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WORKERS' BEHAVIOR AND FORCED VITAL CAPACITY (FVC) BATIK WORKERS IN BATIK JETIS VILLAGE, SIDOARJO

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ABSTRACT

Introduction: Batik is the art of drawing on the surface of the cloth. The process of making batik can cause problems for worker's health. Batik workers interacted directly with chemical materials when producing batik and this material was dangerous for their health. This study aims to determine the behavior and Forced Vital Capacity (FVC) of batik industry workers in Kampung Batik Jetis, Sidoarjo. **Method:** This research is an observational study with a cross-sectional study design. This research was conducted from August to October 2019, located in the batik industry of Batik Jetis Village, Sidoarjo sub-District, Sidoarjo District. The sample was taken by total sampling with Inclusion criteria are research subjects who had age more than 20 years old and willing to be a research sample. Samples consisted of 9 batik workers from Batik Jetis village. Data were collected by observation and interviews, and the measuring of Forced Vital Capacity (FVC) using a spirometer. **Result:** Showed that 66.67% of respondents are ≥50 years old, 66.67% respondents in the obese category, 77.78% respondents had worked for more than 10 years, 33.33% respondents with a duration of work> 8 hours/day, 77.78% did not have smoking behavior, only 1 respondent (11.11%) had abnormal FVC. **Conclusion:** In summary, increase of age, abnormal nutritional status, working period, long duration of exposure and smoking behavior can cause FVC abnormalities, while physical activity (sports) has a positive relationship to FVC.

Keywords: batik workers, forced vital capacity, Batik Jetis Village, batik making.

INTRODUCTION

Batik art has been known in Indonesia since the Majapahit era. Batik is the art of drawing on the surface of the cloth which was originally only used for the clothing of the royal family, but the art of batik has grown and started to be used widely (West Java Provincial Government, 2017). Batik art is divided into three types based on the making method, namely the first was batik *tulis* (hand-drawn batik) or traditional batik, the second was batik *cap* (hand-stamp batik), and the last was a combination of both batik hand-draw and hand-stamp (Soebaryo and Budianti, 2018). Batik has various patterns such as Arabic calligraphy, European garland, Chinese phoenix, bad peacock, and other patterns (UNESCO, 2009). The art of batik is growing both nationally and internationally; the batik industry can have export markets to many countries such as Japan, America, and Europe. Even batik industry played the main role in the growth of the textile and apparel industry sector in the first quarter of 2019, which recorded the highest position around 18.98% (Ministry of Industry, 2015). Batik value production in Indonesia can reach 407.5 billion rupiah per month or equivalent to 4.89 trillion rupiah per year and this production achievement was supported by 37,093 batik workers (Siregar et al., 2020).

Batik has been appointed as an Indonesian Cultural Heritage, namely an intangible cultural heritage by the United Nations Educational, Scientific, and Cultural Organization (UNESCO) in 2009 (Steelyana, 2012). Following the Government's Vision in the 2015-2019 National Medium Term Development Plan

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(RPJMN), the realization of a sovereign, independent, and personality-based Indonesia based on cooperation, the empowerment of Small and Medium Industries is currently directed at having medium-term goals to realize small and medium industries Competitive medium industries, play a significant role in strengthening the national industrial structure, alleviating poverty and expanding job opportunities, and producing industrial goods and / or services for export (Ministry of Industry, 2019) The existence of Kampung Jetis as a collection of many small and medium batik industries is one way to develop national economy.

The process of making batik in Batik Jetis village was similar to other areas, including 4 major stages (Soebaryo and Budianti, 2018). The first stage or the pretreatment was preparing the clothes or material/ mordanting using alum or potassium aluminum sulfate. After the first stage, the second stage continued with designing/ drawing the clothes or blocking part of the clothes with melted wax. The clothes were covered with a coat of liquid wax using a special tool called canting. This tool like a fountain pen, a smaller chopper container with a thin spout connected to a short bamboo handle. This canting was filled with liquid from melted wax and the batik workers used this canting to draw the design on the surface of the clothes. After drawing on the surface of the clothes, then the wax was cooled off and continued with the next stage. The third stage was coloring/dyeing or filling the clothes with colors. This stage was a technique of covering the part surface of the clothes that will not receive color. The clothes were dipped three to four times in the container filled with natural dye. The waxed areas on the surface of the clothes would keep the original color. When the wax was removed, the contrast area between the colored and uncolored areas formed the pattern. The clothes were left to dry on their self then the wax can be removed. The last stage of making batik is fixation using alum, *tunjung*, or *kapur tohor*. After fixation then the clothes were dried.

The process of making batik can cause problems for worker's health. Batik workers interacted directly with chemical material when producing batik and this material was dangerous for their health. According to Junaidi et al. (2017), during the process of making batik, there are many hazards in the batik industry area. Several hazards in batik industry area namely, the low category were in the *nyanting* room, washing and drying rooms, and the waste management room with hazard percentage was 10.26%. The batik workers can be exposed to hot steam inhalation and skin irritation due to body exposure to coloring agents. Medium category hazard namely in the stamp room with hazard percentage was 30.77%, the batik workers can be exposed to hot steam inhalation and burns if exposed to the hot wax and high category hazard namely the coloring room with hazard percentage was 38.46%, the batik workers can be exposed to inhaled the coloring agent and skin irritation due to body exposure to the coloring agent (Junaidi, Fatoni and Fatimah, 2017).

Malam is a traditional wax that is commonly used in the process of making batik. This wax is not pure but a mixture of paraffin, microcrystalline, beeswax, and triterpenoid resin (Febriana et al., 2020). The emission from paraffin wax burning can produce a variety of polluting materials which was harmful to human health especially in the respiratory system. These polluting materials can cause respiratory irritation and shortness of breath (Massoudi and Hamidi, 2017). One of the examination results was done at the Bantul Environmental Health Engineering Center (BBTKL) revealed that the dominant gas contained in the melting process of *Malam* (batik wax) was Carbon Monoxide (CO). According to research by Manubari, Alhamidy and Nurini (2019) H_2S from the burning of batik wax can trigger cell death and inhibit proliferation of the cell, and CO gas produced from burning of batik wax can

also bind with hemoglobin, which should bind oxygen, and this process causes hypoxia in the tissue. Poisoning of CO can cause mild to severe symptoms. According to Hess (2017), mild symptoms that can be experienced by people or workers with CO poisoning were fatigue, malaise, headache, dizziness, confusion, disorientation, blurred vision, nausea, vomiting. Moderate symptoms were chest pain, respiratory depression, non-cardiogenic pulmonary edema, ataxia, syncope, tachypnea, dyspnea, palpitation, rhabdomyolysis. Severe symptoms were hypotension, arrhythmia, myocardial ischemia, coma, and seizures (Hess, 2017).

Research conducted by Latif (2016) regarding batik with the population of this study were all batik industry workers in the City of Pekalongan in 634 batik industries and the sample in this study was 80 respondents who were taken by random sampling. It was found that health problems among batik workers were in the form of lung disease problems, 67.5%. Munthe's research (2014) in the laweyan batik village, Surakarta, has a relationship between exposure to wax smoke and changes in lung function, although statistically, it does not state. The group exposed to wax smoke had a 4.67 times greater risk of developing lung function abnormalities than the non-exposed group.

According to the risk of health in batik workers, the authors researched about the relationship between Force Vital Capacity (FVC) with individual characteristic included age and nutritional status and workers behavior included working period, duration of exposure, and smoking behavior in Batik Jetis Village, Sidoarjo. This study aims determined the relationship between Force Vital Capacity (FVC) with individual characteristic and worker behavior in Batik Jetis Village, Sidoarjo.

METHODS

This research is an observational research which is conducted without giving intervention to the research subjects. Data were collected directly in the field by means of interviews and observations. The research design used cross-sectional, independent variables, and observed variables at the same time (period). From this study, it was obtained an overview of the graduation from the Ethics Commission of the Faculty of Dentistry, Airlangga University No. 565 / HRECCFODM / VIII / 2019.

Time and Location of Research

This research was conducted from August to October 2019, located in batik industry at Batik Jetis village, P. Diponegoro Street, Sidoarjo sub-district, Sidoarjo District.

Table 1 Variables, Operational Definition, Measurement Method, Criteria and Research Data Scale

No	Variable	Operational Definition	Measurement Method	Category	Research Data Scale
	Nutritional status	Health status that results from the balance of the fulfillment of nutrients and nutritional needs.	Measurement of weight and height	1. Thin :<17 dan 17.0-18.5 2. Normal : >18.5-25.00 3. Obese : 25.00->27.00	

No	Variable	Operational Definition	Measurement Method	Category	Research Data Scale
	Age	The length of life of the respondent was calculated from the time he was born to the time of the interview based on the year of birth.	Questionnaire	1. 17-26 years 2. 27-36 years 3. 37-46 years 4. > 46 years	Ordinal
1	Working Period	Length of work was calculated from the first time respondents made batik until now	Questionnaire	1. < 5 years 2. 5-10 years 3. > 10 years 4. >15 years	Ordinal
2	Duration of exposure	The length of time the respondent was exposed to smoke while working was calculated in hours per day	Questionnaire	1.≤ 8 hours/ day 2.> 8 hours/ day	Nominal
4	Smoking Behavior	Smoking is a daily habit of smoking cigarettes	Questionnaire	1.yes 2.no	

Population and Sample Size of Research

The survey was conducted in the batik jetis village, P. Diponegoro Street, Sidoarjo sub-District, Sidoarjo District, and showed there were 18 workers. The sample was taken by total sampling. Inclusion criteria were research subjects which had age more than 20 years old and willing to be a research sample. Exclusion criteria were subjects who the researcher did not make this subject into the sample. Exclusion subjects in this study included workers who were not willing to be research subjects, have dentures, sick and resigned.

The sample size in this study used the entire population, the researcher will make the entire population to be subject as long as it was not included in the exclusion criteria, but when the research was taking place, only 9 workers were ready to become respondents because there were sick, resigned and unpleased workers to become respondents.

Research Variable

The dependent variable is a variable that occurs because of the influence of the independent variable. The dependent variable in this study is the vital capacity of the lung. The independent variable is a variable that affects the dependent variable. The independent variables in this study were temperature, humidity, age, years of service, use of PPE while working, duration of contact with wax smoke, nutritional status, physical activity, smoking.

Data Collection Techniques and Instruments

Data were collected directly by observation and interviews. Observation and Interviews were done by researchers and officers to see individual characteristic and worker behavior of batik industry workers. Measurement and data collection of the individual characteristic and workers behavior can be seen in Table 1.

Forced Vital Capacity (FVC) is a vital capacity obtained in the expiration process quickly and strongly. Measurement of the FVC used a spirometer. The following were categories in the assessment of the pulmonary forced vital capacity, 1 was normal (Vital Capacity (VC)%> 80 and Forced Expiratory Volume 1 (FEV1) / Forced Vital Capacity (FVC)> 75), 2 was restriction (VC% <80 and FEV1 / FVC> 75), 3 was obstruction (VC%> 80 and FEV1 / FVC <75).

RESULT

Individual Characteristic

The total respondents in this study were nine respondents of batik workers in Batik Jetis Village, Lemahputro Village, Sidoarjo District. Interviews were conducted to determine individual characteristics of batik workers including age and nutritional status of workers.

Individual Characteristics

Individual characteristics in this study included age and body weight. Age in this study is defined as the time that the respondent is present from birth to the time the study was conducted and expressed in years. The results of the research on the age of workers can be seen in Table 2. The distribution of worker characteristics by age was presented in Table 4. Based on the results of research on 9 respondents, it was found that the majority of respondents were ≥50 years old with a percentage of 66.67%.

Nutritional Status

Nutritional status is a health status that is obtained from a balance of fulfillment and nutritional needs. Measuring nutritional status was done by measuring body weight and height to calculate according to BMI (Body Mass Index) formula. The nutritional status category was divided into 3 categories, namely thin, normal and obese.

Based on the results of the study, six respondents (66.67%) had nutritional status with obese category, one respondent (11.11%) had underweight nutritional status, and two respondents (22.2%) had normal nutritional status. The results of this research on the workers nutritional status can be seen in Table 2 and Table 5.

Batik Workers Behavior

Interviews and observation were conducted to determine the behavior of batik workers, included working period, duration of exposure, and smoking behavior.

Working Period

The working period is the length of time the respondent has worked until the research is carried out. The working period can be categorized into: New work period that is <5 years, Old work period is ≥ 5 years. Working period> 5 years, the potential for experiencing vital lung disorders is 8 times greater than the working period <5 years. Based on the results of the study, it was found that 1 respondent (22.22%) had worked for <10 years. Meanwhile, 8 respondents (77.78%) had a service life of ≥10 years. The results of this study based on the years of service of the respondents can be seen in Table 4 and the distribution of characteristics of respondents based on years of service can be seen in Table 6.

Duration of Exposure

Duration of exposure is defined as the length of time the respondent was exposed to CO while working, calculated in hours per day. According to the most recent CDC guidelines, duration of close contact is defined as a cumulative time of 15 minutes or more over a 24 hour period. The longer the duration of contact, the more likely the exposure will occur.

This study categorized the duration of exposure into two categories, namely ≤8 hours / day and duration of > 8 hours / day. Based on the analysis result, there were 14 respondents (87.5%) who have an exposure

duration of > 8 hours / day. Only 2 workers (12.5%) worked for ≤8 hours / day. The duration of exposure to the respondents can be seen in Table 4 and the distribution of respondents' characteristics based on the duration of exposure is presented in Table 7.

Smoking Behavior

Smoking behavior is a smoking habit that is done every day. Smoking is a necessity for someone who has a tendency to smoke. Cigarette smoke can interfere with this process so that the supply of O2 to the tissue is reduced causes hypoxia and uninterrupted cellular metabolism as well as increased CO2 in the blood and decreased vital lung capacity.

Data related to smoking behavior were obtained by interview and observation. Based on the research that has been done, there are 2 respondents who smoke behavior and there are 7 other respondents who do not smoke. The number of cigarettes consumed by smokers varies from 10 to 1 pack of cigarettes in one day. The results of observations and interviews on the smoking behavior of respondents can be seen in Table 4 and the distribution of respondent characteristics based on smoking behavior can be seen in Table 8.

Forced Vital Capacity Batik Industry Workers in Kampung Jetis, Sidoarjo District, Sidoarjo Regency

Vital capacity, the volume of air released during maximum expiration after previously carrying out maximum inspiration. Vital capacities are very large such as inspiratory reserve volume plus tidal volume (VC = IRV + ERV + TV). Vital capacity 20 force (FVC) is a measure of the vital capacity obtained in the expression carried out creatively and as strongly as possible. This normal air volume value is approximately the same as VC.

Measurement of forced vital capacity was carried out by occupational health and safety officers from UPT K3 Surabaya. Based on this study, 1 respondent (11.11%) had abnormal lung force vital capacity (obstruction and restriction) and 8 other respondents (88.89%) had normal pulmonary FVC. Measurement of the forced vital capacity of the lungs using a spirometer, which is a tool to measure the forced vital capacity of the lungs. Autospiro brand AS 300, with this tool obtained data on the vital capacity of the lung, including:% FEV1 and% FVC. The vital capacity of the lungs is measured with a spirometer in milliliters. Measurement of the vital capacity of the lung was carried out on all research subjects. The results of the measurement of the respondents' FVC can be seen in Table 2 and Table 3. The distribution of respondents based on the measurement of the FVC of the lungs is presented in Table 2 and Table 3. Table 9.

Table 2. FVC Inspection Results Based on Individual Characteristics of Batik Workers in Batik Jetis Village, Sidoarjo.

No.	Respondent	Age (Years)	BMI	Nutritional Status	FVC
1	Respondent 1	48	27.43129	Mild fat	Normal
2	Respondent 2	56	17.00882	light skinny	Normal
3	Respondent 3	58	25.06575	normal	Normal
4	Respondent 4	65	36.09607	Obese	Normal
5	Respondent 5	61	28.14787	Obese	Normal
6	Respondent 6	60	27.67874	Obese	Abnormal
7	Respondent 7	51	26.84067	Mild fat	Normal
8	Respondent 8	27	18.93878	normal	Normal
9	Respondent 9	39	22.03857	normal	Normal

Table 3 Distribution of Characteristics of Respondents Based on Worker Age in the Batik Jetis Village Batik Industry, Sidoarjo District, Sidoarjo Regency in 2019

Age (Years)	Workers	
	N	%
20-35	1	11,11
36-49	2	22,22
≥50	6	66,67
∑	9	100,00

Table 4 FVC Inspection Results Based on Batik Worker Behavior in Batik Jetis Village, Sidoarjo

No.	Respondent	Working Period (years)	Duration of Exposure		Smoking Behavior	Physical Activity (duration, frequency)	FVC
			Per Week (days)	Per Days (Hours)			
1	Respondent 1	8	6	7	No	<10 minute, >3 times	Normal
2	Respondent 2	16	7	>8		<10 minute , <3 times	Normal
3	Respondent 3	19	7	>8	No	<10 minute, <3 times	Normal
4	Respondent 4	30	6	7	No	<10 minute, <3 times	Normal
5	Respondent 5	36	7	6	No	30 minutes	Normal
6	Respondent 6	30	6	8	No	<10 minute, <3 times	Abnormal
7	Respondent 7	15	7	8	No	<10 minute, <3 times	Normal
8	Respondent 8	5	6	8	Yes	3 hours, <3 times	Normal
9	Respondent 9	17	6	8	Yes	No	Normal

Table 5 Distribution of Respondent Characteristics Based on Nutritional Status in the Work Environment in the Batik Jetis Village Batik Industry, Sidoarjo District, Sidoarjo Regency in 2019

Status Gizi	Pekerja	
	N	%
Normal	2	22,22
Kurus	1	11,11
Gemuk	6	66,67
∑	9	100,00

Table 6 Distribution of Respondent Characteristics Based on Working Period in the Batik Jetis Village, Sidoarjo Regency in 2019

Working Period	Workers	
	n	%
< 10 years	2	22,22
≥10 years	7	77,78
∑	9	100,00

Table 7 Distribution of Respondent Characteristics Based on Duration of Exposure in the Work Environment of Batik Jetis Village, Sidoarjo District in 2019

Duration of Exposure	Workers	
	n	%
≤8 hours/day	6	66,67
>8 hours/day	3	33,33
∑	9	100,00

Table 8 Distribution of Respondent Characteristics Based on Smoking Behavior in the Batik Jetis village, Sidoarjo District in 2019

Smoking Behavior	Pekerja	
	n	%
Smoke	2	22,22
Didn't smoke	7	77,78
∑	9	100

Table 9 Distribution of Respondents Based on Lung Physiology Status in the Work Place of Batik Jetis Village, Sidoarjo District in 2019

Forced Lung Vital Capacity Status	Workers	
	n	%
Normal	8	88,89
Abnormal (Restriction and obstructions)	1	11,11
∑	9	100,00

DISCUSSION

Individual Characteristics

Individual characteristics of batik workers in this study included age and nutritional status.

Age

The distribution of respondent characteristics based on age in the Batik Jetis Village work environment showed that 66.67% of respondents are ≥50 years old. People with more than 40 years old are the age which lung conditions can worsen more rapidly. Workers who had more than 40 years old have a higher risk of experiencing lung function disorders than workers aged < 40 years (Pinugroho and Kusumawati, 2017).

Nutritional Status

The distribution of respondent characteristics based on nutritional status in

the Batik Jetis village showed that the respondents in the obese category are the highest at 66.67%. The results of the analysis conducted by Wulansari (2019) showed there was a relationship between nutritional status and pulmonary function status. More nutritional status (obesity) was not good for a person's lung function capacity. As a result of obesity, there is additional adipose tissue on the chest wall and abdominal cavity which compresses the chest cavity, abdominal cavity and lungs (Wulansari, 2019).

Worker Behavior

Worker behavior in this study included working period, duration of exposure, and smoking behavior.

Working Period

The result observation and interviews were 22.22% respondents who worked for less than 10 years, while there were 77.78% respondents had worked for more than 10 years. The longer the work period, the longer the exposure or contact with the hazard. One of the wax content used for making batik was paraffin (Haerudin and Atika, 2018). The paraffin in this wax contained chlorine. Accidental inhalation of chlorine can cause both restrictive and obstructive lung disease. After chlorine was inhaled, there will be an infiltration of the inflammatory cells and there will be structural damage to the pulmonary (Jonasson, Koch and Bucht, 2013). People can be exposed with low to the high levels of chlorine (White and Martin, 2010).

Duration of Exposure

The characteristic distribution of respondents based on the duration of exposure was 66.67% who work ≤8 hours / day while respondents with a duration of work> 8 hours / day are 33.33%. The duration of exposure in this study was related to exposure to CO, which is a colorless, odorless, tasteless gas produced by burning gasoline, wood, propane, charcoal, or other fuel. CO has a high affinity to bind hemoglobin (Hb) and forming HbCO. This chemical can compete with oxygen for binding with hemoglobin because CO has a high binding affinity, so CO will bind with hemoglobin and reduce oxygen-carrying capacity. In addition to Hb, CO also can bind other heme-containing proteins, include myoglobin in the heart and skeletal muscle, mitochondrial cytochrome c oxidase (Rose et al., 2017).

Smoking Behavior

The distribution of respondent characteristics based on smoking behavior was 2 respondents (22.22%) had smoking behavior and 7 people (77.78%) did not smoke. Batik industry workers smoked during breaks. Even though workers did not smoke while working, smoking can increase the risk of respiratory disease. A cigarette contains more than 4000 types of chemical compounds, 400 hazardous substances, and 43 carcinogenic substances. Carbon monoxide, tar, and nicotine were ingredients found in cigarettes (Ministry of Health of Republic of Indonesia, 2018).

Batik Workers' FVC

Based on the research results, it was found that only 1 respondent (11.11%) had abnormal FVC and 8 (88.89%) respondents showed normal FVC results. Based on these results, the percentage of workers who had normal FVC was more than those who were abnormal FVC. This was presumably because all workers did physical activity (sports) every week and most of the workers (66.67%) did not smoke. Lung vital capacity is an anatomical measurement that is affected by physical exercise and disease. The level of physical activity (exercise) has a positive effect on lung function capacity. The higher the sports activity, the better a person's lung function will be (Bagus, Inten D.P. and Dinata, 2020). FVC has a direct relationship to physical exercise. When people doing sports (physical activity), their

body will need oxygen as fuel for energy formation because the muscles are active. The way this is done to meet the oxygen demand for energy formation, the lungs will increase the respiration frequency which also cause increase lung vital capacity (Basuki and Jeny, 2017).

The results of this study showed that most workers (66.67%) did not smoke. The behavior of workers who do not smoke was thought to be a factor in the normal FVC results for most workers. One of the factors that cause a decrease of FVC was smoking behavior. The results of the analysis test with the independent t-test showed that there was a significant difference in the results of the FVC between smokers and nonsmokers (Barakati, Lintong and Moningka, 2015). This suggests that smoking can affect FVC. Tobacco is an ingredient in cigarettes that can endanger health. When smoking, harmful substances from cigarettes will enter by inhalation, causing tissue damage to the lungs including chronic obstructive pulmonary disease (COPD) (U.S Department of Health and Human Services, 2014, 2010). Expiratory flow-volume curves in young people who have smoked only a few years showed a decrease in flow rates at small lung volume indicating there was small air-way obstruction. The research result conducted by Sushil and Mandira (2017) about the comparison of Pulmonary Function Test (PFT) between smokers and non-smokers showed that the value of PFT in smokers had a decrease compared with non-smokers. A common abnormality in lung smokers was an obstruction in the respiratory tract. Other research about comparison of pulmonary function tests between smokers and non-smokers was conducted by Hasan and Sulaiman (2018), and showed that the level of FVC in smokers was lower than non-smokers (Mohammed, Al-aaragi and Merzah, 2018). Increasing of smoking duration and number of cigarettes can decrease pulmonary function.

Research by Feldman and Anderson (2013) found that there was a different composition in the nasopharyngeal flora between smokers and non-smokers. The competitive aerobic organisms were fewer, increasing the number of pathogenic organisms, specifically *S. pneumoniae*, non-typeable *H. influenzae*, *Moraxella catarrhalis*, and *Streptococcus pyogenes* (Feldman and Anderson, 2013). The respiratory tract was chronically exposed to toxicants of cigarette smoke, primarily carbon and oxygen-centered radicals and other reactive oxygen species such as superoxide, hydrogen peroxide, hydroxyl radical, and nitric oxide. These toxicants can cause cellular damage and death, even cause the failure to activate critical intracellular signaling mechanisms that initiate protective host defense mechanisms; this reaction mainly occurred in the respiratory system.

The results of the FVC examination on batik workers in this study found as many as 1 out of 9 (11.11%) workers showed abnormal FVC status (restriction and obstructions). The characteristics of individual workers who had experienced abnormal FVC based on Tables 2 and 3 was 60 years old and nutritional status was in the heavy fat or obese category (BMI 27.67).

An abnormal FVC result in workers aged 60 years old can be caused by the age of the workers. A person's age can affect lung function. Workers with a work period of > 5-15 years were more at risk of developing lung function disorders compared to those aged < 5 years (Sekarini et al., 2019). Physiologically, lung function will decline at the age of 25-35 years as a result of increasing age. The lungs will undergo anatomical changes as we age, the alveolar ducts will widen due to the loss of elastic tissue so gas exchange surface area decreases, there is a reduction in the small bronchiolar diameter, enlargement of the terminal airspace, reduction in the total alveolar surface area, reduction in the number of capillaries per alveolus, and

degeneration occurs in a disproportionate number of myelinated phrenic nerve fibers which are a contributing factor to reduced strength of diaphragmatic contractility and decreased function of the diaphragm muscles. This appears to be the cause of lower maximal inspiratory pressure in older people (Hasan and Arusita, 2017). This shows that the older a person is, the less the lungs work. The this reduced lung action results in an abnormal FVC.

Nutritional status was measured by body mass index (BMI). Workers who experienced abnormal FVC in this study showed a BMI of 27.68 which was included in the category of heavy fat (obesity) nutritional status. A decrease in FVC can occur in obese people due to airway resistance. People with excess body fat distribution at the top cause the diaphragm to move to the abdomen and adipose that builds up on the chest wall can compress the chest cavity resulting in lower lung volume (Littleton, 2012).

Workers who experience abnormal FVC have a work period of > 10 years with a duration of 6 days per week and more than 8 hours per day and no respondent had abnormal FVC with ≤ 8 working hours. Longer duration of exposure can make workers exposed to chemical materials. The longer the working period, the higher the pollution concentration during batik making. Length of the working period can play a main role in the exposure or contact with hazard in industry batik area. Wax melting smoke exposure with variations of exposure time such as 3, 6, and 9 hours/day for 30 days causes narrowing of the tracheal diameter, decreased epithelial height, widening of the pulmonary alveoli diameter, thickening of the interalveolar septum, and emphysema. The biggest change occurred in the treatment group to exposure of melting wax in 9 hours/ day. So, the exposure length to batik wax smoke will cause malfunction of lung. Duration of exposure in this research was defined as the length of time the respondent was exposed to CO during working. Poisoning of CO from the result of the melting wax process can cause mild to severe symptoms. According to Hess (2017), mild symptoms that can be experienced by people or workers with CO poisoning are fatigue, malaise, headache, dizziness, confusion, disorientation, blurred vision, nausea, and vomiting. Moderate symptoms are chest pain, respiratory depression, non-cardiogenic pulmonary edema, ataxia, syncope, tachypnea, dyspnea, palpitation, rhabdomyolysis. Severe symptoms are hypotension, arrhythmia, myocardial ischemia, coma, and seizures (Hess, 2017).

CONCLUSIONS

Based on the results and discussion that has been presented, it can be concluded that there is a relationship between age, nutritional status, working period, duration of exposure, physical exercise and smoking behavior on the FVC of batik workers. The higher the age, abnormal nutritional status, working period, long duration of exposure and smoking behavior can cause higher abnormalities in FVC, while physical activity (sports) has a positive relationship to FVC.

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