Association Between PM$_{2.5}$ Wood Dust Exposure and Acute Respiratory Infection on Plywood Industry Workers in PT. Muara Kayu Sengon, Jatilawang District, Banyumas Regency

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Abstract. The plywood processing industry is one of the fastest growing industries. However, this has a negative impact and may cause the emergence of air pollution by dust produced from the plywood processing industry. Air pollution caused by the plywood processing industry can trigger problems such as the atmosphere, the economy, and health. The plywood processing industry has potential to create a source of pollution in the form of dust which is harmful to the environment and the health of workers. This study aimed to determine and analyze the association between PM$_{2.5}$ wood dust exposure and the case of acute respiratory infection (ARI) in plywood industry workers. The research method used is cross-sectional with a total sample of 142 female workers at 17 locations PM$_{2.5}$ wood dust measurement and using a standardized Questionnaire British Medical Research Council (QUES BMRC -86). PM$_{2.5}$ wood dust measurement using tools DustTrak. Based on the results of the study showed that the average of PM$_{2.5}$ at 17 points of 5.23 mg/m$^3$ which exceeds the Threshold Value according to the Regulation of the Minister of Manpower of the Republic of Indonesia Number 5 of 2018 concerning the Threshold Value of Chemical Factors in the Air of the Work Environment for Types of Softwood Dust, namely 5 mg/m$^3$ who are at risk of experiencing the case of acute respiratory infection. The results of the analysis and the results of the logistic regression test show that there are 4 significant variables is a association between with the case of acute respiratory infection, for exposure to PM$_{2.5}$ dust ($p = <0.001; \text{RP} = 12.757; 95\% \text{CI} = 1.819 - 89.477$), working period ($p \text{value} = <0.001; \text{RP} = 13.048; 95\% \text{CI} = 4.217 - 40.377$), use of personal protective equipment ($p \text{value} = <0.001; \text{IDR} 7,568; 95\% \text{CI} = 2.453 - 23.352$), and age ($p \text{value} = <0.001, \text{RP} = 5.582, 95\% \text{CI} = 2.323 - 13.413$). The conclusion of this study is that there is a association between exposure to PM$_{2.5}$, wood dust, years of service, use of personal protective equipment, age and the case of acute respiratory infection in plywood industry workers. Therefore, to prevent the occurrence of acute respiratory infection, workers are advised to use complete personal protective equipment when doing work in the plywood industry of PT. Muara Kayu Sengon, Jatilawang District, Banyumas Regency.

Keywords: Wood Dust, PM$_{2.5}$; Acute Respiratory Infection; Plywood Industry Workers

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1. Introduction

The wood processing industry is one of the industries that is growing very rapidly, this is related to the consumption of forest products which reaches 33 million m$^3$ every year. However, this has a negative impact, and may cause emergence of air pollution by dust produced from processing or industrial results [1].

The large consumption of forest products, among others, is absorbed by the plywood, sawmill, furniture, particle board and paper pulp industries. These industries can become a contaminant in the workplace air in the form of wood dust. The impact of the dust can have an impact on the work area and the environment so that workers and the community around the production area will be exposed to wood dust. Too temperature High humidity can increase the spread of dust in the work environment, while high humidity is an optimal condition for microorganisms to multiply [2].

Based on the results of preliminary research on PM$_{2.5}$ wood dust exposure measurements in the plywood industry, in the cutting production area 5.32 mg/m$^3$ and wood sanding 6.79 mg/m$^3$ from these results is a production area that produces the highest dust among other production areas. The Threshold Value is stated in the Regulation of the Minister of Manpower of the Republic of Indonesia Number 5 of 2018 the Threshold Value of Chemical Factors in the Air of the Work Environment for Types of Softwood Dust is 5 mg/m$^3$ [3].

Wood dust is composed of lignin, holocellulose (cellulose and hemi-cellulose) compounds, and low amounts of carbohydrate compounds. Therefore, wood dust is classified as organic dust [4]. Wood dust can be inhaled and deposited in the nose, throat or lungs, depending on the size of the dust particles. The presence of dust can cause several problems such as skin irritation, acute respiratory infections (ARI), impaired lung function, impaired vision, and reduced comfort at work. Wood dust is also categorized as a carcinogen (substances that cause cancer) to humans [5].

PM$_{2.5}$ (Particulate Matter) are fine airborne particles smaller than or equal to 2.5 µm (micrometer), one of which comes from wood dust. PM$_{2.5}$ sized particles referred to as fine particels and is believed to pose the greatest health risk due to their small size (about 1/3 the width of an average human hair) that allows particles to enter the lungs. PM$_{2.5}$ wood dust contained in the air and inhaled by humans can affect human health. According to Rahardjo 2012 PM$_{2.5}$ which is inhaled into the alveoli can cause an inflammatory reaction which can cause lung expansion to be limited and can result in decreased lung function in humans [6].

Acute Respiratory Infection (ARI) is an acute infectious disease that attacks one or more parts of the respiratory tract, starting from the nose, alveoli, including their adnexes (sinus, middle ear cavity, pleura) [7]. This infection is caused by viruses, fungi and bacteria. ARI will attack the host if the immune system (immunology) decreases. Therefore, sufferers of ARI often experience recurrence. The results of Basic Health Research (BHR) show that the prevalence of ARI in Central Java Province in 2016, 2017, 2018 was 54.3%, 50.5%, 62.5% respectively, an increase in 2017 and 2018 [8].

Occupational diseases occur because of a person's work and do not pay attention to the risk factors that exist in the workplace [9]. The cause of this disease is caused by unsafe actions and unsafe conditions [10]. ARI occurs gradually due to the process of accumulation of exposure received by a person into the lungs. Apart from environmental exposures, ARI can be influenced by the characteristics of the workers themselves such as age, gender, history of lung disease, exposure duration, smoking habits, years of service, and use of personal protective equipment in the form of masks or cloth [9].

Research conducted by Sarah in 2016 found that exposure to wood dust in plywood processing had a significant association with the case of impaired lung function in...
wood industry workers ($p = 0.044$). In addition, workers do not use personal protective equipment in the form of masks when doing work.

Another study conducted by Hera in 2020 found that there was a significant association between environmental dust levels and impaired lung function with a $p$-value of 0.032 ($p < 0.05$). The use of personal protective equipment has an important role in causing respiratory complaints.

In the preliminary study, the researchers conducted a sample of 20 workers who were interviewed and found that there were 3 workers who often felt shortness of breath, flu-like symptoms, frequent coughing, allergies and sometimes shortness of breath. There were 5 workers. Measurement of PM$_{2.5}$ wood dust exposure in the plywood industry, in the cutting production area 5.32 mg/m$^3$ and wood sanding 6.79 mg/m$^3$. From these results is a production area that produces the highest dust among other production areas. Exposure to wood dust that is above the Threshold Value can result in work-related illnesses such as acute respiratory infection (ARI). The health of workers, so that if it is not treated immediately it will be more at risk of endangering the health of workers in the plywood industry.

The consideration of the researchers in choosing the research topic on the case of ARI was because the researchers wanted to find out whether there was an association between PM$_{2.5}$ wood dust exposure produced in the plywood processing process and the case of ARI. This study aimed to determine the association between PM$_{2.5}$ wood dust exposure and the case of acute respiratory infection in plywood industry in PT. Muara Kayu Sengon, Jatilawang District, Banyumas Regency.

The originality of this study lies in the research variable, namely exposure to PM$_{2.5}$ wood dust at the same location is then associated with the problem the case of ARI. In addition, the subject used is also different from previous research where the plywood industry used by other researchers is not located in the plywood industry in PT. Muara Kayu Sengon, Jatilawang District, Banyumas Regency.

2. Method

This type of quantitative research is analytic observational and the approach method in this study is to use the method cross-sectional by means of researchers observing or measuring the independent variable (exposure to wood dust PM$_{2.5}$, years of service, duration of exposure, use of personal protective equipment, smoking habits and age) and the dependent variable (ARI occurrence) that occurs in the research object to be measured and collected at the same time and carried out in the same situation. Data obtained from PM$_{2.5}$ wood dust exposure measurements with tools DustTrak and interviews using a questionnaire (Questionarier BMRC -86) is used as a data collection tool. The population of this study is using the technique simple random sampling with the results of calculating the Slovin formula from 221 female workers, the results of respondents were 142 female workers who were on the plywood industry area in PT. Muara Kayu Sengon, Jatilawang District, Banyumas Regency. This study uses an approach simple random sampling with the following inclusion criteria: willing to be a research subject, working in the plywood industry, and having no history of respiratory disease.

The study analysis consists of two phases, namely univariate analysis and bivariate analysis. Data analysis in this study used the IBM SPSS Statistics 29 application, univariate analysis was undertaken to characterize the investigated distribution and frequency. The factors examined are exposure to PM$_{2.5}$ wood dust, age, years of service, duration of exposure, use of personal protective equipment, and smoking habits. In bivariate analysis utilizing the Chi-Square test to the association between the independent variables and the case of ARI, $p = 0.05$ was statistically significant (at the 95% confidence interval level). This study protocol has been deemed ethically sound and has gained information from the Health Research.
3. Result and Discussion

3.1 Description of Air Quality Measurement Results in the Work Environment

The location of this research is located in the plywood industry in PT. Muara Kayu Sengon, Jatilawang District, Banyumas Regency. This industry has been around since 2014. The plywood processing industry consists of many processes, namely sorting logs or logs, logs entering the machine rotary (stripping the bark), kiln dry, rotary short core, rotary long core, machine rotary short core and machine rotary long core, boiler machine, steam drying machine or dryer, the process of setting, gluing, machine cold press or cold pressing, machine hot press or hot pressing, core board, finished product layer insertion, product selection, packaging. Work environment on the plywood processing industry in PT. Muara Kayu Sengon, Jatilawang District, Banyumas Regency is generally dusty, as can be seen from the scattered, sticky dust and thick smoke billowing from the heating process at the workplace. This fine dust can penetrate the human respiratory system, settle in the lungs and pose a health hazard to workers over time.

Figure 1. An overview of the distribution of air quality measurements in the work environment

Based on figure 1 it can be seen that the average PM$_{2.5}$ wood dust exposure at 17 points in the plywood industry of PT. Muara Kayu Sengon, Jatilawang District, Banyumas Regency of 5.23 mg/m$^3$ with the highest PM$_{2.5}$ wood dust exposure at point 14 of 6.86 mg/m$^3$ which has exceeded the threshold value according to the Regulation of the Minister of Manpower Number 5 of 2018 concerning the Threshold Value of Chemical Factors in the Air of the Work Environment for the type of softwood dust, which is 5 mg/m$^3$ and the lowest at point 17, namely 2.49 mg/m$^3$ which is still below the threshold value. The average air temperature at the 17 points is 35°C, and the average humidity is 29%.

3.2 Respondents Characteristics

Table 1 data shows related characteristics of workers which include PM$_{2.5}$ wood dust exposure, age, years of service, exposure duration, use of personal protective equipment (PPE), and smoking habits.
Table 1: Frequency Distribution of Respondent Characteristics

<table>
<thead>
<tr>
<th>Variables</th>
<th>F (Person)</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PM$_{2.5}$ Wood Dust Exposure</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Above the Threshold Value (≥ 5 mg/m$^3$)</td>
<td>107</td>
<td>75.4%</td>
</tr>
<tr>
<td>Below the Threshold Value (&lt; 5 mg/m$^3$)</td>
<td>35</td>
<td>24.6%</td>
</tr>
<tr>
<td>Age</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt; 40 Years</td>
<td>79</td>
<td>55.6%</td>
</tr>
<tr>
<td>≤ 40 Years</td>
<td>63</td>
<td>44.4%</td>
</tr>
<tr>
<td>Working Period</td>
<td></td>
<td></td>
</tr>
<tr>
<td>≥ 5 Years</td>
<td>69</td>
<td>48.6%</td>
</tr>
<tr>
<td>&lt; 5 Years</td>
<td>73</td>
<td>51.4%</td>
</tr>
<tr>
<td>Exposure Duration</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8 Hours/Day</td>
<td>142</td>
<td>100%</td>
</tr>
<tr>
<td>&lt; 8 Hours/Day</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>Use of PPE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Incomplete</td>
<td>88</td>
<td>62.0%</td>
</tr>
<tr>
<td>Complete</td>
<td>54</td>
<td>38.0%</td>
</tr>
<tr>
<td>Smoking habit</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Smoking</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>Not Smoking</td>
<td>142</td>
<td>100%</td>
</tr>
</tbody>
</table>

The results from table 1 show that the respondents were exposed to wood dust PM$_{2.5}$. 107 workers with a percentage of 75.4% were exposed to PM$_{2.5}$ wood dust above the Threshold Value (≥ 5 mg/m$^3$) while the other 35 workers with a percentage of 24.6% were exposed to dust below the Threshold Value (< 5 mg/m$^3$) which has been set. Based on Wulansari’s research in 2018, the results showed that the dust content in the exposed group, namely jumping saw, was 19.903 mg/m$^3$ (exceeding the Threshold Value of dust content of 5 mg/m$^3$) and the unexposed group, namely the office of 0.089 mg/m$^3$ (according to the Threshold Value) [13].

In the age variable, there were 79 (55.6%) respondents aged > 40 years and 63 (44.4%) respondents aged ≤ 40 years. Another similar study was conducted by Sinaga in 2019 which stated that there were > 40 years of age, 23 workers (60%) with pulmonary function [14].

In the working period variable, 69 (48.6%) respondents had worked as plywood industry workers for ≥ 5 years and 73 (51.4%) other respondents worked in the plywood industry < 5 years. The working period in the plywood industry is related to the accumulation of dust exposure received by workers. The longer humans are exposed to dust in places that can be seen from long hours of work, the more likely dust will accumulate in the lungs. This is the result of accumulation of inhalation during work. Working for many years can affect the health conditions of workers because of the frequent frequency of exposure [15].

In the exposure duration variable on the plywood industry, there are 3 shifts/day, namely morning, afternoon, evening, each shift has 8 hours of work/day so that all workers have the same hours to work as many as 142 (100%) respondents have been exposed to doing their work. The longer the worker does his job, the more he is exposed to the hazards posed by his work environment [16].

In the use of personal protective equipment (PPE) variable in the form of masks, as many as 88 (62.0%) of respondents were incomplete in using PPE when doing their work and as many as 54 (38.0%) of other respondents were complete in using PPE while doing work,
However, many respondents use masks that do not meet the standards because many respondents still use cloth masks, used clothes, or buff masks which cause pollutants in the work environment to enter the respiratory tract.

Regarding the smoking habit variable, the results of research conducted by interviewing female workers in the plywood industry with smoking habits showed that out of 142 female workers, none had a smoking habit. The resulting cigarette smoke can affect the escalator mucociliary system which can make it easier for dust to enter the lower respiratory tract so that it can worsen human health conditions.

3.3 The Case of Acute Respiratory Infection on Plywood Industry Workers

The case of ARI data was obtained from the measurement results using a research instrument in the form of a questionnaire (QUES BMRC 86).

The results of the frequency distribution the case of acute respiratory infections are presented as follows:

<table>
<thead>
<tr>
<th>The Case of ARI Category</th>
<th>F (Person)</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Occur</td>
<td>40</td>
<td>28.2</td>
</tr>
<tr>
<td>Not occur</td>
<td>102</td>
<td>71.8</td>
</tr>
<tr>
<td>Total</td>
<td>142</td>
<td>100</td>
</tr>
</tbody>
</table>

In this research, the measurement and the case of ARI variables in plywood industry workers in PT. Muara Kayu Sengon, Jatilawang District, Banyumas Regency was grouped into 2, namely occur ARI and no occur ARI. Measurement data on 142 workers at 17 points of the plywood processing stage around the industrial area showed that 40 workers experienced occur ARI with a percentage of 28.2%, while 102 workers experienced no occur ARI with a percentage of 71.8%.

The majority of plywood industry workers complain of itchy noses, sneezing, nasal congestion, runny nose, shortness of breath, wheezing and coughing while doing their jobs, especially workers who are close to cutting and sanding wood. This is a reflex from the body when a foreign object enters the body through the respiratory system. The work environment with high air pollution greatly influences the case of ARI.

Acute Respiratory Infection (ARI) according to the World Health Organization in 2007 is an upper or lower respiratory tract disease, usually contagious, which can cause a wide spectrum of disease that ranges from asymptomatic disease or mild infection to severe and deadly disease, depending on the causative pathogen, environmental factors and host factors.

ARI is defined as an acute respiratory disease caused by an infectious agent that is transmitted from human to human. The onset of symptoms is usually rapid, ie within a few hours to several days. Symptoms include fever, cough and often sore throat, frequent sneezing, runny nose, shortness of breath, wheezing or difficulty breathing. ARI is one of the workers’ problems, especially for workers who do work with high levels of dust exposure. ARI causes chronic airflow limitation, especially the increased resistance to airways during expiration.

Various factors which influential in emergence the case of ARI consequence dust is characteristics dust, which cover size particle, shape, concentration, one late, and nature chemical, as well as long exposure. Factor individual covers mechanism defense lungs, anatomy, and physiology channel respiratory as well as factor immunological. Factor another which causing occur ARI is profession work which done by someone.

The case of ARI in workers who are in a work environment with high dust levels can be influenced by various factors. One of the modifiable factors for the case of ARI is the completeness in the use of personal protective equipment. Meanwhile, other factors that cannot be changed include age and history of respiratory tract disorders.
be prevented if self-control is carried out. To prevent ARI, it is necessary to adopt a healthy lifestyle such as exercising and consuming healthy food, as well as improving the cleanliness of the surrounding environment to improve quality of life and better quality of the environment.

### 3.4 Analysis Association Between PM$_{2.5}$ Wood Dust Exposure and the Case of ARI

PM$_{2.5}$ wood dust exposure, years of service, use of personal protective equipment (PPE) and age are the independent variables that will be tested with the dependent variable, namely the case of ARI. Test Chi-square used in the analysis with a p value <0.05 which indicates a statistically significant association between. The value of RP (Prevalence Ratio) of more than 1 (≥1) is interpreted as the variable studied is a risk factor associated with the case of ARI.

<table>
<thead>
<tr>
<th>Variable</th>
<th>The Case of ARI</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n = 142</td>
<td>Occur</td>
<td>Not occur</td>
<td>p-value</td>
<td>RP</td>
</tr>
<tr>
<td>PM$_{2.5}$ Dust Exposure</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Above (≥ 5 mg/m$^3$)</td>
<td>39 (27.5%)</td>
<td>68 (47.9%)</td>
<td>&lt;0.001*</td>
<td>12.757</td>
<td>1.819</td>
</tr>
<tr>
<td>Below (&lt; 5 mg/m$^3$)</td>
<td>1 (0.7%)</td>
<td>34 (23.9%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Working Period</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≥ 5 Years</td>
<td>37 (26.1%)</td>
<td>32 (22.5%)</td>
<td>&lt;0.001*</td>
<td>13.048</td>
<td>4.217</td>
</tr>
<tr>
<td>&lt; 5 years</td>
<td>3 (2.1%)</td>
<td>70 (49.3%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PPE use</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Incomplete</td>
<td>37 (26.1%)</td>
<td>51 (35.9%)</td>
<td>&lt;0.001*</td>
<td>7.568</td>
<td>2.453</td>
</tr>
<tr>
<td>Complete</td>
<td>3 (2.1%)</td>
<td>51 (35.9%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt; 40 Years</td>
<td>35 (24.6%)</td>
<td>44 (31.0%)</td>
<td>&lt;0.001*</td>
<td>5.582</td>
<td>2.323</td>
</tr>
<tr>
<td>≤ 40 Years</td>
<td>5 (3.5%)</td>
<td>58 (40.8%)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* : Test the association using Chi-square - Continuity Correction

### 3.5 Association Between of PM$_{2.5}$ Wood Dust Exposure and the Case of ARI

The results obtained from table 3 show that out of 107 respondents who were exposed to wood dust PM$_{2.5}$ above the Threshold Value (≥ 5 mg/m$^3$) there were 39 (27.5%) respondents who experienced the case of ARI while out of 68 (47.9%) respondents who were exposed to PM$_{2.5}$ wood dust did not experience the case of ARI. There were 35 respondents who were exposed to dust below the Threshold Value (< 5 mg/m$^3$) there was 1 (0.7%) respondent who experienced an the case of ARI and 34 (23.9%) other respondents did not experience an the case of ARI.

Statistical test results Chi-square earned value p-value = <0.001 (p-value <0.05) which indicates that there is a association between PM$_{2.5}$ wood dust exposure and the case of ARI in plywood industry workers at PT. Muara Kayu Sengon, Jatilawang District, Banyumas Regency with grades Prevalence Ratio (RP) from the statistical test of 12,757 with 95% Confidence Interval (CI) = 1.819 – 89.477 which means that plywood industry workers are exposed to PM$_{2.5}$ wood dust exceeds the Threshold Value (> 5 mg/m$^3$) has a risk 12,757 times.
3.6 Association Between Working Period and the Case of ARI

≥ 5 years, there were 37 (26.1%) respondents who experienced and ≥ 5 years, there were 37 (26.1%) respondents who experienced and ≥ 5 years, there were 37 (26.1%) respondents who experienced and ≥ 5 years, there were 37 (26.1%) respondents who experienced and ≥ 5 years, there were 37 (26.1%) respondents who experienced and ≥ 5 years, there were 37 (26.1%) respondents who experienced and ≥ 5 years, there were 37 (26.1%) respondents who experienced and ≥ 5 years, there were 37 (26.1%) respondents who experienced and ≥ 5 years, there were 37 (26.1%) respondents who experienced and ≥ 5 years, there were 37 (26.1%) respondents who experienced and ≥ 5 years, there were 37 (26.1%) respondents who experienced and ≥ 5 years, there were 37 (26.1%) respondents who experienced and ≥ 5 years, there were 37 (26.1%) respondents who experienced and ≥ 5 years, there were 37 (26.1%) respondents who experienced and ≥ 5 years, there were 37 (26.1%) respondents who experienced and ≥ 5 years, there were 37 (26.1%) respondents who experienced and ≥ 5 years, there were 37 (26.1%) respondents who experienced and ≥ 5 years, there were 37 (26.1%) respondents who experienced and ≥ 5 years, there were 37 (26.1%) respondents who experienced and ≥ 5 years, there were 37 (26.1%) respondents who experienced and ≥ 5 years, there were 37 (26.1%) respondents who experienced and ≥ 5 years, there were 37 (26.1%) respondents who experienced and ≥ 5 years, there were 37 (26.1%) respondents who experienced and ≥ 5 years, there were 37 (26.1%) respondents who experienced and ≥ 5 years, there were 37 (26.1%) respondents who experienced and ≥ 5 years, there were 37 (26.1%) respondents who experienced and ≥ 5 years, there were 37 (26.1%) respondents who experienced and ≥ 5 years, there were 37 (26.1%) respondents who experienced and ≥ 5 years, there were 37 (26.1%) respondents who experienced and ≥ 5 years, there were 37 (26.1%) respondents who experienced and ≥ 5 years, there were 37 (26.1%) respondents who experienced and ≥ 5 years, there were 37 (26.1%) respondents who experienced and ≥ 5 years, there were 37 (26.1%) respondents who experienced and ≥ 5 years, there were 37 (26.1%) respondents who experienced and ≥ 5 years, there were 37 (26.1%) respondents who experienced and ≥ 5 years, there were 37 (26.1%) respondents who experienced and ≥ 5 years, there were 37 (26.1%) respondents who experienced and ≥ 5 years, there were 37 (26.1%) respondents who experienced and
The results of the study are in line with research conducted by Nafisa's in 2016, which stated that workers who had worked for more than ≥ 5 years as many as 29 people had a risk of experiencing impaired lung function ($p = 0.026$) [11]. In addition, this study is in line with research conducted by Sinaga's in 2019, which showed that tenure at work can cause lung function ≥ 5 years in as many as 24 (60%) [14].

The results of this study are in line with research conducted by Yusof's in 2019, which shows that the high exposure group and workers who worked 10 years or more showed decreased lung function [20].

Things that can be done to reduce the risk caused by dust exposure should be for workers in the plywood processing industry whose working period is ≥ 5 years to get enough rest and flexible working hours so they don't stay in the industrial environment for too long when the work done has been completed. Fellow industrial workers can arrange a work schedule for each worker who carries out his activities at 1 point in order to reduce the risk and the case of ARI occurring in workers. In addition, alternative solutions to reduce the risk and the case of ARI in workers who have worked for ≥ 5 years based on theory are carrying out routine health checks, using personal protective equipment, adopting a healthy lifestyle such as exercising and getting enough rest.

By doing these things, you can reduce the risk of developing the case of ARI from an early age. Therefore, people who check their health regularly can find out whether there is a problem in their body caused by working in a risk place for a long time.

3.7 The Association Between the Use of Personal Protective Equipment (PPE) and the Case of ARI

The results of interviews and observations made at the time of data collection showed that out of 142 respondents there were 88 respondents who did not fully use personal protective equipment (PPE) there were 37 (26.1%) respondents who experienced the case of ARI and 51 (35.9%) others did not experience the case of ARI. Of the 54 complete respondents using PPE, there were 3 (2.1%) respondents who experienced the case of ARI and 51 (35.9%) other respondents did not experience the case of ARI.

Statistical test results prove that there is a significant association between the use of personal protective equipment (PPE) and the case of ARI on plywood industry workers in PT. Muara Kayu Sengon, Jatilawang District, Banyumas Regency ($p$ value $= <0.001$; IDR 7,568; 95% CI $= 2.453 – 23.352$). The value of RP $= 7.568$ means that workers in the plywood industry who do not use personal protective equipment in the form of masks have a 7.568 times greater risk of experiencing the case of ARI compared to workers who use masks while doing their work.

The use of personal protective equipment is very important to use when doing work and minimize the occurrence of exposures that can enter the body, one of which enters through breathing and skin. Plywood processing industry workers are at high risk of being exposed to dust inhaled through the respiratory tract such as the mouth and nose. The use of personal protective equipment (PPE) is very important to use when working to minimize exposure received by the body. One way to prevent dust absorption from entering the body is by using personal protective equipment (PPE) in the form of a mask which functions to protect the respiratory tract and acts as a place for outside exposure to enter. For this reason, plywood industry workers should be able to use PPE in the form of masks and extras such as long-sleeved shirts, trousers, gloves, glasses, hats, aprons and shoes to avoid direct contact with dust during the plywood processing. In addition, between workers can remind one worker to another to use personal protective equipment, especially masks when doing work.
very risk, namely at the stage of cutting and sanding wood, the closer to the area, the greater the level of dust pollutants received and the greater the likelihood that respondents will experience an ARI if they do not use personal protective equipment. The results of another study conducted by Nafisa's in 2019, found that 19 workers had a habit of using PPE (masks) and most only used PPE at certain times or occasionally. The results of the statistical test analysis obtained a $p$-value = 0.049, so $p < 0.05$ so that there was a significant association between the use of PPE (masks) and lung function capacity in workers [11]. Another similar study was conducted by Sinaga's in 2019, which stated that there were 22 workers (55%) who did not use PPE with pulmonary failure [14]. The case of ARI can result from negligence or incompleteness of workers in using PPE in the form of masks while working [22]. In the meantime, the Minister of Health's Regulation No. 48 of 2016 concerning OSH Standards stipulates that one of the occupational health standards is improving occupational health by increasing knowledge of occupational health, so it is hoped that health workers from health centers or other health workers can provide information and education about the use of masks that are good and correct when working in areas dusty and the health impacts that might be caused [23].

3.8 Association Between Respondents of Age and the Case of ARI

Of the 79 respondents aged > 40 years, there were 35 (24.6%) respondents who had the case of ARI and 44 (31.0%) other respondents who did not have the case of ARI. Of the 63 respondents aged ≤ 40 years, there were 5 (3.5%) respondents who had the case of ARI and 58 (40.8%) other respondents who did not experience the case of ARI. Statistical test results obtained ($p$ value = <0.001, $R^2 = 5.582$, 95% CI = 2.323 – 13.413) which means there is an association between age and the case of ARI on plywood industry workers in PT. Muara Kayu Sengon, Jatilawang District, Banyumas Regency. Result $R^2 = 5.582$ with 95% Confidence Interval (CI) = 2.323 – 13.413 which means that workers in the plywood industry aged > 40 years are 5.582 times more likely to experience an ARI event than workers aged ≤ 40 years. People aged 40 years will experience a decrease in the function of organs including the respiratory organs so that it can cause respiratory problems such as the case of ARI if they do not take preventive measures such as exercise and maintain a healthy lifestyle. The older a person is, the more likely there is a decrease in lung function with symptoms of breathing becoming heavier and the vital capacity of the lungs in the respiratory system decreases, plus if you don't take preventive measures to reduce the severity of respiratory disorders. People who are under 40 years of age but have experienced respiratory problems such as the case of ARI can be caused by several things such as lack of exercise which causes the elasticity of the lung and chest muscles to decrease and does not have enough rest time [24]. Respiratory work function will increase with age so that there is a decline after reaching the point of adulthood both pulmonary diffusion and oxygen inspiratory processes according to age changes. As we get older, the respiratory system becomes more vulnerable to disorders/disease especially when there is a great opportunity to be exposed to components that can cause a reaction. The age variable in this study has an association with the case of ARI, therefore to reduce the risk an ARI occurrence both at a young and old age which is based on theory is to maintain a healthy lifestyle such as exercising regularly, not smoking, managing a healthy diet and getting enough rest. By carrying out these activities, it will reduce the risk early on for respiratory disorders such as the case of ARI because the organs of the body, especially the respiratory organs, become healthier.

The results of another study conducted by Nafisa's in 2019, found that the age of the most respondents was in the 31-40 year category as many as 12 people, the highest was 60.
years, the lowest was 20 years with lung function capacity [11]. Another similar study was conducted by Sinaga's in 2019, which stated that there were > 40 years of age, 23 workers (60%) with pulmonary function [14].

Precautionary measures in order to reduce the risk of respiratory complaints or the case of ARI in workers aged > 40 years, it is better for these workers to be facilitated by periodic checks to see whether increasing age in workers will affect the worker's lung capacity and check whether there are symptoms of respiratory problems such as the case of ARI or occupational diseases felt on plywood industry workers in PT. Muara Kayu Sengon, Jatilawang District, Banyumas Regency.

4. Conclusion

The conclusion from the results of this study found 4 variables that had an association with the case of ARI on plywood industry workers in PT. Muara Kayu Sengon, Jatilawang District, Banyumas Regency, namely exposure to PM$_{2.5}$ wood dust, years of service, use of personal protective equipment and age. While the variables that have no association with the case of ARI in workers are the duration of exposure and smoking habits. PM$_{2.5}$ wood dust exposure inhaled to the case of ARI namely above the Threshold Value (> 5 mg/m$^3$) have a 12,757 times greater risk of experiencing the case of ARI. Plywood industry workers are exposed to PM$_{2.5}$ wood dust above the Threshold Value is expected to use personal protective equipment in the form of a mask to avoid direct exposure to dust during the plywood manufacturing process.

5. References


