaints suffered by workers in the stone industry are flu and cough, these respiratory complaints are the same as the guidelines from the Material Safety Data Sheet for limestone products,

it is explained that the acute and chronic effects of limestone or are cough, flu, and respiratory problems.

According to the guidelines of the World Health Organization that lime dust can cause respiratory complaints such as coughing, flu and tightness in the chest (WHO, 2011). This is in accordance with respiratory complaints experienced by workers in limestone burning industry, Margasari District, Tegal Regency, Central Java.

Acute Respiratory Infection (ARI) is an upper or lower respiratory tract disease that can cause a wide spectrum of disease ranging from asymptomatic disease or mild infection to severe and deadly disease, depending on the causative pathogen, environmental factors, and host factors. Based on the physical examination of the respondents by health

workers, of all the symptoms of acute respiratory infections (ARI) most experienced by workers are cough without rapid breathing, runny nose (removing mucus), hoarseness in the throat, and fever (Marniati & Yarmaliza, 2017).

The incidence of acute respiratory infections (ARI) in workers in dusty areas can be influenced by various factors. One of the factors that can be changed is the smoking habit. While the factors of acute respiratory infection (ARI) that cannot be changed, such as age and a history of respiratory disorders. Acute respiratory infections (ARI) can be prevented if self-control is carried out. Therefore, to prevent ARI, it is necessary to implement a healthy lifestyle, one of which is by reducing smoking habits in their daily lives (Yunus et al., 2020).

**Table 2.**  
**Distribution Frequency of Incidence ARI**

Incidence of ARI	F (Person)	Percentage%
ARI	42	70.0
No	18	30.0

Source: primary data

**Analysis of Risk Factors for Lime Dust Exposure with the Incidence of ARI**

Bivariate analysis was used to see the relationship between the independent variables (total dust particulate content, exposure to inhaled dust, years of service, length of work, use of personal protective equipment (PPE) and

smoking habits) with the dependent variable the incidence of ARI. The statistical test used was chi-square with p value <0.05 indicating a statistically significant relationship. The RP (prevalence risk) value of more than 1 is interpreted as a variable suspected of being a risk factor associated with the incidence of ARI.

**Relationship between risk factors and the incidence of ARI**

Risk Factors	Incidence of ARI						p value	RP (95% CI)
	ARI		No		Amount			
	F	%	F	%	F	%		
Total Dust Particulate Content								
≥230 µg/Nm <sup>3</sup>	35	77.8	10	22.2	45	100	0.048	1.667
<230 µg/Nm <sup>3</sup>	7	46.7	8	53.3	15	100		(0.949-2.927)
Inhalation of Dust								
≥1 mg/m <sup>3</sup>	37	77.1	11	22.9	48	100	0.031	1.850
<1 mg/m <sup>3</sup>	5	41.7	7	58.3	12	100		(0.931-3.677)
Years of Service								
≥10 Years	36	76.6	11	23.4	47	100	0.046	1.660
<10 Years	6	46.2	7	53.8	13	100		(0.903-3.048)
Length of Working								
>8 Hours per day	14	66.7	7	33.3	21	100	0.906	0.929
≤8 Hours per day	28	71.8	11	28.2	39	100		(0.647-1.332)
Use of Personal Protective Equipment								
Incomplete	34	79.1	9	20.9	43	100	0.034	1.680
Complete	8	47.1	9	52.9	17	100		(0.992-2.847)
Smoking Habits								
Yes	34	73.9	12	26.1	46	100	0.319	1.293
No	8	57.1	6	42.9	14	100		(0.796-2.101)

Source: primary data

**DISCUSSION**

**The Relationship between Total Dust Particulate Content and the Incidence of ARI**

Based on table 3 the results obtained, from 45 respondents who were exposed to total dust above the

quality standard (≥230 g/Nm<sup>3</sup>) there were 35 (77.8%) who experienced the incidence of ARI. The results of statistical tests prove that there is a significant relationship between total dust particulate levels and the incidence of ARI in limestone burning workers in Margasari District, Tegal Regency, Central Java (p-value = 0.048; RP = 1.667; 95% CI = 0.949-2.927) which means that limestone burning workers

exposed to total dust above the NAV has a risk of more than 1.6 times for ARI compared to limestone burning workers exposed to total dust below the NAV. The results of this study are related with Sholikhah's, et al in 2015, the results obtained that (90.6%) of respondents who were in a work environment with a maximum total dust content (above NAV) experienced respiratory complaints, when compared to respondents who were in a work environment with a minimum total dust content (below the NAV) only 9.4% experienced respiratory problems. The results of the Chi-Square test showed that there was a significant relationship between total dust content and respiratory problems experienced by workers ( $p=0.004$ ) (Sholikhah & Tualeka, 2015).

Dust particles in the workplace which are measured by calculating the total dust particulate content, can affect workers' breathing, because dust particles can float in the air for a certain period of time so that they are inhaled by the respiratory system during inspiration (Nuryati, 2017). According to a 2015 Qiro study, dust inhaled by the respiratory system will cause retention (dust is retained in the body) and cause irritation to the respiratory organs (Qiro, 2015).

From the results of the study, it is known that the working environment in the limestone burning industry, Margasari District, Tegal Regency, Central Java is generally very dusty, these dust particles can then be inhaled into the workers' bodies and can cause symptoms of respiratory tract infections (ARI) due to lime dust which is irritant to the human respiratory tract. Therefore, an automatic vacuum cleaner is needed to minimize dust particles floating in the air that have the potential to enter the worker's body during the limestone burning process (Armaeni & Widajati, 2017).

### **The Relationship of Inhaled Dust Exposure with the Incidence of ARI**

Based on table 3 the results obtained, from 48 respondents who were exposed to inhaled dust above the NAV ( $\geq 1$  mg/m<sup>3</sup>) there were 37 (77.1%) respondents who experienced the incidence of ARI. The results of statistical tests prove that there is a significant relationship between exposure to inhaled dust and the incidence of ARI on workers limestone burning industry in Margasari District, Tegal Regency, Central Java ( $p$ -value = 0.031;  $RP = 1.850$ ; 95%  $CI = 0.931-3.677$ ), which means that limestone burning workers exposed to inhaled dust above the NAV ( $\geq 1$  mg/m<sup>3</sup>) had a risk of more than 1.8 times for ARI compared to limestone burning workers exposed to inhaled dust below the NAV ( $< 1$  mg/m<sup>3</sup>). This result is in line with Anjani's, et al in 2018, from 30 respondents, 19 (82.6%) respondents experienced impaired lung function in workers who were in the work environment with dust levels exceeding NAV ( $\geq 1$  mg/m<sup>3</sup>), when compared to workers who are in a work environment with dust levels below the NAV ( $< 1$  mg/m<sup>3</sup>), there are only 2 (28.6%) respondents who have impaired lung function. The results of statistical tests showed a significant relationship between total dust levels and impaired lung function in workers ( $p=0.014$ ) (Anjani, 2018).

Dust can cause respiratory tract disorders both acute and chronic (Chew et al., 2010). Exposure to inhaled dust can irritate the respiratory tract of workers. ARI can occur when the human respiratory tract is often exposed to increasing amounts of dust so that the cilia will constantly emit dust. Over time, the cilia will become irritated and desensitized so that the dust is susceptible to respiratory tract infections (Juwita & Is, 2015).

From the results of field observations, it was found that in general, limestone burning workers in Margasari District, Tegal Regency, mostly inhaled dust during the combustion production process. During the combustion process, the distance between the furnace and workers is very close coupled with the number of workers who do not use personal protective equipment (PPE) in the form of masks, it is strongly suspected that workers have a high risk of getting acute respiratory infections (ARI). Therefore, there is a need for socialization from the Tegal District Health Office regarding the importance of using masks at work and masks used at work must be in accordance with the criteria set by the Ministry of Health of the Republic of Indonesia. (Ferguson et al., 2020).

### **The Relationship of Working Period with the Incidence of ARI**

Based on table 3 the results obtained, from 47 respondents who had a working period of 10 years, there were 36 respondents (76.6%) who experienced the incidence of ARI. The results of statistical tests prove that there is a significant relationship between years of service and the incidence of ARI on workers limestone burning industry in Margasari District, Tegal Regency, Central Java ( $p$ -value = 0.046;  $RP = 1.660$ ; 95%  $CI = 0.903-3.048$ ) which means that limestone burning workers who having a working period of 10 years has a 1.6 greater risk of getting ARI compared to limestone burning workers who have a working period of  $< 10$  years. The results of this study are related with Noer's, et al in 2013 on "The relationship between worker behavior and ARI symptoms in the phosphoric acid factory, production department III PT. Petrokimia Gresik" which shows that there is a relationship between years of service and symptoms of ARI in workers with a value ( $p$  value = 0.017). The equation with Noer's research in 2013 is that the respondents used are workers who are in the production process (Noer & Martiana, 2013).

These results indicate, in accordance with the theory which states that the longer people work, the greater the risk of occupational diseases (Darmawan, 2015). From interviews and field observations, the majority of limestone burning workers have worked for more than 10 years. This figure can be interpreted that the limestone burning industry is a permanent job for limestone burning workers in Karangdawa Village, Margasari District, Tegal Regency and is likely to continue as long as they are still able to run it. During these 10 years, limestone burning workers were exposed to dust as a result of the combustion production process. The working period of more than 10 years for limestone burning workers causes more exposure to lime dust that enters the body.

The longer the limestone burning workers carry out burning activities and it occurs continuously, the higher the risk of experiencing respiratory problems caused by the entry of hot and irritating limestone dust (Sandra C, 2013). Therefore, to reduce the risks that may be caused by exposure to dust, workers should limestone burning which has a service life of more than 10 years requires adequate rest and not too long in the combustion industry when finished working. The owner of the kiln can set a work shift schedule for limestone kiln workers aged over 30 years with a working period of more than 10 years, thereby reducing the risk factor for acute respiratory infections (ARI) in limestone burning workers.

### **The Relationship of Length of Work with the Incidence of ARI**

Based on table 3 the results obtained, from 21 respondents who had a working length of > 8 hours per day, there were 14 respondents (66.7%) who experienced the incidence of ARI. The results of statistical tests prove that there is no significant relationship between length of work and the incidence of ARI on workers limestone burning industry in Margasari District, Tegal Regency, Central Java (p-value = 0.906; RP = 0.929; 95% CI = 0.647-1.332) which means that the length of work is not a protective factor for the incidence of ARI. The results of this study are related with Irjayanti's, et al in 2013 which said that the length of working hours does not mean that the exposure is also getting bigger. The results of observations and interviews in the field show that, although the working hours are the same between one worker and another, the dose of exposure that enters the worker's body is different according to the location of the worker and the completeness of the use of personal protective equipment (Irjayanti et al., 2012).

The longer working hours in a day, the greater the amount of dust that enters the worker's body, dust will accumulate in several working days for one week and accumulate over a longer period of time (Tria, 2018). The occurrence of respiratory tract disorders in workers is not only influenced by the level of concentration received per day during working hours, it is also influenced by the length of time the pollutant is exposed to workers (Herdianti et al., 2018).

From the results of interviews and field observations, it was found that 39 (65.0%) stone burning workers worked less than 8 hours per day. Although it is found that many workers work less than 8 hours per day, there are still some workers who work more than 8 hours per day, with the reason to increase daily income. Therefore, for workers who choose to work more than 8 hours per day, it is hoped that they can arrange a schedule for rest, at least 1 hour before returning to their activities in the limestone burning industry, especially for workers who have a history of respiratory problems (Susanti & Faisya, 2021).

### **The Relationship between the Use of Personal Protective Equipment with the Incidence of ARI**

Based on table 3 the results obtained, from 43 respondents who used incomplete personal protective equipment (PPE) there were 34 respondents (79.1%) who experienced the incidence of ARI. The results of statistical tests prove that there is a significant relationship between the use of personal protective equipment (PPE) and the incidence of ARI on workers limestone burning industry in Margasari District, Tegal Regency, Central Java (p value = 0.034; RP = 1.680; 95% CI = 0.992-2.846) which means Limestone burning workers who work using incomplete personal protective equipment (PPE) have a risk of more than 1.7 times for ARI compared to limestone burning workers who work completely using personal protective equipment (PPE). This study are related with research conducted by Lantong, et al in 2017 on factors related to the incidence of ARI among rice mill workers in Wononggere Village, Polinggona District, Kolaka Regency in 2016 with the results of research from 48 respondents there were 29 with a percentage of 60.4% of respondents incomplete in using personal protective equipment. After analyzing the data, it was concluded that there was a relationship between the use

of personal protective equipment and the incidence of ARI (p value = 0.000) (Lantong et al., 2017).

These results indicate that one of the main factors in dust exposure is the complete use of personal protective equipment (PPE) and someone who does not use complete personal protective equipment (PPE) when carrying out limestone burning activities can increase the exposure that enters the body causing an impact. acute and chronic health (Chughtai & Khan, 2020).

From the results of interviews and observations in the field, obtained from 60 respondents there are 43 (71.7%) using incomplete PPE, respondents are incomplete in using personal protective equipment (PPE) when working, because respondents feel uncomfortable when wearing all the completeness of PPE, and feel disturbed when carrying out the activities of the limestone burning process. This has a high potential for acute respiratory tract disorders (ARI) due to exposure to dust from various routes of entry, namely through breathing, mouth, or skin. For this reason, limestone burning workers should use complete personal protective equipment (PPE) consisting of 7 types, namely: long sleeves, long pants, masks, head coverings (hats), glasses, gloves and boots. Avoid direct contact with dust during the combustion process. (Baratawidjaja, 2011) (Olry de Labry-Lima et al., 2021).

### **The Relationship of Smoking Habits with the Incidence of ARI**

Based on table 3 the results obtained, from 46 respondents who had a smoking habit there were 34 respondents (73.9%) who experienced the incidence of ARI. The results of statistical tests prove that there is no significant relationship between smoking habits and the incidence of ARI on workers limestone burning industry in Margasari District, Tegal Regency, Central Java (p-value = 0.319; RP = 0.929; 95% CI = 0.647-1.332), which means that smoking is not a risk factor for the incidence of ARI. These results are in line with research conducted by Apsari in 2018 shows that smoking has no relationship with the incidence of respiratory disorders, but in theory it has a relationship with lung conditions which can lead to health problems if the lung condition is damaged and if they continue to smoke and workers who have smoking habits can have a risk or subjective complaints. respiratory tract and pulmonary ventilation disorders in workers (Laeila, 2014).

These results indicate that limestone burning workers in Margasari District, Tegal Regency, Central Java, who have a smoking habit or do not have a smoking habit, do not directly affect the danger due to acute respiratory infections (ARI). Smoking is one of the factors for the incidence of ARI. The duration of smoking and the amount of cigarette consumption had a significant relationship with the prevalence of ARI, asthma, pneumonia, and heart disease (Sapta Wardana et al., 2020). The results of this study are supported by the theory which states that cigarette side smoke has a worse toxic effect than the main smoke, especially in causing irritation of the respiratory tract mucosa and increasing the tendency to get ARI (Muliadi, 2015).

Based on the results of observations and interviews in the field, it was found that respondents who smoked had varying frequencies. In the limestone kiln industry, there are no designated smoking areas and no smoking restrictions, making it easier for workers to smoke when they take a break or after eating while waiting to resume their work activities. Therefore, to reduce the risk of workers against the

incidence of ARI, it is expected that workers can eliminate smoking habits, carry out regular health checks, and maintain healthy lifestyles such as exercise and adequate rest (Suwanto, 2018).

## CONCLUSIONS AND SUGGESTIONS

The results of the study obtained several variables that were risk factors and related to the incidence of ARI in limestone burning workers, Margasari District, Tegal Regency, Central Java, including total dust particulate content, exposure to inhaled dust, working period and use of personal protective equipment (PPE). While the variables that are not related to ARI in workers are the length of exposure and smoking habits. The biggest risk factor for exposure limestone dust to the incidence of acute respiratory infections (ARI) is exposure to inhaled dust, where workers limestone burning industry exposed to dust above NAV ( $\geq 1$  mg/m<sup>3</sup>) have a 1.8 times greater risk of experiencing acute respiratory infection (ARI). Limestone burning workers who have exposure to inhaled dust above the NAV are expected to be able to use complete personal protective equipment consisting of 7 types, namely: long sleeves, long pants, masks, head coverings (hats), glasses, gloves and boots to avoid direct exposure to dust during the working process.

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## Conflict of Interest Statement

The authors declared that no potential conflicts of interest with respect to the authorship and publication of this article.

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