RELATIONSHIP OF WORKERS' CHARACTERISTICS AND THE USE OF PERSONAL PROTECTIVE EQUIPMENT AGAINST THE ENHANCEMENT OF C-REACTIVE PROTEIN SERUM ON KAPOK-PROCESSING INDUSTRY WORKERS AT BANDREK, PASURUAN

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ABSTRACT

Introduction: The cotton processing industry is an industry that produces cotton dust during the production process. Workers are at risk of exposure to cotton dust, if inhaled and accumulated in the body will cause inflammation that causes an increase in C-Reactive Protein (CRP) serum. The purpose of this research was to determine the relationship between the use of personal protective equipment and worker characteristics that can cause an increase in serum CRP of workers before and after work in the cotton processing industry. **Methods:** This was observational research with a prospective longitudinal design. Respondents in this study were 11 workers in Bandrek village, Mojotengah, Pasuruan. Data collection of worker characteristics was done by interview and observation. Personal dust content data was collected using a personal dust sampler (PDS) with gravimetric calculation methods. increase in CRP data collection using blood specimen collection before and after and conducted laboratory testing using i-chroma reader. Measurement of average dust levels of 5.49 mg / m^3. **Result:** There was no significant correlation between personal dust level ($p = 0.324$) and the use of PPE ($p= 0,925$) with the increase in CRP serum levels. There was a significant correlation between the ages of workers ($p = 0.005$), years of service ($p = 0.006$), and length of work ($p = 0.004$) with the increase in CRP serum level. **Conclusion:** The older the workers, the longer the working period and the longer the working hour, the higher the increase of CRP serum level would be.

Keywords: Worker characteristics, Personal protective equipment, and C-Reactive protein

INTRODUCTION

The development of industrial sectors in Indonesia is growing rapidly, especially in today's globalization era. The development of industry in Indonesia has a positive impact, one of which is the job opportunities for the community around the industry. The impact will affect the increase of economy in the community indirectly (Purwasih & Soesatyo, 2017). However, the growing industry will harm the environment and workers. Environmental problems will arise (environmental pollution) such as air, water, and soil pollution. Health problems that will arise will give a poor impact on the health of workers and communities that are located around the industry (Sampul *et al*., 2015).

Air pollution is the inclusion of substances, energies, and/or other components into the air by human activities, so that air quality decreases to a certain degree that affects human health (Ministry of Health 2002). *The World Health Organization* (WHO) estimates that in 2016, about 58% of early deaths due to outside air pollution were caused by heart disease and ischemic stroke. While 18% of deaths are caused by chronic obstructive pulmonary disease and acute lower respiratory tract infections, and 6% from death due to lung cancer. Exposure to chemicals and physical or biological substances will cause air pollution (WHO, 2018).

In Indonesia, nearly half of Indonesia's population, or about 100 million people work in the agricultural

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sector. Ministry of Agriculture made efforts to nurture business actors to become a foundation to support Indonesia's economy (Kementerian Pertanian, 2018). Kapok industry is one of the industries that are in the agricultural sector. According to *International Labor Organization* (ILO), about 2.3 million people in the world died (due to work) because of the occurrence of occupational accidents and occupational diseases. Work-induced illness dominates the death case of 2.02 million cases so the need to improve health and safety for workers (Departement of Health, 2015). Agriculture work when associated with working conditions, it poses certain risks such as exposure to harmful substances (eg. chemical substances or radiation). A common form of illness found is pneumoconiosis. This work is a dangerous job and kills thousands of people in the world. ILO states that pneumoconiosis disease is one of the work-induced illnesses suffered by many workers.

Kapok industry is one of the industries that produce kapuk dust, resulting in a negative impact on worker health. The impact caused by dust during kapok-production process is one of the risk factors. Dust is a hazardous chemical as the impact of air pollution with a concentration exceeding the Threshold Limit Value (TLV) that has been set. These chemical hazards can be absorbed by the worker through the respiratory (inhalation), through the skin, and can be swallowed or eaten (ingested). Chemicals that are absorbed by the worker will negatively affect the health of workers. So, worker health needs to be monitored from the exposure to air pollution in the workplace (Lestari, 2010).

The research conducted by Fujianti et al (2015), showed that there is a link between the dust level and the symptoms of respiratory problems in workers. According to the research conducted by (Akunsari, 2010), it shows that cotton dust in the cotton industry environment exceeds the TLV limit which results in the decrease in pulmonary function. The decrease in pulmonary function is due to inflammation in the body. Inflammation is a reduction of body response. In the lungs, inflammation is usually caused by pathogens or by exposure to toxins, pollutants, irritants, and allergens. During inflammation, many types of inflammatory cells are activated. Each of them releases cytokines and mediators to modify the activity of other inflammatory cells. This cell and molecule orchestration lead to the development of inflammation (Moldoveanu *et al.*, 2009).

Low lung capacity may cause an increase in C-Reactive Protein (CRP) Hancoxa et al (2016). The presence of cytokine removal in the body (TNF-α, IL-1, IL-6) results in inflammatory cell activation and stimulates the liver to produce CRP. CRP is produced rapidly and causes an increase in the number of CRP (Handayani, 2014). CRP is a plasmatic protein from the pentraxin and acute-phase reactant family, which is very useful as a common inflammatory marker (Salazar *et al*., 2014).

Kapok dust enters through inhaled pathways in healthy subjects with different doses which results in the inflammatory cells, respiratory epithelium, and the release of certain cytokines. This causes decreased airflow, increased CRP, clinical symptoms of fever, and changes in lung function. During inflammation, there is endotoxin which stimulates macrophages to release proinflammatory cytokines and CRP. CRP serum levels can diagnose the process of inflammatory events in the body (Handayani, 2014). Increased CRP may result in increased plasma viscosity so that the blood erythrocyte sedimentation rate will increase. The presence of a high CRP indicates a persistent infection. CRP is produced by the liver as an inflammatory cytokine reaction (Baratawidjaja & Rengganis, 2012).

Kapok industry is one industry that has a risk of dust exposure that can harm the health of employees if it is not managed properly. The low awareness of workers to use good respiratory protection equipment

leads to a higher risk of workers being exposed to respiratory disorders. According to the research (Naini, 2009), workers who do not use Personal Protective Equipment (PPE) have a risk 5.38 times higher for respiratory disorders compared to workers who use PPE such as masks. Mask is one of the PPE that should be used in a dust-production working environment. This is because 90% of poisoning cases are caused by the presence of toxic or corrosion chemicals that enter the body through the respiratory pathways (Sa'diyah, 2013).

Industrial workers are working to make a living by fulfilling their household needs so that the health and safety of workers must be assured. Therefore, it was necessary to conduct further research on the relationship of workers' characteristics and the use of Personal Protective Equipment (PPE) to the increased levels of CRP serum on workers in the Kapuk industry, Mojotengah, Pasuruan regency.

METHOD

The type of research used was observational research by using 'an analytical research design. In terms of time, this research was a *longitudinal study prospective.* This research was conducted in one of the kapok-processing industry at Bandrek, Mojotengah, Sukorejo District, Pasuruan Regency. In this research, the population consists of 12 workers in the household industry of kapok processing in Mojotengah village, Sukorejo District, Pasuruan. The population of the study was a population that meets the criteria of inclusion; (1) employees with an age range of 17-55 years old, (2) working at least 1 year, and (3) willing to become a respondent by following a series of sampling activities in this study. The size of samples was determined by calculation using the Lameshow formula. After being calculated using the Lameshow formula, there were 11 workers as the respondents. The samples in this study were workers who meet the criteria of inclusion. The method used for sampling was the *simple random sampling* method that all workers have the same opportunity to become samples of this research. The independent variables used in this study were personal kapok dust levels, PPE usage, and worker characteristics such as age, working period, and length of work. While the dependent variable in this study is the increased CRP serum levels of workers.

The Data collection used were interviews, observation, and measurement techniques. The interview technique is done for the data collection on the respondent's characteristic variables including age, working period, and length of work as well as the use of PPE on workers while working. Observation techniques are used to support data collection which is done by interview techniques.

The measuring technique conducted in this study included measuring personal dust levels as well as measuring increased CRP levels of workers. The measurement of personal dust levels is carried out using a Personal Dust Sampler (PDS) tool for 8 hours and uses a Gravimetric method to analyze personal dust levels. Measurement of personal dust content carried out by officers from the Technical Implementation Unit of Occupational Safety Surabaya. Measurement of increased CRP levels was done by sampling the blood of the worker before and after work and analyzed using the method of *fluorescence immunoassay i-CHROMA T^{M} Reader*. Blood sampling on workers was done by officers from Cendana Laboratory, Pasuruan.

The data that had been collected were analyzed gradually from the descriptive analysis of each variable to the analysis using a statistical test that includes Sapiro wilk test, and Spearman correlation test with 95% degree of confidence (α = 0.05). This research had been expressed by certificate No. 414/HRECC. FODM/VI/2019 issued by the Health Research Ethical Clearance Commission of Airlangga University**.**

RESULT

Table 1. Result of personal dust level measurement on kapok-processing industry workers at Bandrek, Mojotengah, Pasuruan, the year 2019

Respondents	Result of measurement (mg/m^3)	>TLV
A	6.42	≤ TLV
B	1.01	≤ TLV
C	1.58	> TLV
D	5.74	≤ TLV
E	0.21	> TLV
F	4.05	≤ TLV
G	1.81	> TLV
H	3.04	>TLV
I	17.93	>TLV
J	11.51	>TLV
K	7.1	>TLV
Mean	5,49	
Minimum	0,21	
Maximum	17,93	

Table 2. Distribution of PPE usage on kapok-processing industry workers at Bandrek, Mojotengah, Pasuruan, year 2019

PPE Usage	N	%
Yes	8	27,3
No	3	72,7

Table 3. Characteristic distribution of kapok-processing industry workers at Bandrek, Mojotengah, Pasuruan, year 2019

Variables	N	%
Age		
31-35	2	18,2
36-40	4	36,3
41-45	2	18,2
46-50	2	18,2
51-55	1	9,1
Mean	41	
Minimum/Maximum	35/53	
Working period		
1-3	1	9,1
4-6	6	54,5
7-9	2	18,2
10-12	2	18,2
Mean	6	
Minimum/ Maximum	3/10	
Length of work		
≤ 8 hours	3	27,3
> 8 hours	8	72,7

Variables	N	%
Mean	8,4	
Minimum/ Maximum	6/9	

Table 1. indicates that the average of personal dust level measurement result was 5.49 mg/m^3, with the lowest dust content of 0.21 mg/m^3 and the highest one of 17.93 mg/m^3. There were 4 points of dust measurement that result in smaller than the TLV determined by the regulations of Minister of Manpower and Transmigration No. 5 Year 2018 about occupational health and safety of the working environment at 3 mg/m^3. And 7 measuring points exceed the Threshold Limit Value (TLV). Table 2 explains the distribution of PPE among industrial workers in kapok-processing industry. There are 8 workers who use PPE at work and 3 workers who do not use the PPE while working.

Table 3 shows that there are 2 workers (18.2%) aged in the range of 31-35 years, 4 workers (36.3%) aged in the range of 36-40 years, 2 workers (18.2%) aged in the range of 41-45 years, 2 workers (18.2%) aged at range 46-50 years, and 1 worker (9.1%) aged at a range of 51-55 years. The average age of workers is 41 years old with the youngest age of 35 years, while the oldest one is 53 years. Table 3 shows that the minimum working period of workers in the kapok-processing industry at Bandrek in this study is 3 years and the longest working period is 10 years, while the average working period of workers is 6 years. In table 3, it shows that the fastest length of work for industry workers is 6 hours and the longest one is 9 hours. The average length of work is 8.4 hours.

Table 4 shows the results of the CRP content measurement before and after work. The result of the measurement shows that there are 4 workers (36.4%) having increased CRP levels, 6 workers (54.5%) having decreased CRP levels, and 1 worker (9.1%) having fixed CRP levels. The average of increase is 0.02 EU/m^3.

Table 4. Distribution of C-Reactive Protein (CRP) Serum examination on kapok-processing industry workers at Bandrek, Mojotengah, Pasuruan, year 2019

Respondents	CRP levels before (mg/L)	CRP levels after (mg/L)	Description
A	4.25	4.14	Decrease
B	2.85	2.98	Increase
C	3.12	3.01	Decrease
D	3.49	3.32	Decrease
E	5.31	5.36	Increase
F	1.22	1.05	Decrease
G	3.14	3.64	Increase
H	3.7	3.54	Decrease
I	1.44	1.44	Unchanged
J	1.78	1.53	Decrease
K	4.15	4.61	Increase
Mean	3,13	3,15	
Minimum/Maksimum	1,22/5,31	1,05/5,36	

Table 5. Analysis of relationship between dust level and the movement of CRP Serum levels on kapok-processing industry workers at Bandrek, Mojotengah, Pasuruan, year 2019

Variable	CRP Movement (mg/L)	
	Significant Value (p)	
Personal kapok dust level	0,324	Personal kapok dust level

Table 6. Analysis of relationship between ppe usage and the movement of CRP Serum on kapok-processing industry workers at Bandrek, Mojotengah, Pasuruan, year 2019

Variable	CRP Movement (mg/L)	
	Significant Value (p)	
PPE Usage	0,925	PPE Usage

Table 7. Analysis of relationship between workers' characteristics and the movement of CRP Serum levels on kapok-processing industry workers at Bandrek, Mojotengah, Pasuruan, year 2019

Workers' characteristics	CRP Movement (mg/L)	
	Significant Value (p)	
Age (year)	0,005	Age (year)
Working period (year)	0,006	Working period (year)
Length of work (day)	0,004	Length of work (year)

A correlation test is used to see the relationship between the personal dust levels and the movement of CRP levels on workers before and after work. The results of the analysis can be seen in Table 5 which shows a significant value of 0.324. This means that there is no link between the personal dust levels and the movement of CRP Serum on kapok-processing industry workers at Bandrek, Pasuruan, 2019. Table 6 shows the significant value between the uses of PPE against the movement of CRP by 0.925. This means there is no link between the use of PPE and the movement of CRP serum levels of workers before and after work.

Table 7 shows that the significant value between the age to increased CRP was 0.005, meaning that there was a relationship between the worker's age to the increase in serum CRP levels of workers before and after work. The value of the correlation coefficient was 0.780; meaning that the positive relationship between ages to increased CRP was very strong. Table 7 shows the significant value between the length of work against the increased CRP by 0.006. This means that there was a relationship between workers' working period and the movement of CRP Serum levels of workers before and after working. The value of the correlation coefficient was 0.761, meaning that there was a positive relationship between the working period to the increased CRP which was a very strong relationship. Table 7 shows a significant value between the length of work against the movement of CRP by 0.004. This means that there is a relationship between the workers' length of work to the increased CRP serum before and after work. The value of the correlation coefficient between the length of work and the increase in the CRP was 0.787, meaning that there was a positive relationship between the length of work and the increasing CRP, which had been a very strong relationship.

DISCUSSION

Personal Dust Level

Kapok-processing industry is one of the industries that produce dust in its processing. Dust is a solid particle that

originates from human activities and natural processes (Mukono, 2010). Kapok dust is respiratory dust that easily causes the condition of the pulmonary to decline. So that workers are easily affected by diseases, especially diseases that attack breathing organs (Helmy, 2019).

Inspection of dust levels is carried out by officers from the Technical Implementation Unit of Occupational Safety of Surabaya. Dust level check is measured using the PDS tool with a filter from fiberglass material. Dust level inspection is done when the worker performs the kapok-processing process. The TLV of kapok dust has been stipulated in the regulations of the Minister of Manpower and Transmigration No. 5 year 2018 on occupational safety and health environmental work of 3 mg/m^3 for 8 hours a day or 40 hours a week. The result of the average personal dust level measurement was 5.49 mg/m^3. When it is compared to the TLV, the result of the measurement has exceeded the threshold value. This is because the dust particles contained in the kapok-processing industry have a smaller size. The dust that is resulted from the processing process will continuously cause inflammation indicated by the increase in the CRP.

The inhalation of the dust and its accumulation in the body will result in a decrease in lung function and become the cause of immunological symptoms in the respiratory tract. Possible immunological symptoms are asthma and *rhinitis* allergies, toxic pneumonitis (a syndrome in toxic organic dust), *pneumonitis granulomatosa* (Extrinsic allergies to *Alveolitis* and hypersensitivity to *Pneumonitis*), chronic bronchitis and decreased pulmonary function. The mechanism of these symptoms is still not well understood (Vogel et al., 2012; Poole et al., 2010).

CRP Levels

CRP is one of the proteins in the acute phase, belonging to the protein group in the blood, and can be increased in acute phase infections as a form of the non-specific immune response. Recent studies show more evidence that CRP plays an important role in inflammatory processes and host responses to infections including complement pathways, apoptosis, phagocytosis, nitric oxide (NO) release, and cytokine production, especially IL-6 and TNF-α. Unlike recent publications, early findings of the CRP may appear somewhat obscure and sometimes contradictory. Transcription induction of the CRP gene occurs in hepatocytes in the liver as a response to the elevated levels of inflammatory cytokines, especially IL-6. CRP can demonstrate increased expression during inflammatory conditions such as *rheumatoid arthritis*, some *cardiovascular* diseases, and infection. As an acute phase of protein, the plasma concentration of CRP deviates at least 25% during inflammatory disorders. The highest CRP concentrations are found in serum, with multiple bacterial infections increasing up to 1,000 times. However, when the stimulus ends, the CRP value decreases exponentially for 18-20 hours, close to the CRP's half-life. Plasma levels of CRP increased from approximately 1 μg/mL to more than 500 μg/mL within 24-72 hours of severe tissue damage such as trauma and progressive cancer (Sproston & Ashworth, 2018). The rate of CRP according to consensus which is less than 5 mg/L is considered normal. Mild inflammation or mild infections is less than 40 ml/L. Active inflammation or bacterial infections is 40-200 mg/L. Severe inflammatory such as an invasive bacterial infection has some degree of malignancy reaching 500 mg/L (Aguiar *et al*., 2013; Irving *et al*., 2010).

This study in table 4, shows an increase in CRP by 36.3%. The causes of increased CRP were an increase in phagocytosis, clearance of Microoba, and cell death (Apoptosis). Those processes are called opsonization. The opsonization occurs not only due to the increase in CRP but also involves other cells of the immune system, especially macrophages and

neutrophils (Baratawidjaja & Rengganis, 2012).

In this study, there was a fixed CRP rate of 9.1% and a decrease of 54.7% as well. This research is in line with research (Handayani, 2014) stating that there are regulatory mechanisms played by Toll-Like Receptors (TLR) to regulate negative-gram bacteria. TLR which recognizes the presence of negative-gram bacteria is TLR4. So that, if negative-gram bacterial levels are high, TLR will be induced. When the negative-gram rate is low, then the regulatory process will not occur.

The relationship between dust levels against increased CRP levels

Based on the Spearman test that had been conducted to see the relationship of personal wood dust levels with the increase in CRP, it was obtained the result of *p*= 0,925 which means that there was no relationship between the personal wood dust levels with the increase in CRP. This is because the size of dust that does not contain endotoxin will not affect the increase in CRP. The inflammatory state of the body will trigger the liver to produce the CRP rapidly and resulting in an increase in it (Sproston & Ashworth, 2018).

The research on dust levels against inflammatory events is characterized by the increase in TNF-α. This is in line with the research that stated that the size of dust that does not contain chemicals or other substances will not affect the inflammatory occurrence (Meifina, 2018). Another study expressed that personal dust levels have nothing to do with inflammatory events. The one that leads to the presence of inflammatory events is the LPS endotoxin. The study said that the presence of an increased level of IL-8 serum will begin with the onset of inflammation. This suggests that even though dust is used as an ingredient extracted to determine the endotoxin levels, the levels of the endotoxin do not originate from dust but the outer components of a negative-gram bacteria wall. So that the cause of the existence of inflammatory events in the body is not dust (Lusno, 2013).

The Use of Personal Protective Equipment (PPE)

The analysis was using the Spearman test to see the relationship between the use of PPE on workers with the increase in CRP serum before and after work (*cross shift*). It shows the *p* of 0,925 which means that there was no connection between the use of PPE on workers and the increased CRP serum before and after work (*cross shift*). The PPE used by the kapok-industrial workers has not been considered PPE since it still cannot protect the respiratory tract. This is due to the used PPE having large pores, while the dust can enter through the pore gaps of the PPE used by workers.

According to Perdana & Muliatna (2014) the research that has been conducted, it is stated that there is an influence of the implementation of PPE in workers on occupational health and safety. The PPE used by workers must be worthy and compliant. One of the appropriate PPE to protect workers in kapok industry is a mask. This is because in kapok industry, dust is much produced and there are 90% of poisoning cases due to exposure to toxic or corrosive chemicals that enter the body through the respiratory organs (Sa'diyah, 2013).

The relationship of workers' characteristics to increased CRP levels
Age

Increasing age will be more susceptible to disease, due to changes in the metabolism body and hormonal imbalance. This research is in line with research (Meifina, 2018) which stated the older the age of someone, the more likely the occurrence of inflammatory effects on the worker's body. The inflammatory effect on workers can be known by increased CRP.

From the results of the analysis using a Spearman correlation test, it was

obtained *p*= 0.005 which means that there was a relationship between workers' age with the increase in CRP serum before and after work (*cross shift*). In this research, workers who had increased CRP were those who aged above the average age of workers. The results of this study are reinforced by the result of a previous study which stated that the highest result of CRP levels is found in the older age groups. At a young age, if it is found high CRP examination results, then it is more likely that the inflammation to happen (Wyczalkowska-Tomasik *et al*., 2016). (Karepowan *et al*., 2018) stated that a person who grows up will be increasingly susceptible to diseases, due to a decrease in physical condition from the cell to all organs of the body.

Working period

The working period is a vulnerable time for a worker working in the industry where they work. The working period plays a role in determining the length of exposure, resulting in the accumulation of exposure which is a risk factor for the health impact of workers (Aji *et al*., 2012). This research is in line with research conducted by (Handayani, 2014) stated that the working period causes a decline in lung function because the inhalation of dust will settle into various organs depending on the particle type, and size of particles, exposure length, and pollutants. Dust sized 0.5-25 micron generally harms health. From the analysis of the results using the Spearman correlation test, it was obtained *p*= 0.006 which means that there was a relationship between the working period of workers with the increase in CRP serum before and after work (*cross shift*). In table 2, it was shown that the average working period of a worker in this study was 6 years. Workers who had more than 6 years of working experience suffer increased levels of CRP. The working period can increase CRP levels due to the length of the working period of kapok-industry workers who are exposed to continuous dust and the use of respiratory protection equipment that cannot protect the nose and mouth from dust exposure. It can cause the stimulation of an inflammatory reaction that causes the accumulation of macrophages.

Length of work

The length of work affects the daily dose of exposure that workers will receive (Fujianti et al., 2015). Results of analysis using the Spearman correlation test obtained the result of *p*=0.004, meaning that there was a relationship between the length of the work with the increase in CRP serum before and after work (*cross shift*). This research is in line with the research (Fujianti et al., 2015) which stated that if workers work at a location with high dust content and more than 8 hours of working time, the workers will experience more risk of health problems in the respiratory system. The research is also in line with research conducted by (Deviandhoko, Nur, & Nurjazuli, 2013) stating that there is a meaningful relationship between the length of work with impaired pulmonary function. The longer workers are in the working environment exposed to dust, kapok will accumulate in the body of the worker which will cause disease and inflammatory reactions occurrence. It is supported by the length of working in one day exceeding the limit that is recommended by the regulation of the Ministry of Manpower, which is 8 hours per day in 5 working days within 1 week. More than 70% of workers work more than 8 hours per day.

CONCLUSION

Based on the research that has been conducted, there is a relationship between the characteristics of workers (age, working period, and length of work) and increased CRP serum of workers. Personal moisture measurements result in an average value exceeding the specified TLV. Advice from the conducted research on measured personal dust level which exceeds the threshold value, it is a need to reduce dust levels in the working environment. The

kapok-processing industry is advised to make improvements to the air ventilation system due to the high-dust levels in the working environment and the need to give more attention to the protection of workers. Industry owners are obliged to give orders for workers to use masks that conform to standards like *particulate respirator N series* during work. It aims to reduce exposure to kapok dust. They also need to give more attention to the length of work of each worker to reduce the exposure to those hazardous elements that workers will receive.

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