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Analysis of Characteristics and Pulmonary Function Status of Garlic Crackers Home Industry Workers in Sidoarjo East Java Indonesia

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Abstract---

Background *this research showed that flour dust has the potential on pulmonary function impairment. The basic material for making garlic crackers came from flour, flour dust had the potential on the worker's pulmonary function status.* ***Purpose of the research*** *was to analyze the characteristics and measure the pulmonary function status of garlic crackers home industry workers in Sidoarjo Regency East Java Indonesia.* ***Research method*** *was cross sectional design, the sample was a total sampling of 15 workers. The measurement of pulmonary function was carried out using a Spirometry tool by officers of UPT Occupational Safety and Health Surabaya. Data analysis used analysis of the results of a cross tabulation (crosstab). Time of the research was March to December 2019.* ***Results of the research*** *from the measurement of pulmonary function, 33.3% had an abnormal status, with details of 20% of workers had a light restriction category and 13.3% a light obstruction category. The results of the cross tabulation of characteristics of respondents with pulmonary function status showed that there was a relationship between age and pulmonary function status with a coefficient contingency value of 0.442. Male sex with pulmonary function status with a coefficient contingency value of 0.577, smoking habits with a pulmonary function status with a coefficient of contingency value of 0.577, working period over 10 years with a pulmonary function status with a contingency coefficient value of 0.106. The type of effects of respiratory impairments from flour dust exposure were affected by the dose and duration of exposure. Mask (Personal Protective Equipment) with pulmonary function status with a coefficient contingency value of 0.186. There was a relationship between flour dust and pulmonary function status with contingency coefficient value of 0.408.* ***Conclusion*** *Increasing age and long working period need to protect pulmonary function for workers in the potential environment of flour dust by increasing obedience to using masks (Personal Protective Equipment), and stopping smoking habits especially for male workers. Workers who experienced pulmonary function impairments should take further treatment so it would not get worse and get proper treatment so it would not reduce productivity while working.*

Keywords--- *Workers Characteristics and Workers Pulmonary Function Status.*

I. INTRODUCTION

Air pollution has been a problem in the world, especially in Indonesia. One of the pollutants produced is derived from industrial activities (1). As the industry develops, more and more products are produced that are both beneficial and have a negative impact on human health. One of them is a dust or metal pollutant that can float into the

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respiratory tract and settle in the alveoli (2). Particulates and gases resulting from industrial activities can cause health risks especially to humans. Increased pollutants in the room can not only come from penetration of pollutants from outside the room, can also come from sources of pollutants in the room. Such as cigarette smoke, smoke from the kitchen or the use of insect repellent (3).

One of the air pollutants that can potentially endanger human health is particulate matter. This becomes dangerous for human health at high and stable concentrations in an area. This type of particulate matter has been extensively studied because of its penetrating properties to the deepest part of the lung (4).

The United States Conference of ACGIH defines flour as complex organic dust containing cereals such as wheat (Triticum sp.), Rye (Secale cereale), sorghum (Panicum miliaceum), barley (Hordeum vulgare), wheat (Avena sativa), rice (Oryza sativa) or corn (Zea mays), or a combination of these, which have been processed by grinding (5).

Dust that comes from flour itself has the ability to sensitize and hyperreactivity of the respiratory tract which can cause asthma. Wheat flour is a fine flour or powder derived from grains of wheat, and used as a basic material for making cakes, noodles and bread. Wheat is a seed crop similar to rice, which generates quite a lot of dust, which can cause respiratory impairments in workers (6,7).

Flour dust can also cause irritation and can cause short-term respiratory, nasal and eye symptoms, or it may trigger asthma attacks in individuals with preexisting diseases. In the UK, for example, flour and grain dust are the most common, the two agents cited related to asthma. The effects of respiratory impairments from flour dust exposure are affected by the dose and duration of exposure. This differs from one work environment to another (8,9).

Flour dust is a heterogeneous organic substance that can have a tendency to cause respiratory disease. There is a growing consensus about the bad effects of flour dust on respiratory symptoms and performance of flour mill workers.

Manipulation of flour dust is a known risk factor for respiratory conditions, in particular for asthma. While lower than the French TWA-TLV for respirable or inhalable non specific dust, personal exposure values of young bakery apprentices are greater than the ACGIH recommendation. General or process ventilation devices were not frequent in the study facilities, and this is likely to contribute to these exposure values (21).

Step-wise approach to a clinical diagnosis of occupational asthma allowed detection of a small number of cases of previously undiagnosed flour-induced asthma in an epidemiological sample of exposed workers. The definition of the aetiology of occupational asthma is important for prevention and compensation (22).

Occupational exposure to flour dust could cause respiratory dysfunction, thereby reducing lung efficiency. Personal protective devices were not available at workplaces and the workers usually do not wear the materials (7)

Exposure to cement dust can cause various acute and chronic respiratory diseases including respiratory function impairment, a duration response effect shows that long term exposure to cement dust prominently decreased the pulmonary function (23).

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Sidoarjo is one of the regencies whose main sectors in the economy are industries, services and fisheries. The location which is close to the business center in Surabaya, Tanjung Perak Harbour and Juanda Airport makes the industrial sector in Sidoarjo Regency develop quite rapidly. As well as having human resources that are quite productive and a safe and quite stable area. Sidoarjo Regency can attract investors to make big investment in Sidoarjo Regency. Not only the large industrial sector, MSME (micro small and medium enterprises) also developed quite well, including the bag and luggage industry center, the shoes and sandals industry center, and also the crackers industry center (3).

Jenek Village, Taman Sidoarjo Subdistrict, is one of the villages whose residents have crackers household industry business for generations. The cracker industry is one of industries that has contributed to air pollution. Even though most cracker industries are still in the scope of small scale industries (household), but the production process of garlic crackers has the potential to cause air pollution from dust produced during the process of making dough (flour) in a crackers home industry is a routine activity carried out every day to meet consumer orders. The process cannot be separated from the use of flour as basic material and can pollute the environment around the home industry.

Pulmonary disease occurs due to pollutant particles that enter the human body mainly through the respiratory system which is directly detrimental to the respiratory system with a prevalence of 5.6% or 4.8 million cases with moderate to severe degrees (10). The respiratory health effects have been documented in workers exposed to various dust in small and large scale industries, which produce dust during the production process (11).

The longer the duration of employment the higher the prevalence of allergic symptoms. It is interesting to note that advanced age was not associated with symptoms suggesting that these symptoms are related to irritation and sensitization to flour particles at workplace rather than to chronic permanent damage (8).

The results of this study imply that exposure to monoterpenes was neither a medical nor an occupational hygiene problem during industrial production of wood pellets. The wood pellet industry shows an exposure to wood dust and there was a high prevalence of nose symptoms but no effect on lung function (24).

Based on research conducted by Demeke (2018) on flour mill workers in Ethiopia showed that there was a significant decrease in the pulmonary function of flour mill workers compared to controls used as a comparison. Similarly, research conducted by Mutmainnah (2019) showed the results that flour dust in 4 different work sections can affect pulmonary function in tapioca industry workers (11).

II. RESEARCH METHOD

This research was an observational descriptive study in which the researcher observed directly and did not give special treatment to the object researched. The research design used was cross sectional because the research was only done at one time. Large The study population was all workers of garlic crackers home industry in Sidoarjo Regency with several inclusion criteria, namely willing to take part in the study, minimum working period of 1 year, length of work at least 8 hours and not suffering from diseases of the respiratory tract. The sample in this research

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used total sampling where after the inclusion criteria, samples included in the criteria amounted to 15 workers, namely all home industry workers meet these criteria.

The variables in this study consisted of the dependent and independent variables. The dependent variable was the dependent variable which in this study is a pulmonary function impairments in garlic crackers home industry workers in Sidoarjo Regency. The independent variable was the independent variable that can affect the dependent variable, namely the characteristics of the workers (Gender, Age, Smoking Habits, Working Period and Length of Work, Use of PPE and Part of Job)

Data collection techniques used questionnaire sheets for workers characteristics variable and used observation sheets to see smoking habits and the use of PPE (masks).

Analisis data menggunakan metode analisis deskriptif dan analisis tabulasi silang (*crosstab*). Data analysis used descriptive analysis methods and cross tabulation analysis (crosstab). Descriptive analysis was used to identify the characteristics of workers, the level of dust inhaled by workers, the level of dust in the work environment and pulmonary function. Cross tabulation analysis was used to determine the relationship of dust levels in the work environment and the characteristics of workers with pulmonary function impairments on garlic crackers home industry workers in Sidoarjo Regency.

III. Research Results And Discussion

Pulmonary Function Status

Measurement of pulmonary function was carried out by spirometry tool with several categories namely (31):

Table 1: Interpretation of pulmonary function impairments assessment results by American Thoracic Society

Restriction (%FVC)	Interpretation	Obstruction (%FEV_1)
≥80	Normal	≥75
60-79	Light	60-74
30-59	Moderate	30-59
<30	Severe	<30

Source: *American Thoracic Society*, 2006.

Based on table 1 above, it was known that there were 2 categories of pulmonary function impairments according to the American Thoracic Society namely restriction and obstruction. It said restriction if % FVC <80 and obstruction category if % FEV1 <75.

Tabel 2: Distribution of Respondents Based on Pulmonary Function Conditions of Garlic Crackers Home Industry Workers in Sidoarjo Regency

Pulmonary Function Impairments	**Total (n)**	**Percentage (%)**
Normal	10	66,7
Light Obstruction	2	13,3
Light Restriction	3	20,0
Total	15	100

An urgent need for prevention programs, such as local and general ventilation and using appropriate respiratory masks that can play an important role in reducing exposure to flour dust. Also the use of new equipment and also enclosing the production process can reduce dust emissions in the air (29).

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Table 3: Distribution of Respondents Based on Pulmonary Function Conditions of Garlic Crackers Home Industry Workers in Sidoarjo Regency

Number	Responden Number	Sex	Section	Value % FVC	Value % FEV_1	Pulmonary Function Status	
						Normal	Abnormal
1.	Respondent 1	Male	Dough	76,1	93,4		v
2.	Respondent 2	Male	Dough	80,1	69,0		v
3.	Respondent 3	Male	Dough	76,5	85,2		v
4.	Respondent 4	Female	Frying	135,1	84,1	v	
5.	Respondent 5	Female	Frying	128,8	83,0	v	
6.	Respondent 6	Female	Packing	128,1	83,9	v	
7.	Respondent 7	Female	Packing	96,3	81,8	v	
8.	Respondent 8	Female	Packing	130,3	66,3		v
9.	Respondent 9	Female	Packing	109,1	96,6	v	
10.	Respondent 10	Female	Packing	104,1	85,9	v	
11.	Respondent 11	Female	Packing	100,9	93,5	v	
12.	Respondent 12	Female	Packing	103,9	85,9	v	
13.	Respondent 13	Female	Packing	105,1	85,0	v	
14.	Respondent 14	Female	Packing	97,3	94,1	v	
15.	Respondent 15	Female	Packing	74,4	83,1		v

Based on tables 2 and 3, measurement of pulmonary function on home Industry workers using spirometry tool, which was carried out by officers from the UPT Occupational Safety and Health Surabaya by bringing officers to the study site. Measurement of pulmonary function on workers was done after the production process took place. The distribution of workers regarding the pulmonary function status showed that as many as 33.3% or 5 workers had pulmonary function impairments with the category of light restriction 3 workers and light obstruction 2 workers who were in the dough and packing sections. Where as in the frying section workers had normal pulmonary function status. One of the factors that caused the workers to experience pulmonary function impairments was flour dust produced from the work environment of the garlic crackers home industry (12).

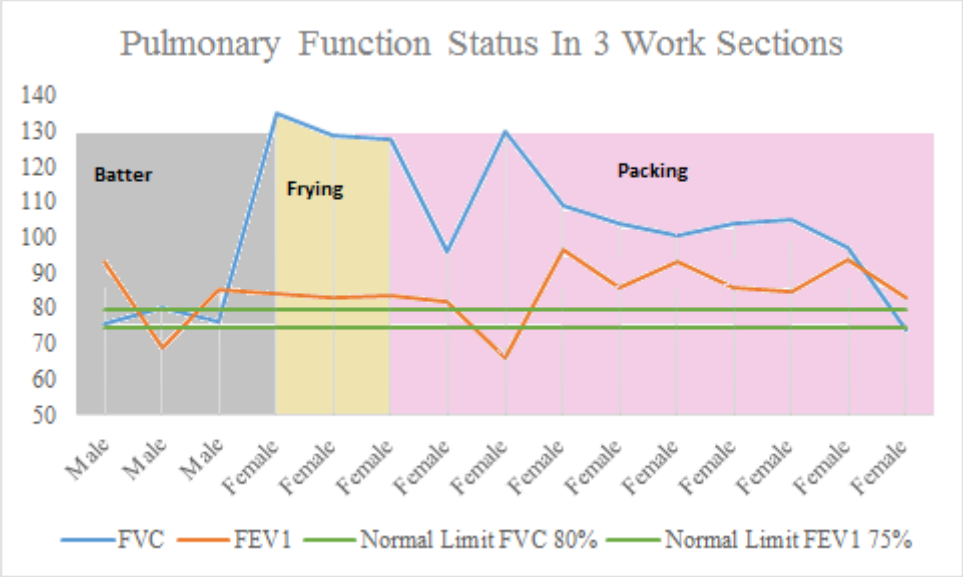

Figure 1: Workers Pulmonary Function Status in 3 Work Sections

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Occupational exposure to flour dust may cause or affect respiratory irritation and sensitization; and reduce the pulmonary function tests such as FVC, FEV1, and FEV1/FVC and FEF25–75%. These findings mandate to pre-employment and periodic spirometry and SPT examination for bakers (25). Bakers are exposed to flour dust at a level that most likely represents an excess risk of developing chronic diseases of the respiratory system, and a decrease of present exposure level is imperative (26).

Most workers in the flour mill are exposed to flour dust more than the threshold limit value which has been proposed by ACGIH, and this might reduce their pulmonary function, and lead to pulmonary symptoms in the long-term (27).

Impaired pulmonary retriction was usually characterized by reduced lung volume caused by allergenic substances such as mold, spores, and dust. In addition, pulmonary retriction was associated with limited lung expansion. This happens because of changes in the walls, pleura, and neuromoskular organ (13).

Table 4: Cross Tabulation of Work Sections and Workers Pulmonary Function Status

Work Section	**Pulmonary Function Status**				**Total**	
	Normal		**Abnormal**			
	n	**(%)**	**n**	**(%)**	**n**	**(%)**
Dough section	0	0%	3	100%	3	100%
Frying section	2	100%	0	0%	2	100%
Packing section	8	80%	2	20%	10	100%
Total	10	66,7%	5	33,3%	15	100%

Based on the table above, it can be seen that the workers who experience the most pulmonary function impairments are workers who work 100% in the dough section. With category of 2 light restriction workers and 1 light obstruction worker. So that there is a relationship between variable levels of $PM_{2.5}$ in work environment with pulmonary function variables on Garlic Crackers *Home Industry* Sidoarjo Regency workers with *contingency coefficient* value of 0.408 which means the level of strength of the relationship between these variables is included in weak category. Workers who work 100% in the dough section have a greater potential for pulmonary function impairments compared to other work section.

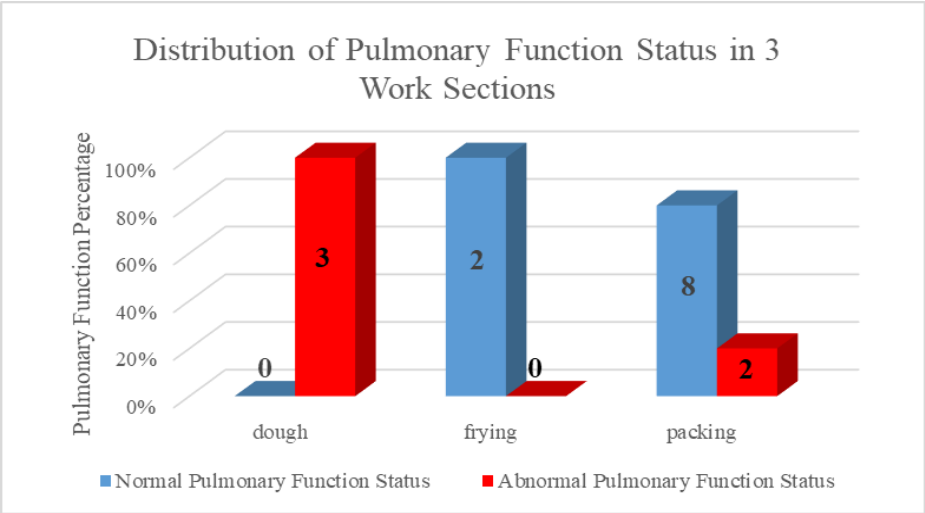

Figure 2: Distribution of Pulmonary Function Status in 3 Work Sections

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Figure 2 above shows that 100% or as many as 3 workers have impaired pulmonary function with a relationship strength level of 0.408 in the dough section. Wheat flour-mill workers in Nigeria are at increased risk of developing abnormalities of pulmonary functions compared to control subjects, and the dominant pattern of respiratory disease among them is airway obstruction (32). Despite knowledge of the exposure risks to flour being available forcenturies, US workers are still at risk of sensitization and respiratory symptoms from exposure to high levels of BAA (33).

The flour mill workers in Pakistan, like grain workers elsewhere, are at an increased risk of developing occupational related pulmonary function impairments. The results suggest that there is an urgent need to improve dust control measures and the health status of flour mill workers (23)

Most workers in the flour mill are exposed to flour dust more than the threshold limit value which has been proposed by ACGIH, and this might reduce their pulmonary function, and lead to pulmonary symptoms in the long-term (30) .

Different components of flour dust such as enzymes, proteins, and bakers additives can cause both non-allergic and allergic reactions among exposed workers. Moreover, the problem of exposure to cereal allergens present in flour dust can also be a concern for baker's family members (28) .

The inhalable dust, wheat flour and α-amylase allergen exposure are higher in traditional bakeries than in industrial ones. The exposure to inhalable dust is well below the occupational exposure limit currently used in Belgium (35) .

The bronchial response to wheat flour depends on the individual specific hyperreactivity. This specific reactivity varies greatly from one subject to another. The bronchial response was related to the dose of allergen inhaled and to deactivation (36) .

Many work-related symptoms which develop after first employment in modern UK bakeries or flour mills were not accompanied by evidence of IgE sensitization to flour ora-amylase. Although average dust exposures are within current occupational standards, the risks of development of upper and lower respiratory symptoms and of specific sensitization are clearly related to total dust and/or flour allergen exposure (34).

IV. Cross Tabulation Of Characteristics And Pulmonary Function Status

A cross tabulation of workers characteristics (sex, age, smoking habits, length of use of personal protective equipment/PPE and part of job) with pulmonary function status can be seen in the table below:

Sex with Pulmonary Function Status

Table 5: Cross Tabulation of Sex and Pulmonary Function Status

Variable	Pulmonary Function Status			
	Normal		Abnormal	
	N	%	N	%
Sex				
Male	0	0%	3	100%
Female	10	83.3%	2	16.7%

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Results of cross tabulation table 5 between sex variable and pulmonary function impairment variable of workers at Garlic Crackers *Home Industry*, Sidoarjo regency showed that workers who have abnormal status of pulmonary function are more on male workers, as much as 3 workers (100%) or all male workers in Garlic Crackers *Home Industry*, Sidoarjo Regency have pulmonary function impairments. So there is a relationship between sex variables and pulmonary function impairments variables on Garlic Crackers *Home Industry*, Sidoarjo Regency workers with a value of *coefficient of contingency* amounting to 0.577, which means the strength level of the relationship between these variables are included in the moderate category. Research conducted by Agita *et al* (2016) that sex has a relationship with vital lung capacity where the vital lung capacity in men is greater than that of women (14). So that 60% of male workers have abnormal pulmonary function status.

Age with Pulmonary Function Status

Workers' age is measured based on birth year until the study is conducted. The following are the results of age measurements with pulmonary function status:

Table 6: Cross Tabulation Between Age and Nutritional Status with Pulmonary Function Status

Variable	Status of pulmonary function			
	Normal		Abnormal	
	N	%	N	%
Age				
25-34 years old	1	100%	0	0%
35-44 years old	6	85.7%	1	14.3%
45 - 54 years old	2	50%	2	50%
55 - 64 years old	1	33.3%	2	66.7%

It is known that the garlic crackers *home industry* is at most aged 35 and over, which is 47% with an age range of 35-44 years. Around 27% aged 45 - 54 years and 20% aged 55 - 64 years. According to BKKBN, the age is in the productive period, which is 16-64 years.

The older a person is, the more a person's health condition decreases, so the person's respiratory system also decreases because age is a characteristic that has a risk of lung function (15) . The level of productivity will be much higher for workers of productive age compared to workers who are old, so their physical at work will be much more limited (16).

Results of the cross tabulation between age variables and pulmonary function impairment variable in Garlic Crackers *Home Industry*, Sidoarjo Regency, are known that workers who have abnormal pulmonary function are more experienced by workers who are in the age range between 55-64 years (66.7%). So, there is a relationship between age variable and pulmonary function impairment variable in Garlic Crackers *Home Industry*, Sidoarjo Regency workers with a *coefficient contingency* value of 0.442 which means the level of strength of the relationship between these variables is included in the weak category. This is in line with research conducted by Riesa and Lilis (2017) that says increasing age of a person and coupled with unfavorable working environment conditions may cause health problems, especially pulmonary disease so that one's lung function decreases (17) . Old age makes it easier for obstructive pulmonary function impairment due to old age pulmonary defense system experiencing anatomic and physiological disorders Research (18). So that workers who have abnormal pulmonary function status by 80% over 45 years.

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Smoking Habits with Pulmonary Function Status

Workers smoking habits are measured using observation sheets and questionnaires. The following are the results of smoking habits and pulmonary function status:

Table 7: Cross tabulation between smoking habits and pulmonary function status

Variable	Status of pulmonary function			
	Normal		Abnormal	
	N	%	N	%
Smoking habit				
Not smoking	10	83.3%	2	16.7%
Smoking	0	0%	3	100%

Workers' smoking habits can cause health problems by inhaling smoke from the burned cigarettes. The distribution of workers who smoke can be known by distributing questionnaires to workers. it is known that most of the workers are women, there are only 3 male workers who have a smoking habit (20%). As many as 3 workers have the habit of smoking included in the medium category using the *Brinkmen Index* (IB) of 200-599, there are 2 workers, namely 210 and 201 and 1 worker in the weight category with a *Brinkmen Index* (IB) of 600. The effect of smoking on pulmonary function test shows that smoking will cause moderate and large airway constriction as a result of prolonged smoking. Results of the cross tabulation table 6 between smoking habit variables and pulmonary function impairments variables in Garlic Crackers *Home Industry*, Sidoarjo Regency workers showed that workers who had the most abnormal pulmonary function condition were workers who had 100% smoking habits. Basically, human's lung has elastic properties like a balloon, it will expand when someone breathes in and deflates when someone exhales (19). This is in accordance with research conducted by Agita, et al (2016), Pawitra (2019), and Sudrajad (2016) that states smoking habits cause pulmonary function impairment in workers. Someone who is accustomed to smoking has a 4 times greater chance of experiencing pulmonary dysfunction compared to someone who does not have the habit of smoking. This is in line with research conducted by Nisa et al (2015) on the smoking habits of male workers in a university building with impaired pulmonary function showing that smoking duration has a significant relationship to decreased pulmonary function. So for cigarette consumption of 10 cigarettes per day was found to be associated with a 25-75% reduction compared to nonsmokers. Pulmonary function status is not normal for 60% smoking.

Exposure to wheat flour increases the risk of developing respiratory symptoms; it also causes reduction in pulmonary function parameters, as regards spirometry and DLCOSB. Exposure to wheat flour causes interstitial lung disease as detected by HRCT chest. Smoking augments the wheat flour induced lung disease (23).

Working Period with Pulmonary Function Impairments

Working period in this study is measured by working time from the start of work until the time the research takes place in a matter of years. The following are the results between the length of work and the status of pulmonary function status.

Table 8: Cross Tabulation of Working Period and Length of Work with Pulmonary Function Impairments

Variable	Status of pulmonary function			
	Normal		Abnormal	
	N	%	N	%
Working period				
<10 years	3	75%	1	25%
>10 years	17	63.6%	4	36.4%

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. It is known that a total of 15 workers at most employees working for more than 10 years by 66.7%, so that workers have been exposed to dust $PM_{2.5}$ longer. Workers who are exposed longer to dust with high concentrations in the work environment will experience pulmonary function impairments because dust entering the respiratory tract will settle in alveoli (20) .

Results of the cross tabulation between length of work variable and pulmonary function impairments variable in Garlic Crackers *Home Industry*, Sidoarjo Regency showed that workers who have abnormal pulmonary function are more experienced by workers who have worked more than 10 years, as many as 4 workers (36.4%). So there is a relationship between the variable of working period and pulmonary function impairments variable on Garlic Crackers *Home Industry*, Sidoarjo Regency with a *coefficient contingency* value of 0.106 which means level of strength of the relationship between these variables is included in the weak category.

The longer the worker in the environment is exposed to dust, the greater the risk of the worker being exposed to work environment dust due to the impact on pulmonary conditions. Results of research conducted by Pawitra (2019) in tempe chips home industry showed that the length of service had a significant relationship. A long working period will cause carcinogen vapors produced from the frying process to accumulate every day. Pulmonary function status is not normal by 80% of working period above 10 years.

PPE Usage with Pulmonary Asphalt Status

PPE usage of workers is measured by questionnaires and observation sheets. Here are the results between PPE usage and pulmonary function status:

Table 9: Cross Tabulation Between Disease History and PPE Usage with Pulmonary Function Status

Variable	**Status of pulmonary function**			
	Normal		**Abnormal**	
	N	**%**	**N**	**%**
Use of PPE				
Yes	2	100%	0	0%
No	8	61.5%	5	38.5%

PPE (Personal Protective Equipment) usage is a worker's habit of using tools to protect the respiratory area from dust in the form of masks that are used when working. The distribution of workers who use PPE when working as much as 13.3%. While 86.7% more workers do not use PPE. Workers who do not use PPE mostly feel PPE is not something that must be used to protect the respiratory tract from environmental dust. The types of masks used by Garlic Crackers *home industry* workers are mostly disposable or 3 ply disposable masks.

Results of cross tabulation between the variables of PPE usage (masks) and pulmonary function impairments of garlic crackers *home industry* workers in sidoarjo regency showed that workers who had abnormal pulmonary function were more experienced by workers who did not use PPE (masks), namely as many as 5 workers (38.5%). So there is a relationship between the history of disease variables with pulmonary function disorder variables on garlic crackers *home industry* workers in Sidoarjo Regency with a *coefficient contingency* value of 0.186 which means the level of strength of the relationship between these variables is included in the weak category .

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Research conducted by Yuliawati (2015) stated that workers who do not always wear masks have a 44 times greater risk of pulmonary dysfunction compared to workers who always use masks. The protective equipment must be able to filter materials or substances that are able to enter the respiratory tract. Respiratory protective devices include disposable masks and respirators. The use of protective equipment must be adjusted to the risk. Abnormal pulmonary function status of 38% did not use PPE.

V. CONCLUSIONS AND RECOMMENDATIONS

Increasing age and long working period needed to protect pulmonary function for workers in the potential environment of flour dust by increasing obedience to using masks (Personal Protective Equipment), and stopping smoking habits especially for male workers.

Suggestions that can be given by workers are to pay more attention to the use of PPE (masks) that are proper and accurate, especially to workers in the dough and frying sections. *Home industry* owners can be more active in providing PPE that has been provided and to socialize to workers that masks are available for use. Workers who experience pulmonary function impairments should take further care so as not to get worse and get proper treatment so as not to reduce productivity while working. Suggestions for other researchers can do further research on location or in dough section with workers who are female and do not have the habit of smoking.

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