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RELATIONSHIP BETWEEN PM10 EXPOSURE AND LUNG DYSFUNCTION IN THE WORKERS OF RICE MILL, DELI SERDANG, IN 2019

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ABSTRACT

Background: PM10 is solid air particles with diameter of less than 10 micrometer which can penetrate thorax in the pulmonary system. They can stay in lungs with diameter from two to five microns. Coughing, dyspnea, and pain in chest are health disorder undergone by the workers caused by PM10.

Materials and Methods: The research used analytic survey method with cross section design. The samples were 30 workers.

Result: The result of the research showed that PM10 content in the rice mill was high (1,24 mg/m2) at the grinding point and 1,44 mg/m2 at the drying point. There was the relationship of the length of service (p-value=0,024; p<0,05), the use of PPE (Personal Protective Equipment) (p-value=0,004; p<0,05), and PM10 content (p-value=0,001, p<0,05) with lung dysfunction. The variable which had the most dominant influence was PM10 content at the probability value of 84,10%.

Conclusion: The exposure of PM10 content had the most significant influence on lung dysfunction in the workers of rice mill, Deli Serdang Regency at Exp(β)=24 which indicated that workers who worked in a location with high PM10 concentration had 24 times of the possibility to be affected by lung dysfunction, compared with those who worked in a location with low PM10 concentration.

Keywords: PM10, LD, Rice Mill, PPE

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1.0 Introduction

Air has a very important meaning for the life of living things and the existence of other objects. Air is a natural resource that must be protected for life, human life and other living things (Kepmenkes RI, 2002). Air is needed by humans every moment of their lives. For this reason, adequate air quality must be available to support the creation of public health (Mulia, 2005). Air pollution has now reached an alarming level. According to WHO (2012) around seven million people died due to air pollution. As of 2016, approximately 200,000 premature deaths each year in the United States are caused by heavy industrial activity, transportation as well as commercial and residential heating. Air pollution occurs because there are sources of pollutants (emissions), and that pollutants are transferred from the source to the community in the presence of meteorological factors, and finally that there are people who can be disturbed because of the pollution (Slamet, 2009). Air pollution can have an impact on health. Generally, health problems as a result of air pollution occur in the respiratory tract (Mulia, 2005). For developing countries, industry is essential to expand the foundation of development and meet the increasing needs of the community (Kristanto, 2004). The consequences of industrial problems are also increasingly complex, including the issue of Occupational Safety and Health (K3) (Rahardjo, 2010).

One of the industries that support the fulfillment of food self-sufficiency is the rice milling industry. In the rice milling process there are danger factors that can interfere with the health of the workforce, in the form of PM10 exposure, smoke from the rice milling machine, and heat exposure. PM10 can cause lung damage and fibrosis if inhaled during continuous work. If the alveoli hardens, consequently it reduces elasticity and accommodates the volume of air so oxygen binding ability decreases (Rahardjo, 2010). The rice milling industry consists of drying, grinding, packaging and storage. The grinding process produced by dust particles can significantly cause respiratory tract disorders and impaired lung function.

Particles are air pollutants that can be together with other pollutant materials or forms. Particles can be interpreted as pollutants in the form of solids (Mulia, 2005). Particulate Matter10 (PM10) is air particles in solid form with a diameter of less than 10 micrometers. PM10 is a particle in the air that is small enough to penetrate the thoracic region of the respiratory system (WHO, 2013). Particulates smaller than 0,1 microns will easily enter the alveoli, but will easily come back out. Particulates that can stay inside the lungs have diameters between two to five microns. The shape of the particulate also determines whether or not easy and how far a particulate can enter the lungs. Needle-shaped particles will easily enter the lungs and can enter the lining of the lungs (mesothelium), even though the diameter of the particles is greater than 10 microns. The entry of pollutants through the lungs can cause various symptoms and diseases that are determined by many factors in the human body. Therefore air pollutants will generally affect the respiratory tract (Slamet, 2009).

Research conducted by Rahardjo (2010) in Sragon states that dust measurements in the rice mill environment exceeded the Threshold Value (NAV) conducted at five points using HVS (High Volume Sampler), which amounted to 3,85 mg/m3, 2,6 mg/m3, 3,55 mg/m3, 2,5 mg/ m3, and 1,2 mg/m3. According to Aji's research (2010) in Surakarta, there was a very significant relationship between dust exposure and lung function capacity of rice milling workers in Karanganyar District, Karanganyar Regency. The research of Katherine et al (2014) with the cross sectional study design obtained the results of statistical tests which showed that the dust

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content variable (p = 0,017), the age variable (p = 0,000), the length of service variable (p = 0,003), the smoking habit variable (p = 0,017), and the PPE usage variable (p = 0,038) has a significant relationship with lung function capacity. Research by Aryasih et al (2011) in Badung Regency states that dust levels, length of service, and height are significantly related to lung vital capacity (p <0,05), thus the higher the dust level the lower the vital lung capacity, the longer work increasingly menrun vital capacity of the lungs and the higher the height the more vital lung capacity of the workforce.

Based on the results of a preliminary survey that has been carried out on 20 Deli Serdang regency rice workers, there were complaints of shortness of breath, coughing, chest pain and sore throat. Shortness of breath, coughing, chest pain, and sore throat are among the health problems arising from PM10 exposure. Workers who experience these complaints mostly work in milling and drying. The laborers who work nine hours/day (8:00 to 16:00 WIB) and rest at (11:30 to 13:00 West Indonesia Time) the majority inhale dust particles from rice seeds milling and drying in addition they also breathe dust particles originating from the work environment, in fact most workers still do not realize the importance of using masks. The rice refinery consists of grinding, drying with a large yard, and storage of rice. In the grinding and drying room produces dust particles from rice seeds that can threaten the health of the workforce. These workers have been exposed for quite a long time, from morning to evening. The workers have also worked for years. These workers are exposed to dust particles every day such as PM10, so workers in the rice refinery have the potential to experience lung dysfunction due to PM10 contained in the work environment so they want to conduct research on the relationship between PM10 exposure and impaired function of rice refinery workers in Deli Serdang Regency in 2019.

2.0 Materials and Methods

This type of research is an analytic survey with cross sectional design. This research was conducted in Deli Serdang Regency in 2019. When the research was conducted in August 2019 until completion.

The population in this study were all workers in rice refinery in Deli Serdang Regency in 2019 as many as 30 people. The sample is the entire population used as samples in the study, namely all workers, amounting to 30 people.

Primary data collection methods were obtained from respondents based on interviews with workers using a questionnaire related to individual lung function disorders and also measurement of PM10 levels in the Deli Serdang Regency 2019 rice refineries. Secondary data were obtained from library literature and related agencies that have something to do with the object of research.

The method of measuring PM10 levels in rice refineries in Pantai Labu Sub-district of Deli Serdang Regency using a Dustrax tool was carried out by an expert from the Occupational Safety and Health Center (K3), and then the results of these measurements will be analyzed in the Laboratory of Occupational Safety and Health (K3) Medan. Measurement of lung function disorders is measured by using a Spirometer which is a tool to measure the lung function

capacity of an expert from the Occupational Safety and Health (K3) Medan, and interviews with respondents using a questionnaire.

Data analysis methods include univariate analysis, bivariate analysis, and multivariate analysis to see how much the relationship between independent and dependent variables is.

3.0 Result

3.1 Overview of Research Locations

Geographically, Deli Serdang Regency is located between 2057'-3016' North Latitude and 98033'-99027' East Longitude, which is part of an area in a cross position in the West Pacific Trench area with an area of 2.497,72 km2 from the area of Sumatera Utara Province consisting of 22 districts and 403 villages, with the following boundaries: In the North it is bordered by the Sumatera Strait, in the South it is bordered by Karo Regency, East is bordered by Serdang Bedagai Regency, West is bordered by Karo Regency and Langkat Regency. According to data obtained from the government website of Deli Serdang Regency, the current area of Deli Serdang Regency is 2.497,72 km2, consisting of 22 subdistricts and 403 villages/sub-districts, which reach 3,34 percent of the total area of Sumatera Utara.

Labu Coastal District is geographically located between 3062'-3069 'North Latitude and 98080'-98093' East Longitude with an area of 81,85 km2. East side is bordered by Pantai Cermin Subdistrict, Serdang Bedagai District, West side is bordered by Batang Kuis Subdistrict and Percut Sei Tuan Subdistrict, North is bordered by Malacca Strait, and South is bordered by Beringin District. The area of Paluh Sibaji village is 2,06 km2 with a population of 4.362 people.

The rice refinery industry is located in Paluh Sibaji, Pantai Labu District, Deli Serdang Regency. The rice refinery industry has a workforce of 30 people, of which 10 people are in the milling section, nine people in the drying section, and 11 people in the packaging/storage section. Environmental conditions in rice refineries are clearly visible dust can be clearly associated in the room, namely in the process of grinding, drying, and packaging/storage. There is no exhaust fan (exhaust fan) that is to breathe dusty air in the workplace so that grain dust can be flowed out of the workplace.

Table 1: Distribution of PM10 Level Measurement Results Rice Refinery in Deli Serdang Regency in 2019

Location of Sampling	PM_{10} (mg/m^3)	The number of workers
Milling	1,24	10
Drying	1,44	9
Packaging/storage	0,13	11

Distribution of PM10 levels in Rice Refinery
Note: TLV (0,15 mg/m3)

Based on table three, the measurement results obtained at the three locations above the NAV are >0,15 mg/m3, PM10 levels in the first location namely milling have PM10 levels of 1,24 mg/m3, the second location ie drying has PM10 levels of 1,44 mg/m3, while in the third location that is packaging/storage has PM10 levels of 0,13 mg/m3. The highest PM10 levels obtained from the drying area have a level of 1,44 mg/m3.

Based on the PM10 sampling location the number of workers in the rice mill area is 10 people, the number of workers in the drying area is nine people, and the number of workers in the storage area is 11 people.

Table 2: Frequency Distribution Based on Lung Function Capacity of Sumber Agung Rice Refinery Workers in Deli Serdang Regency in 2019

Lung Function Capacity	Frequency	Percentage (%)
There is a disturbance	18	60
- Restrictive	8	26,7
- Mix	10	33,3
Normal	12	40

Based on table four out of 30 workers there were 18 people (60%) who experienced impaired lung function capacity in the form of restrictive, obstructive, and mixed, of the 18 workers who experienced impaired lung function there were eight people (26,7%) who experienced restrictive, and 10 people (33,3%) who experienced mixed lung function disorders. Whereas for respondents who have normal lung function capacity as many as 12 people (40%).

3.2. Relationship of Respondent Characteristics Based on Age, Working Period, History of Tuberculosis, Smoking Habits, Use of PPE (masks), with Impaired Lung Function in Rice Refinery Workers in Deli Serdang in 2019

Table 3: Relationship of Respondent Characteristics Based on Age, Working Period, History of Tuberculosis, Smoking Habits, Use of PPE (masks), with Impaired Lung Function at Rice Refinery Workers in Deli Serdang in 2019

Variable	Impaired Lung Function				Total		*p-value*
	There is interference		There are no distractions		n	%	
	n	%	n	%			
Age							0,418
≥30 years	14	66,7	7	33,3	21	100	
<30 years old	4	44,4	5	55,6	9	100	
Years of service							0,024
<5 years	4	33.3	8	66.7	12	100	
≥5 years	14	77,8	4	22,2	18	100	
History of Tuberculosis							1,000
Ever	1	100	0	0	1	100	
Never	17	58,6	12	41,4	29	100	

Smooking habitat							1,000
Smoke	15	60	10	40	25	100	
Do not smoke	3	60	2	40	5	100	
The use of PPE (mask)							0,004
Use	2	20	8	80	10	100	
Do not use	16	80	4	20	20	100	
PM_{10} Exposure							0,001
> NAV	16	84,2	3	15,8	19	100	
< NAV	2	18,2	9	81,8	11	100	

Based on table five it is known that the results of the respondents' age, history of tuberculosis, and smooking habitat are no relationship between age, history of tuberculosis, and smooking habitat and lung function disorders in Deli Serdang rice refinery workers.

The results of the analysis of the relationship of working period, the use of PPE (mask), and PM10 exposure means that there are a relationship between working period, the use of PPE (masks), PM10 exposure and lung function disorders in Deli Serdang rice refinery workers.

3.3. Multivariate Analysis

Variables that meet the criteria are years of service, use of PPE, and PM10 levels. Furthermore, the independent variable will be multivariate analysis using logistic regression tests to estimate the effect of the independent variable on impaired pulmonary function using the Enter method. The results of multivariate analysis are presented in the following table:

Table 4: Results of Multivariate Logistic Regression Analysis

Step	Variable	Coefficient (B)	*p-value*	Exp (B)	95% CI	
					Lower Limit	*Upper Limit*
1	Years of service	, 466	.693	1,594	, 157	16,182
	Use of PPE (mask)	-2,050	0.079	, 129	, 013	1,266
	PM10 levels	2,524	, 031	12,473	1,258	123,622
	Constant	- 644	0.534	, 525		
2	The use of PPE (mask)	-2,186	, 053	, 112	, 012	1,030
	PM10 levels	2,708	0.013	14,998	1,760	127,818
	Constant	-, 468	0.612	, 626		
3	PM10 levels	3,178	0.002	24,000	3,358	171,539
	Constant	-1.504	0.054	, 222		

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Based on the results of multivariate analysis in table seven in stage one, it is known that after the variable of tenure, the use of PPE (mask), and PM10 entered into multivariate analysis, it turns out that the variable of tenure has a high value of p, namely p = 0,693 so that the variable of tenure is not included in the second stage.

In stage two it is known that the variable analyzed is the variable use of PPE (mask), and PM10 levels, it turns out that the variable use of PPE (mask) has a high p value of p = 0,053 so that the variable use of PPE (mask) is not included in the third stage.

In stage three it is known that the variable analyzed is the PM10 content variable, which can be seen the PM10 content variable has a value of p = 0,002 (p <0,05), so that the PM10 content variable is the most influential variable in this study with the value of Exp. B = 24,000.

Furthermore, the results of the multivariate analysis above are entered into the multiple logistic regression equation model to identify the probability of pulmonary dysfunction as follows:

$$p = \frac{1}{1+e^{-y}}$$

$$p = \frac{1}{1+2,7^{-(-1,504+3,178)}}$$

$$p = \frac{1}{1+2,7^{(-1,674)}}$$

$$p = \frac{1}{1+0,189} \times 100$$

$$p = \frac{1}{1,189} \times 100$$

p = 84.10%

Information:

p = Probability of lung function capacity

y = Number of constants regression coefficients

e = natural number = 2,7

Based on the equation as a whole, the chance value is 84,10%, this means that PM10 exposure in rice refineries causes lung function impairment in Deli Serdang refinery workers, while 15,9% is influenced by other factors not examined.

4.0 Discussion

According to Nugroho (2010), although lung function decreases in line with increasing age, it has never been directly related to the incidence of abnormal lung function. The results of this study are in line with research by Rahardjo (2010) between the age group and lung function capacity, it is found that with a significant level of 95%, the value of p = zero point one hundred

seventy-five so that p is greater than zero point zero five, so there is no relationship between age with lung function capacity.

The work period referred to in this study is the length of time the worker worked in the rice production section from the start of the work until the time the study was conducted. In this study, the respondents who experienced the most pulmonary function disorders in workers who have worked more or more than five years. The longer the working period of a person in a year, the lower the capacity value of his lung function so that it has the effects of restrictive, obstructive, and mixed. The work period determines how often and for a long time a worker is exposed to PM10.

Smoking can cause changes in the structure and function of the respiratory tract and lung tissue. If the work environment condition of a smoker has a high level of dust particle concentration, it can cause lung function disorder which is characterized by decreased lung function (VC, FVC, and FEVI) (Karabella, 2011). Workers who have a smoking habit and are in a dust-filled work environment are more likely to experience lung dysfunction compared to workers who are in a dusty environment but do not smoke.

The use of PPE (mask) or nose covering which is a tool for self-protection prevents the entry of contaminated dust, gas, vapor or air particles at work into the respiratory tract, which are likely to experience abnormal lung capacity capacity (Sugeng, 2003) . Respiratory protective equipment that is effective against exposure to dust particles is a dust mask with the aim to provide a reduction in the entry of dust into the respiratory system and cause health problems in the lungs (Suma'mur, 2013).

Based on the three measurement locations selected are places where workers spend a lot to work there. The first area is rice milling with a value of 1,24 mg/m3 with the number of workers as many as 10 people, the second area is drying with a value of 1,44 mg/m3 with the number of workers 9 people, and the third area is the packaging/storage with a value of 0,13 mg/m3 with the number of workers 11 people.

PM10 measured at Deli Serdang Regency rice refinery is are air particles in solid form with a diameter of less than 10 micrometers. Measurements begin in the morning until noon.

Air pollution, especially dust from the process and yield of rice production is respirable where the size of dust can be inhaled and enter the human body. The dust produced can enter the respiratory tract and be retained in the airways or accumulate from small airways or terminal bronchi to the alveoli or air bubbles in the lungs which is the end of the airways (Khusna, 2009).

Impaired pulmonary function from the results of pulmonary function capacity obtained in the form of restrictive, obstructive, and mixed. Respondents who experience restrictive, obstructive, and mixed complaints often feel shortness of breath, coughing, and chest pain. Pathophysiological effects caused by exposure to organic dust are fibrotic in the lungs and result in a decrease in elasticity and lung development so that the alveoli experience a very strong respiratory workload, to overcome the elasticity needed fast and shallow breaths. This breathing results in an inability to survive alveolar hypoventilation and an inability to maintain gas under normal conditions. This can cause a reduction in lung development and lung capacity (Khusna, 2009).

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5.0 Conclusion and recommendation

PM10 exposure is the most dominant factor affecting lung function disorders in Sumber Agung Deli Serdang District refinery with den Exp value. (B) = 24; which means that workers who work at locations with high PM10 concentrations have an effect on 24 times impaired lung function.

It is recommended that the Department of Health conduct monitoring and control to business owners regarding controlling PM10 levels so as not to cause more harmful effects.

Employers must install exhaust fans to breathe dusty air in the workplace so that grain dust can be flowed out of the workplace and provide proper PPE (masks) for workers.

For workers who are already experiencing lung function disorders, it is necessary to carry out lung function capacity checks on rice refinery workers continuously and always use the right mask to reduce the entry of PM10 exposure into the respiratory system.

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Declaration

The authorsdeclare that this article is our original work and has never been published before.

Authors contribution

Author 1 : Research concepts and designs, preparing research proposal, collecting data, analyzing data, and writing manuscripts

Author 2 : Research concepts and designs, supervising the research process, actively involved in data analysis, reviewing manuscripts and final editing.

Author 3 : Research concepts and designs, supervising the research process, actively involved in data analysis, reviewing manuscripts and final editing.

References

Agusnar., (2008). *Analisa pencemaran dan pengendalian pencemaran*. Medan: USU Press.

Aji, S. S. S., (2010). *Hubungan paparan debu dengan kapasitas fungsi paru pekerja penggilingan padi di Kecematan Karanganyar Kabupaten Karanganyar* (Skripsi, Universitas Sebelas Maret).Accessed from *http://digilib.uns.ac.id/*

Alves, C., A., Vicente, A., M., Custodio, D., Cerqueira, M., Nunes, T., Pio, C., Lucarelli, F., calzolai, G., Nava, S., Diapouli, E., Eleftheriadis, K., Querol, X., and Bandowe, B, A., (2017). *Polycyclic aromatic hydrocarbons and their derivatives (nitro-PAHs, oxygenated PAHs and azaarenes) in PM from Southern European cities, Science of the Total Environment*. *35(5), 15-25*. Accessed from*https://www.sciencedirect.com-science/-article/pii/S0048969717307878.*

Aryasih, LG. A. M., Mahardika, IG., & Suyasa, IW. B., (2011).*Analisis dampak debu usaha penggilingan padi terhadap kapasitas vital paru tenaga kerja di Kecamatan Abiansemal Kabupaten Badung* (Tesis, Universitas Bandung) Accessed from*https://ojs.unud.ac.id/-index.php/-ECOTROPHIC/-article/-download/13474/9173/*

Badan Pusat Statistik Kabupaten Deli Serdang, (2018). *Katalog Kecamatan Pantai Labu dalam Angka 2018*. Diakses dari *https://deliserdangkab.bps.go.id.*

Fardiaz, S., (2012). *Polusi air dan udara*. Yogyakarta: Kanisius.

Karabella, H., K., (2011). Hubungan lingkungan tempat kerja dan karakteristik pekerja terhadap Kapasitas Vital Paru (KVP) pada pekerja bagian Plant PT. Sibelco Lautan Minerals Jakarta (Skripsi, Fakultas Kedokteran dan Ilmu Kesehatan Universitas Islam Negeri Hidayatullah). Accessed from*https://repository.uinjkt.ac.id*.

Katherine, R., Djajakusli, R., Rahim, M., R. (2019). *Hubungan paparan debu dengan kapasitas fungsi paru pekerja penggilingan padi di Kabupaten Sidrap* (Skripsi, Fakultas Kesehatan Masyarakat Hasanuddin). Accessed from*https://repository.unhas.ac.id*.

Keputusan Menteri Kesehatan Republik Indonesia Nomor 1405/MENKES/SK/XII/2002 tentang Persyaratan Kesehatan Lingkungan Kerja Perkantoran dan Industri.

Khusna, (2009). *Hubungan Antara Masa Kerja dengan Gangguan kapasitas Vital Paru (KVP) pada Pekerja bagian Pengamplasan di Industri Meubel PT. Kota Jati Furindo di Desa Suwawal Kecamatan Mlonggo Kabupaten Jepara* (Tesis, Universitas Diponegoro Semarang). Accessed from *https://undip.ac.id*.

Kristanto, P., (2004). *Ekologi industri*. Yogyakarta: ANDI

Mulia, R. M., (2005). *Kesehatan lingkungan*. Yogyakarta: Graha Ilmu.

Nugroho, T., (2010). *Buku ajar obstetri*. Yogyakarta: Nuha Medika.

Rahardjo, R. A. H., (2010). *Hubungan antara paparan debu padi dengan kapasitas fungsi paru tenaga kerja di Penggilingan Padi Anggraini Sragen Jawa Tengah* (Skripsi, Fakultas Kedokteran Universitas Sebelas Maret). Accessed from*https:/digilib.uns.ac.id/dokumen/download/15563.*

Sari, S., Nurjazuli., Dangiran, H., L., (2017). Analisis perbedaan fungsi paru pada pekerja berdasarkan kadar debu di PT. Bogowonto Primalaras Semarang. *Jurnal Kesehatan Masyarakat*. *5*(5), 1-20

Slamet, J. S., (2009). *Kesehatan lingkungan*. Yogyakarta: Gadjah Mada University Press