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Original Article

Acute Respiratory Infection Among Brick Kiln Worker in Banjarnegara, Indonesia and Its Related Factors

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Background Occupational risk factors are one of the primary causes of acute respiratory infection (ARI). The high incidence of ARI in Banjarnegara Regency due to the process of bricks manufacturing is needed for further investigation. **Objectives**: This study aims to analyze risk factors such as air quality, tenure, smoking habits, the use of masks, knowledge of ARI incidence. **Methods:** This is an analytic study with a cross-sectional design. 342 of brick workers in three villages in Banjarnegara Regency were involved in this study. Air quality examination on dust particles, temperature, humidity, smoke, and air germ numbers was carried out in 15 of the brick kiln. Data about the duration of work, smoking habits, knowledge of ARI, and the use of masks were obtained by a structured questionnaire. **Results**: This study highlighted that the duration of work was the most influential variable in ARI incidence. Smoking habits and the use of personal protective equipment (mask) while working also correlated with ARI. **Conclusion:** This study suggested the regular use of a face mask while working to prevent the workers from dangerous pollutants. Periodic medical check-ups for workers and health education are also important prevention to be carried out to reduce ARI incidence.

Keywords: Risk factors, acute respiratory infection, workers, brick

INTRODUCTION

The detrimental consequence of air pollution on health particularly on respiratory infection has been recognized in several previous studies (1, 2). According to the World Health Organization, more than 1.5 million deaths annually in developed countries are caused by respiratory infections. These infections are caused by environmental pollution, including at least 42% of lower respiratory infections and 24% of upper respiratory infections (3). One of the problems of air pollution that has not been extensively studied is the impact of the work environment on the risk of exposure of workers to respiratory infections.

One of the industries at risk is closely linked to the possibility of exposure to poor air quality and the development of respiratory infections, i.e. the effect of the brick-making industry on respiratory infections. Stages that occur in this sector are very likely for workers to be exposed to respiratory infections. The process of bricks manufacturing through several stages: digging the soil, processing raw materials, printing, drying, and combustion processes at high temperatures. High temperature combustion can reduce air quality, and the presence of smoke and dust from brick kilns is an important source of air pollution (4). The brick processing industry produces waste from bricks burning activities in the form of firewood and rice husks. Air pollution from the burning of bricks produces gas such as; Carbon dioxide (CO_2), Carbon Monoxide (CO), and dust particles are quite high. The process of burning bricks with rice husks takes around 3-7 days and workers always wait for the burning process. Air pollution could increase the risk of brick-making workers experiencing respiratory problems such as Acute Respiratory Tract Infection (5). In addition, after inhalation, air pollutants may affect inflammation and release of oxygen radicals may cause local

tissue injury and pulmonary distress (2). Other risk factors for ARI are environmental conditions (air pollutants, humidity, and air temperature), host factors (age, nutritional status, and smoking habits) and virulence factors and the number of microbes (5, 6). Previous studies have shown that workers with different occupations, including brick kiln workers exposed to dust and smoke, are at higher risk of developing respiratory symptoms and illnesses (7).

This industry adds hazardous gasses to the air that affect human health and cause air pollution. Brick production pollutants include SO_2, NOx, particulate matter with an aerodynamic diameter of 2.5 μm and 10 μm, CO_2, CO, dust particles, organic matter, H2S and PAHs. It is expected to emit of 127 million tons of CO2, 3.9 million tons of CO and 0.94 million tons of particulate matter (PM) from brick kilns in south asia (5). Average emission factors of PM 0.64–1.4 kg, SO2 0.52–5.9 kg and CO 6.35–12.3 kg were released from the 1000 baking brick cycle. Epidemiological studies have also shown that the deterioration of air quality is directly related to higher levels of cough, emphysema, bronchitis, asthma, pharyngitis and allergic reactions. Particulate matter was the primary cause of respiratory disease, including chronic bronchitis, coughing, asthma and decreased lung function in humans and, at the same time, unbalanced natural habitats. (8).

The brick industry is an industry in which development is quite rapid in Indonesia. One area that has a large number of the brick industry is Banjarnegara Regency, Central Java. The highest number of brick industries is in Mandiraja Subdistrict, Banjarnegara Regency with 978 brick kiln with 2,704 workers. The high number of ARIs in this area raises the question of whether there is a correlation between air pollution in the brick kiln and the incidence of ARIs. Data on ARI cases in Mandiraja Subdistrict in 2017 were 4,888 cases (9). Research on the risk of occupational diseases , particularly in brick workers, is still very limited. In this study, we eager to analyze several risk factors such as air quality (dust particles, temperature, humidity, ammonia (NH_3), carbon monoxide (CO), nitrogen oxides (NO_2), Ozone (O_3), sulfur oxides (SO_2) and germ numbers), duration of work, smoking habits, the use of masks, knowledge to ARI incidence. The results of this study are expected to give essential information for promotive and preventive efforts towards ARI events caused by the work environment.

METHODS

This study is a cross-sectional observational analysis conducted in a brick kiln in three villages, Purwasaba, Blimbing and Panggisari Village in the Mandiraja District, Banjarnegara Regency, Central Java, from July to September 2018. The population of this study was all brick-making workers in Mandiraja sub-district as many as 2,378 people. The determination of sample size was carried out by the Slovin formula, with a total sample of 342 respondents. Distribution of samples per village was based on proportional random sampling calculations, 259 respondents in Panggisari Village, 55 respondents in Blimbing Village, and 28 respondents in Purwasaba Village. Primary data were obtained from the measurement of air quality parameters at each location in the brick kiln area and from a structured questionnaire (work duration, knowledge, smoking habits and use of personal protective equipment / mask). Secondary data was obtained from the Central Bureau of Statistics of Banjarnegara Regency such as population, number of brick industries, and map of research locations. The incidence of ARI data in Mandiraja Subdistrict, Banjarnegara Regency was obtained from Banjarnegara District Health Office.

The dependent variable in this study was the incidence of ARI detected in brick-making workers, while the independent variables were dust particles, temperature, humidity, smoke (NH_3, CO, NO_2, O_3, and SO_2), germ numbers, characteristics and behavior of workers including work period, knowledge, smoking habits and the use of personal protective equipment (masks). The instrument of this research is a structured questionnaire and an air quality measurement tool. For air quality measurement, 15 of Brickkiln in Panggisari, Blimbing, and Purwasaba Villages were inspected. Air quality parameters measured in each location in the area of brick making include dust particles, temperature, humidity, smoke (NH_3, CO, NO_2, O3, and SO_2) and air germ numbers. Air quality testing was carried out at the Laboratory of Environmental Health, Purwokerto. The tool used to measure air quality is EPASS, which placed at the location of the study then turned on for 5-10 minutes the tool will produce air quality figures automatically. For measurement of germ, numbers were carried out by microbiological methods: sterile NA media opened at an angle of 45^o for approximately 10 minutes in the location of study. After 10 minutes the petri dish is closed again and then the petri dish is wrapped upside down in the incubator for 48 hours at 37 ° C and after 48 hours the amount is observed.

Several variables were collected, such as duration of work, knowledge, smoking habits and the use of personal protective equipment (masks) through a structured

questionnaire. The validity and reliability of the questionnaire test was carried out on 30 respondents in the district of consisted of univariate analysis, bivariate analysis and multivariate analysis. Bivariate analysis using a chi-square statistical test, while multivariate analysis using a statistical logistic regression method. Data is then presented in the form of a table. This research was conducted with research permission from the Regional Development Agency, Banjarnegara Regency, Health office of Banjarnegara, and the informed consent procedure was carried out to the respondents before field data collection.

Purwareja Klampok because it has the same characteristics as the district of Mandiraja. The analysis of data in this study

RESULTS

Based on the results of the air quality examination, it can be seen that the air quality at the research location includes the physical, chemical, and biological parameters that were unqualified. The results of measurements of dust, temperature, humidity, wind speed, NH_3, CO, NO_2, O_3, SO_2, and air germ numbers can be seen in Table 1.

Table 1. The average of air quality measurement in Brick kiln, Banjarnegara

Parameter	Panggisari	Blimbing	Purwasaba	Qualified	Unqualified	Unit
Physical						
Dust	0,45	0,48	0,39	0,15	> 0,15	mg/m^3
Temperature	27	28	28	18-28	< 18	°C
Humidity	72	71	70	65-95	> 65	%
Wind speed	1,2	0,5	0,9	0,15-0,25	> 0,25	m/s
Chemistry						
Ammonia (NH_3)	0,5	0,3	0,3	25	> 25	ppm
Carbon monoxide (CO)	42.855	3.576	5.788	25	> 25	ppm
Nitrogen Dioxide (NO_2)	44	43	45	3	> 3	ppm
Ozone (O_3)	2	3	2	0,08	> 0,08	ppm
Sulfur Dioxide (SO_2)	393	382	393	2	> 2	Ppm
Biology						
Number of bacteria	100200	346500	208650	<700	> 700	colony/ m^3
Acute respiratory Infection	52	54	51			%

The results of chemical parameters examination consisting of CO, NO_2, O_3, and SO_2 categorized as unqualified, except for NH_3 was still qualified. The results of the examination of biological parameters showed that the number of germs in Panggisari, Blimbing, and Purwasaba Villages does not meet the requirements because it is above the quality standard <700 colonies / m^3.

Data collection from a questionnaire of 342 respondents was conducted to find out the risk factors of ARI among brick workers in the area of study. Details of respondents characteristics can be seen in Table 2.

Table 2 Characteristics of respondents based on gender, education, and age

Characteristic	Number	Percentage (%)
Sex		
Male	188	55
Female	154	45
Education level		
Primary School	110	32.2
Secondary School	143	41.8

Senior High School	89	26.0
Age groups (years old)		
17 – 25	16	4.7
26 – 35	137	40.1
36 – 45	145	42.4
46 – 55	31	9.1
56 – 66	13	3.8
Total	342	100

Based on Table 2, the majority of workers are male (55%), finished secondary school (41.8%) and most of them in age groups 26-35 years old (40.1%) and 36-45 years old (42.4%). We also carried out a univariate analysis to describe each of the variables (Table 3).

Table 3. Percentage of workers based on the duration of work, ARI knowledge, smoking habits and use of masks/personal protection

Variables	Panggisari (%)	Blimbing (%)	Purwasaba (%)	Total (%)
Tenure				
< 5 years	57	57	44	52,6
≥ 5 years	43	43	56	47,4
ARI Knowledge				
High	39	48	39	42,1
Low	61	52	61	57,9
Smoking Habits				
Smoking	46	53	56	51,5
Not smoking	54	47	44	48,5
Use of mask				
Using mask	54	53	40	46,2
Not using mask	46	47	60	53,8
ARI incidence				
ARI	52	54	51	52,3
Not ARI	48	46	49	47,7

From Table 3, we can see that 52,6% of respondents have worked for less than 5 years, while 47,4 has worked for more than 5 years. Based on their knowledge of ARI, 42,1 % had high knowledge, while 57,9% showed low knowledge. 51,5 % of respondents smoke, and 48,5% did not smoke. For their behavior of using personal protection (mask) while working, only 46,2% which using a mask, and 53,8% of them did not use a mask. 52,3 % of respondents showed symptoms of ARI and 47.7% categorized did not have ARI. Subsequently, we carried out a bivariate analysis to determine the correlation between independents variables with ARI occurrence in the area of study. The results of the bivariate analysis are the relationship of characteristics and behavior of brick-making workers to ARI events using the chi-square statistical test can be seen in Table 4.

Table 4. Relationship between duration of work, ARI knowledge, smoking habits, and mask use with ARI

Variables		*p-value*	Interpretation
Tenure	> 5 years ≤ 5 years	0,011	correlated
Smoking	smoking not smoking	0,042	correlated
Use of mask	Not using mask Using mask	0,046	correlated
ARI knowledge	High Low	0,804	not correlated

Based on Table 4, it can be seen that the variables associated with ARI events were the duration of work, smoking habits, and the use of personal protective equipment such as masks. The results of the multivariate analysis using the statistical method of multiple logistic regression for each variable resulted in the risk factors most affecting the incidence of ARI as shown in Table 5.

Table 5. The most influential risk factors for ARI occurrence in brick-making workers in Mandiraja District, Banjarnegara Regency

Variables	Wald	df	Sig.	Exp(B)	95% C.I.for EXP (B)	
					Lower	Upper
Tenure	5.603	1	0,018	1.692	1.095	2.615
Use of mask	2.911	1	0,088	1.464	0,945	2.267
Smoking	2.734	1	0,098	1.446	0,934	2.240
Constant	6.735	1	0,009	0,579		

DISCUSSION

Study of risk factors of ARI occurrence among brick kiln workers is important to find out determinant factors of ARI, and then prevention effort could be carried out to decrease the incidence of acute respiratory infection. This study involved 342 brick workers in the area of study and we found that tenure is the most influential variable to ARI incidence. The odds ratio (OR) is 1,783, which means that brick kiln workers who had ARI were 1,738 times more frequent happen at workers who worked more than 5 years than others who worked less than 5 years. The tenure affects the incidence of ARI because the longer a person is at work, the more exposure to the danger caused by the work environment. This result following previous research in Kathmandu valley, Nepal which showed that brick kiln workers are at greater risk of respiratory-related diseases (5). Another study also stated that workers at brick kiln who engage different tasks of brick manufacturing could suffer respiratory illnesses (10).

The longer duration of work could increase the risk of brick kiln workers to have ARI. This could be due to the accumulation of long exposure of workers in the area of the brick kiln. This is also supported by air quality examination in this study which showed that air quality at the research location includes the physical, chemical, and biological parameters that were unqualified. Some parameters observed were CO, NO_2, O_3, and SO_2 which did not meet requirements, while the highest number of germs was recorded in the study, 346,500 colonies/m^3. Air quality and environmental conditions that do not meet health requirements can increase the risk of contracting respiratory infections. Several previous studies showed that air pollution has a detrimental effect on respiratory health (11, 12). Brick kiln workers who work in a long period could expose to air pollution in the area of work. The influence of the air pollution's negative effects will cause inflammation and damage to the lung's innate immune system (1).

This condition could be much worse when the workers did not use a mask for their health protection against air pollution. In this study, 53,8 % of workers did not use a mask when working. The use of face masks could prevent infection of airborne pathogens and exposure of airborne particulates and aerosols (environmental pollutants and allergens)(13). This method could be an effective, practicals, and economic way to avoid inhalation of dangerous matter (14). However, previous research showed a lack of adherence to mask-wearing because of low knowledge and awareness of face mask benefits (15). The lack of awareness of brick kiln workers on the importance of wearing masks is also possible due to a lack of knowledge about the dangers of the risks of their work. Knowledge of health risks due to work can cause a person to take preventative behavior to avoid being exposed to health hazards (16). Individuals are more likely to wear face masks due to perceived vulnerability and perceived seriousness of life-threatening diseases. While perceived vulnerability appeared to be the most significant factor deciding compliance, perceived mask-wearing benefits have also been shown to have significant effects on mask-wearing compliance. Perceived obstacles include feeling or perceiving personal distress and a sense of shame. Media blitz and public

health promotion programs funded by government agencies include recommendations to expand public use of face masks. Complex strategies using multi-pronged methods addressing the five components of the Health Belief Model, in particular perceived vulnerability, are required to increase the use of face masks in the community (17). In addition, it is also likely due to the poor educational history of the workers. As many as 41.8% of employees had only finished junior high school, and 32.2% had only basic education. Low education may be a factor in the lack of awareness of workers about the dangers of their employment. Health promotion initiatives are most also focused on one's own experience. Higher a person's education, it will be easy to receive new information, including health related (18).

Another result of this study found that smoking habit also correlated with ARI occurrence. The odds ratio (OR) of 1,593 which means that brick kiln workers who had ARI were 1,593 times more frequent happen at workers who smoking than others who non-smoking workers. smoking workers have a risk of 1,593 times greater ARI compared to non-smoking workers. This result in line with a previous study that showed that age, nature of work, and smoking were strong predictors of developing these symptoms and illnesses among brick kiln workers (19).Tobacco use could reduce lung function such as alterations in resistance to airflow, cough, and irritation of the airway (20). Several studies also showed that smoking can affect respiratory tract inflammation and exacerbate symptoms such as cough and sputum production (21). Studies suggest that long-term smoking can have harmful health effects on the function and structure of the lungs. Another effect of smoking is that it can impair the lung's ability to suppress infections, which can cause irreversible lung damage. The smoking habits of workers may increase their risk of being more susceptible to respiratory infections because of the negative effects of smoking which has resulted in poor respiratory conditions (22).

In this study, 51,5 % of workers had smoking habits which higher their risk of respiratory diseases. Knowledge of brick kiln workers about air pollution and its prevention showed no correlation of ARI occurrence in the area of study. 57,9 % of workers still had low knowledge about the risk of air pollution in their area of work. Result of this study in contrast with previous results which stated that a low level of knowledge of workers causes a lack of awareness to take preventive measures such as using masks while working (15). Health education for brick kiln workers in essential prevention effort to increase knowledge and awareness of respiratory disease risk factors.

This study emphasizes the danger of the working environment in brick kiln employees. Bad air quality, lack of prevention steps, raise the risk of respiratory disease staff. In fact, this added matter accumulates over a long period of time, with an increase in working time for workers. Intervention measures are required in order to reduce the number of respiratory infections. For example, by rotating staff, so that they are not exposed to the area at risk for too long. Increased awareness of preventive strategies, such as wearing masks while working and following safe lifestyle practices, needs to be made for staff. This is very important to avoid and reduce the occurrence of respiratory infections. The findings of this study will also be concerned with the risk of respiratory infections in the workplace. It requires the commitment of the local health department to the introduction of prevention and control programmes. It is also important to be aware that the incidence of respiratory infections in brick kiln workers is often not well documented. That is because ARI signs are often not clear. Health checks on staff are also very rare. The concern for the owners or managers of the brick industry is still very limited, this should be a concern for improvement.

The drawback of this research is that its cross-sectional nature is due to difficulties in obtaining ARI cases in brick workers, so that it is not strong enough to infer the impact of risk factors. Respiratory infections have also not been clearly classified in this report, despite information on what infections workers have personally encountered. This is due to the limited resources available in this study. In this study, the air quality variable can only be described because it is only performed in 15 brick business sites in three villages in the sub-district of Mandiraja, so that it can not be further analyzed in relation to respiratory infections in workers. The advantage of this study is that this study has been carried out in a specific population, namely brick workers. This information is rarely found and provides new information on occupational health risks in a comprehensive manner, both from the point of view of air quality and other factors that may influence respiratory infections. This study is also very detailed in investigating several potential variables linked to the frequency of respiratory infections in brick workers. The information from this study is supposed to provide a warning of a high risk of respiratory infections in the brick industry, which is why multiple measures are needed to avoid it.

CONCLUSION

The results of this study highlighted the correlation between tenure, smoking habits, and the use of a mask with the occurrence of acute respiratory infection. This study recommends the regular use of a face mask while working to prevent the workers from dangerous pollutants and airborne diseases. Job rotation attempts on workers are also necessary so that they are not too long exposed to environmental factors in the brick industry. The brick industry owner also needs to pay attention to the process of making bricks in order to be able to reduce air pollution around the factory. It also takes into consideration the health of its workers to avoid the hazards of health effects from their work. The industry and health institutions should carry out environmental health supervision in the brick industry and also conduct health checks on workers regularly.

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