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RESEARCH ARTICLE

THE DUST CONTENT ANDUPPER RESPIRATORY TRACT INFECTIONS RISK ON C-CATEGORY QUARRY WORKERS IN WATUSAMPU VILLAGE, ULUJADI SUB-DISTRICT, PALU CITY

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ABSTRACT

The C-Category Mines, in the form of rocks and soil, is one type of mines of which management authority is carried out by the local government. The C-category quarry does indeed provide benefits in the form of employment and contributions to certain parties, but the mining activities conducted within produce dust that can have a negative impact on the environment and health in the form of air pollution that causes Upper Respiratory Tract Infections (URI) in workers. The purpose of this study was to determine the total dust content and the relationship between working hours, the use of Personal Protective Equipment, and workers' knowledge on the risk of URI in C-category quarry. This study was categorized as quantitative study with a *cross sectional study* approach. There were 76 workers of C-category quarry in Watusampu Village as the sample of study. The sampling was conducted by using *simple random sampling* technique. The data were analyzed using *chi-square* test. Total dust content was measured at two points using the LVS (*Low Volume Sampler*) tool. The measured total dust content was determined gravimetrically. The results showed that total dust content at both sampling points exceeded the Threshold Limit Value of Chemical Substances contained in the air at the workplace which was 125 mg/m^3 at sample point I and 140,6 mg/m^3 at sample point II. Threshold Limit Value for total dust content contained in the air at the workplace was 10 mg/m^3. There is no relationship between working hours (ρ=1,000) and the risk of URI in workers, there is a relationship between the use of mask as a PPE (ρ=0.030) and workers' knowledge (ρ=0.012) and the risk of URI in C-category quarry workers which can cause negative impact on the environment and the health of workers.

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INTRODUCTION

The C-category quarry does indeed provide benefits in the form of employment and contributions to certain parties. Class C mining of mining material provides benefits in the form of employment and contributions to certain parties. However, it also has some negative impact, especially for the workers Workers have the potential to health problems which requires special treatment efforts, both at workplace and in the health service unit. Occupational health problems often cannot be cured that can cause disability even death, so that the main principle in providing health services for workers is to prevent health problems (Sholihah *et al*., 2008). Construction is one of the largest employments where workers are exposed to dust which employs about 6% of the workforce in Denmark. The incidence of respiratory diseases at workplace work reported by the *National Board of Industrial Injuries* in Denmark recorded 660 cases each year. In 2013, about 127 (19%) cases were reported to occur on construction workers related to dust, fiber, smoke, and pollution, but only a few workers received compensation as occupational diseases (Jessing, 2015). Based on data from the *International Labor Organization* (ILO), 34% occupational fatality was caused by cancer, 25% by accidents, 21% by respiratory diseases, 15% by cardiovascular diseases and 5% by other factors (Hafsari *et al*., 2015).

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The 2013 Riskesdas stated that most provinces in Indonesia had a decrease in the *period prevalence* of URI in 2013 compared to 2007. The decrease in the *period prevalence* of URI in Indonesia in 2013 was 25%, not much different from 2007, which was 25,5%. The Upper Respiratory Tract Infections (URI) is one of the most common diseases in healthcare services, including in Central Sulawesi. URI is spread throughout the Province of Central Sulawesi with a highly varied prevalence (18,8% to 42,7%). The prevalence of URI in a month can reach 28,4%. The prevalence is more than 30% found in 5 Regencies/Cities, one of which is the Palu (31,6%) (Badan Penelitian dan Pengembangan Kesehatan, 2009). In general, the highest disease rate found in the Community Health Center of Watusampu, Palu, where the C-category quarry located, based on the report of Community Health Center in 2008 was another acute infection in the upper respiratory tract which amounted to 59.462 cases (41,26%). While the third highest disease pattern is another disease in the lower respiratory tract which is 13.689 cases (9,49%) (Halim, 2012). This study wanted to find out the factors related to the incidence of URI in C-category quarry in Palu.

MATERIALS AND METHODS

This research is a quantitative research with a *cross sectional study* approach. It was conducted on May 8 - June 26, 2016. It was conducted in Watusampu Village, Ulujadi Sub-District, Palu. The population was 311 people and the Sampling was conducted using *Simple Random Sampling* with a total of 76 respondents.

Operational Definition and Objective Criteria: Upper Respiratory Tract Infection (ARI) is a group of infectious diseases that attack the respiratory system sufferred by the workers. The symptoms of URI occur in a short period of time, which is only several hours to several days. Risk: if the respondents have the symptoms of fever and one of the symptoms of cough, sore throat, nasal congestion, wheezing or breathing difficulties. Working hours is the amount of exposure time for workers during the time the workers are in the work environment, calculated according to their working hours at the workplace. Risk: If the respondents work for > 8 hours a day. The use of Personal Protective Equipment (PPE) is a preventive effort that can be done by workers to avoid occupational accidents or diseases. Risk: if the respondents do not wear PPE. Knowledge, is the result of the process of finding the truth in a matter after sensing a particular object, such as, knowledge about URI. Knowledge is also a guide in directing the actions of workers. Risks: If the respondent's answer is < 50%.

Data Collection: Primary data were obtained from observations and interviews conducted with people who work in C-category quarry in Watusampu. The primary data were collected using a questionnaire to describe the variables studied. The independent variables were the working hours, the use of personal protective equipment and the workers' knowledge URI which were obtained by using interview on the questions listed on the questionnaire. The dependent variable was the risk of Upper Respiratory Tract Infections (ARI) measured by anamnesis method which is only limited to asking for respiratory complaints and not to establish a diagnosis of URI in the respondents (Hikmawati, 2013). The data about total dust content in the air was obtained using gravimetric analysis method.

This method is an analytical method based on weight measurements involving the formation, isolation and measurement of the weight of a sediment by inhalling and passing air in a certain volume through a glass fiber filter/filter paper. Total dust weight measurement was done using *Low Volume Sample* (LVS). The following is the procedures of measuring total dust content using the *Low Volume Sample* (LVS) based on SNI 16-7058-2004 regarding the measurement of total dust content in the air:

Principles: Total dust content measured was determined gravimetric method. The LVS was placed at a measurement point as high as the respiratory zone. Sampling was carried out for 8 hours to find out the average concentration of total dust content in the air.

Procedures: The first filter is stored in the desiccator for 24 hours to get a stable condition.The stored filter is weighed using an analytical scale (sensitivity of 0,01 mg) until obtaining constant weight, record the results of the filter weight and then store it in a closed container.than the filter is put into the *Low Volume Sampler holder* using tweezers and cover the top of the *holder*. Next step LVS is placed at the measurement point with a level that is evenly distributed with the respiratory zone.The air suction pump is turned on with air flow rate of 2 lpm.Turn off the pump at the specified time limit. After finishing sampling, dust on the outside of the *holder* is cleaned to avoid contamination, than the filter is transferred using tweezers to a closed container.The filter is weighed again and the results of weighing are recorde, so that the weight of the filter after measurement is obtained.

Total dust content in the air is calculated using the following formula:

$$C = \frac{(\text{Weight of Filter B} - \text{Weight of Filter A})}{(Q \times t)} x10^3 (mg/m^3)$$

Notes:
Weight of Filter A : weight of filter paper before sampling (mg)
Weight of Filter B: weight of filter paper after sampling(mg)
Q: volume of inhaled air (lpm)
t: measurement time (minute)

RESULTS

Total Dust Content: The environmental conditions observed include total dust content in the air at the workplace and the air temperature in the C-category quarry environment. Temperature measurement was conducted to determine the environmental conditions when taking dust samples. Measurements were carried out at two points located at the workplace of C-category quarry in Watusampu Village, Ulujadi Sub-District, Palu. The observations of these environmental conditions can be seen in the Table 1. Table 1 shows that the total dust content at both sampling points exceeds that of the Threshold Limit Value of Chemical Substance in the air of the workplace which is 125 mg/m^3 in sampling point I and 140,6 mg/m^3 in sampling point II. The Threshold Limit Value for total dust content in the air of the workplace is 10 mg/m^3. Based on guidelines for measuring total dust content in the air issued by the Indonesian National Standard in 2004, there is a need to measure the air temperature to determine environmental conditions when taking dust samples, so that the results are given in accordance

Table1. Results of Total Dust Content Measurement in C-Category Quarry in Watusampu Village, Ulujadi Sub-District, Palu

Sampling Point	Weight of Filter		Results of Total Dust Content Measurement (mg/m^3)	NAB (mg/m^3)	Information
	Before Sampling (mg)	After Sampling (mg)			
Point I	818	938	125	10	> NAB
Point II	797	932	140,6	10	> NAB

Table 2. The Relationship between Working Hours, the Use of PPE, Knowledge, and URI Incidence Risk

		URI Incidence Risk				Total		*ρvalue*
		URI Risk		Non URI Risk				
		n	%	n	%	n	%	
Working Hours	> 8	6	37,5	10	62,5	16	100	1,000
	≤ 8	24	40	36	60	60	100	
The Use of PPE	No	16	57,1	12	42,9	28	100	0,030
	Yes	14	29,2	34	70,8	48	100	
Knowledge	Low	16	57,1	12	42,9	28	100	0,012
	High	14	29,2	34	70,8	48	100	
Total		46	60,5	30	39,5	76	100	

with the conditions of the workplace environment at the time of measurement. The following is a table of measurements of air temperature at both sampling points. Table 2 showed that there are 16 respondents (21,1%) with working hours of > 8 hours/day, and 6 respondents (37,5%) are at risk of URI, while 10 other respondents (62,5%) are not at risk of URI. Furthermore, 60 respondents (78,9%) have working hours of ≤ 8 hours/day and 24 respondents (40%) are at risk of URI, while 36 other respondents (60%) are not at risk of URI. Based on *Chi Square* statistical test, the results of the analysis showed that the value of $\rho > 0,05$, means that there was no relationship between the working hours and the risk of URI in C-category quarry workers. Table 2 shows that of 28 respondents (36,8%) who do not wear PPE mask, 16 respondents (57,1%) are at risk of URI, while 12 other respondents (42,9%) are not at risk of URI. Furthermore, of 48 respondents (63,2%) who wear PPE mask, 14 respondents (29,2%) are at risk of URI, while 34 other respondents (70,8%) are not at risk of URI. Based on *Chi Square* statistical test, the results of the analysis showed that the value of $\rho < 0,05$, means that there was a relationship between the use of PPE mask and the risk of URI in C-category quarry workers. The results showed that out of 76 respondents, 41 respondents (53,9%) have low-level knowledge on URI. Out of 41 respondents (53,9%), 22 people (53,7%) are at risk of URI, while 19 other respondents (46,3%) are not at risk of URI. Furthermore, in 35 respondents (46,1%) had good knowledge about URI, 8 people (22,9%) are at risk of URI, while 27 other respondents (77,1%) are not at risk of URI. Based on *Chi Square* statistical test, the results of the analysis showed that the value of $\rho < 0,05$, means that there was a relationship between knowledge and the risk of URI in C-category quarry workers.

DISCUSSION

Total Dust Content: Table 1 shows that the two sampling points of total dust content in the working environment do not meet the Threshold Value as stipulated on the Regulation of the Minister of Manpower and Transmigration No. 13 of 2011 and SNI of 2005 amounted to 10 mg/m^3. At sampling point I, the weight of the filter paper before sampling is 818 mg, and increased to 938 mg after the sampling. The dust samples obtained at sampling point I for 8 hours have a weight of 120 mg.

After measuring and calculating the total dust content in the workplace in the sample point I, the total dust content obtained was 125 mg/m^3. These results are compared with the Threshold Limit Value set by the Ministry of Manpower and Transmigration Decree No. 13 in 2011 and SNI in 2005 that it does not meet health requirements, even exceeds 100% of the threshold value of the dust content in the air. Based on the results of research conducted at the sampling point II, the results are similar to which at sampling point I, that the sample does not meet the requirements of a healthy work environment. This can be seen at the sampling point II of the weight of the filter paper before sampling of 797 mg that increased to 932 mg after sampling. The dust samples obtained at sampling point I for 8 hours have a weight of 135 mg. After measuring and calculating the total dust content in the workplace in the sample point II, the total dust content obtained was 140,6 mg/m^3. The final results in the sampling point II showed that the total dust content in the work environment does not meet the air health requirements in the work environment. The total dust content at both sampling points can be due to the production process in the C-category quarry which results in high dust concentration.

This can be seen from the initial material obtained by conducting mining activities in C-categorry quarry site by using heavy equipment in the form of an excavator and transporting relatively large pieces of rock into the dump truck which will then be put into a funnel to be channeled to the primary and secondary rockbreakers. The C-category material production process through many stages of rockbreaking is due to there are several types of C-category mine materials produced. The process of primary and secondary rockbreaking produces large amounts of dust. In order to minimize the dust produced from this rockbreaking, there should be some efforts made to water the rockbreaking process, but from the results of observations made, there is no effort to control the dust content. The high level of dust can also be caused by the mobility of vehicles, both heavy vehicles (*excavators, loaders, dump trucks*) and workers' vehicles. Besides, the dust is also resulted from the access to mining roads that are constructed using asphalt, so that a lot of dust is in the air when the vehicles mobile. The results of this study are in line with the research conducted by Septyaningrum (2014), which is based on the results of measurements of dust levels at PT.

Putri Indah Pertiwi in Pule Village, Gedong Pracimantoro, Wonogiri, the results showed that the dust content in the environment exceeds the Threshold Limit Value (NAB) of 18,92 mg/m^3. In accordance with the theory which states that the NAB of dust of 10 mg/m^3 cannot result in diseases, the results of the study that state the dust content of 18,92 mg/m^3 can endanger the health of the workers and can cause respiratory diseases.

The Relationship between Working Hours and Risk of URI: The results of the analysis showed that the value of $\rho > 0.05$ means that there is no relationship between working hours and the risk of URI in C-category quarry workers. This can occur because the disease caused by inhaling dust can be avoided in various ways including administrative control, technical control of machinery, and the use of Personal Protective Equipment. Based on the results of observations made at the time of the study, there were several controlling efforts that had been carried out so as to reduce dust exposure to workers and prevent workers from sufferring from the risk of URI. One of the efforts made is the administrative control in the form of work shifts. As for workers who work for 8 hours/day and suffer from the risk of URI of 40%, this can occur because of many influencing factors of the risk of URI in workers.

The mechanism of respiratory tract infection is very complex and can be influenced by many factors, such as high dust concentration in the work environment, individual factors of workers in preserving their body condition so that they are not easily exposed to dust. According to Al-Asmary (2007) smoking and influenza vaccine are the risk factors which can cause the URI. However, the short-term dust exposure, even in the low concentration, can also have negative impact on the respiratory system of the workers, one of which is URI. The results also showed that workers who have working hours for 8 hours/day do not suffer from the risk of URI of 60%. This can be caused by the working hours of workers who are in accordance with normal working hours of 8 hours/day or 40 hours/week, so that the length of exposure to dust received by the worker does not exceed 8 hours.

This illustrates the relatively small risk of having symptoms of URI, because the length of working hours a person can affect the amount of dust exposure in the work environment that can be inhaled by workers. The results of this study are in line with previous research that there is no relationship between the working hours and the risk of URI[5]. The absence of a relationship between the working hours and the risk of URI in this study can be caused by each C-category mining company has the same operating hours of 8 hours/day. Based on the results of observations, the application of working hours in the company can be seen in the company's weekly presence data. The company's operating hours start at 8.00 a.m., with a break hours at 12.00-1.00 p.m., restart working until 5.00 p.m. The results of this study are not in line with the research (Rini, 2014; Jaiswal, 2011), that the the length of exposure has a significant relationship with the risk of URI in workers. The results are in accordance with the theory which states that the duration and frequency of single or multiple exposures will produce exposure effects, both acute and chronic, as in this study, the frequency of exposure to the C-category quarry workers does not exceed the specified working time limit of 8 hours/day (Halim, 2012).

The Relationship between Personal Protective Equipment and The Risk of URI: The results of the analysis showed that the value of $\rho < 0.05$ means that there is a relationship between the use of PPE mask and the risk of URI in the C-categorry quarry workers. The results also showed that 42,9% of C-category quarry workers who do not wear PPE mask do not suffer from the risk of URI. This can happen because there are workers who consider that the location of the work unit who are not directly exposed to dust, so that workers feel they do not need to wear PPE mask. In contrast, there are 29,2% of workers who wear PPE mask suffer from the risk of URI. This can be caused by the habits and discipline of workers in wearing PPE mask. PPE mask must be applied during working hours, but many workers do not wear PPE mask during working hours, this can be caused by the absence of supervision, regulation, and punishment from the company. In addition, the risk of URI in workers who wear mask can be caused by the mask worn by the workers does not meet the requirements so that it cannot prevent dust from being inhaled into the respiratory tract of workers. This has been explained by the Center for Disease Control and Prevention in the United States which states that surgical mask is not designed to be used as particulate respirators and does not provide much protection against airborne diseases because it does not effectively filter small particles from the air or prevents leakage around the edges of the mask when the user breathe air at workplace (Al-Asmary, 2007). The results also showed that there are 70.8% of workers who wear PPE mask do not suffer from the risk of URI. This can occur because of the benefits of wearing PPE mask can reduce exposure to dust that can enter the respiratory tract of workers so that it can interfere with the respiratory system of workers and cause the risk of URI in workers. The behavior of workers who wear PPE mask is based on the workers' awareness on the importance of health preserving. The awareness of workers in wearing PPE mask can also be influenced by the level of knowledge of workers. Based on research conducted by. In addition to self-awareness, support from the company also becomes one of the influencing factors workers' discipline in wearing PPE mask. The support provided by the company is in the form of the provision of PPE masks to the C-category quarry workers. The results of this study are in line with the research (Tarwaka, 2008) that ther is a relationship between the use of personal protective equipment in the form of masks and the risk of URI in workers. The relationship in this study can be caused by more dust entering the respiratory tract in workers who are not wearing masks. The results of this study are in accordance with the theory proposed by Tarwaka (2008) which states that mask is one of personal protective equipment used to reduce exposure to dust or larger particles into the respiratory tract (Tarwaka, 2008). However, it is different from the results of the study (Halim, 2012) that there is no relationship between the use of PPE and the risk of URI in workers.

The Relationship between Knowledge and The Risk of URI: The results of the analysis showed that the value of $\rho < 0.05$ means that there is a relationship between knowledge and the risk of URI in C-category quarry workers. The results also showed that there are 46,3% workers who have low-level knowledge about URI do not suffer from the risk of URI. This can occur because of the varied educational background of the C-category quarry workers. The level of education can affect the ability of workers to receive information and influence the knowledge of workers about URI. However, the lack of knowledge does not affect the risk of URI in 46,3% of

workers. This can occur because of several influencing factors of the emergence of airborne diseases or disorders due to dust, such as individual factors which include the respiratory defense mechanism, airway anatomy and physiology and immunological factors, but these individual factors are not examined in this study because it must be done by the doctors of the company who can diagnose occupational diseases in workers. There are 22,9% workers who have high-level knowledge and have a risk of URI. This can happen because knowledge has several levels, namely, know, comprehension, application, analysis, synthesis and evaluation. In the C-category quarry workers, the level of knowledge possessed is only to know but not to apply well, so that it can affect the risk of URI in workers. The results also showed that there are 77,1% workers who have high-level knowledge but do not suffer from the risk of URI. This can be influenced by the educational background of workers, most of whom are high school graduates, as the high-level education will be able to form a more conscious workforce and use their brain to work rather than their muscle forces.

Higher education will also shape understanding, compliance and discipline in work. In addition, based on the results of a preliminary study conducted in the Watusampu Village Office, that the socialization was carried out by the company before the C-category quarry workers working. The high-level of knowledge of workers about URI can also be caused by the socialization conducted by the college students in their Community Service Program (KKN) from various State and Private Universities, both in health and non-health fields. In addition to providing socialization, such college students also provided social actions in the form of distributing masks for free in Watusampu Village. The results of this study are in line with previous research that there is a relationship between the knowledge of mine workers about URI and the risk of URI in workers. Lavanya and Giridhar (2013) stated in their research that the high-level knowledge about work safety is strongly influenced by the level of education of workers (Yusnabeti, 2010; Wijiningrum, 2009). The relationship between workers' knowledge of URI and the risk of URI in miners can be influenced by varying levels of education of workers. The level of education can affect the ability of workers to receive information. The results of this study are in accordance with the theory proposed by Green in Wijiningrum (2009) which states that knowledge is one of the influencing factors of behavior change. An educational background will determine how to understand the problem faced (Wijiningrum, 2009).

Conclusion

Based on the results of this study, it can be concluded that there is a relationship between the use of PPE, knowledge about the risk of URI and the risk of URI in the C-category quarry workers. However, there is no relationship between the working hours and the risk of URI in C-category quarry workers in Watusampu Village, Ulujadi Sub-District, Palu. It is suggested that every C-category quarry company can provide PPE in the form of masks for use by the workers. In addition, for the workers, it is suggested to increase awareness in the use of Personal Protective Equipment (PPE) in the form of masks that have met the standards during working hours. In order to support this effort, the management of company can issue strict regulations to require every worker to use PPE, especially for standard masks.

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