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Assessment of Respiratory Quality among Batik Artisans: as a Safety Education for The Workers

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Abstract: As the production and usage of chemicals in workplaces around the world increases, workers are more at risk of toxicant chemical exposures that may be harmful to their health, this includes in the use of paraffin wax in Batik industry. The aim of this research is to analyze the relationship between respiratory quality and toxicant in the process of batik production. The sample of this research consisted of 5 batik workers. The data were collected using an interviewer administered structured questionnaire and the measuring of Peak Expiratory Flow Rate (PEFR) using peak flow meter about toxicant exposure and the application of occupational safety and health related to toxicant. The variable of this study was the respiratory quality of the workers towards toxicant exposure. The results showed that there were both positive and negative correlations between exposure to toxic substances and the workers, depending on their age, sex, and duration of exposure. However, we recommend implementing control measures to improve the quality of work for the workers.

Keywords: Respiratory; Batik; toxicant; workers

INTRODUCTION

Toxicants are materials that have toxic characters and can be a single toxic chemical substance or a mixture of toxic chemical compounds (Fatma et al., 2021). It can be found in the air, soil, water, or food, and humans can be exposed to toxicants (Fatma et al., 2021). A toxicant is any substance that can harm or kill humans, animals, or plants (Whelan et al., 2013).

Toxicant exposure can occur through a variety of ways, including inhalation, ingestion, and skin contact. Humans are exposed to hundreds of chemicals, many of which have the potential to harm their health (World Health Organization, 2004). Toxicant exposure can result in cognitive impairment and dementia, and it is well known that many of these toxicants have neurodegenerative as well as neurodevelopmental effects (International Labour Organization, 2021). The World Health Organization (WHO) has issued guidelines for preventing hazardous exposures, and each year, a substantial number of people are harmed or killed as a result of exposure to both man-made and naturally occurring toxins (International Labour Organization, 2021). Furthermore, the International Labour Organization (ILO) has long recognized that protecting employees from hazardous chemicals is critical to ensuring healthy populations and long-term environmental sustainability. Nevertheless, workers continue to be overexposed to toxins in almost every occupational sector. Chemical production and use are rising, implying a substantial risk of increased occupational exposure. Furthermore, with new chemicals being launched every year, procedures for regulating exposure, such as the application of occupational exposure limits, are having difficulty keeping up. As a result, there is an urgent need to take action and put in place a variety of effective measures to protect workers, their families, and the larger community (International Labour Organization, 2021).

As the production and usage of chemicals in workplaces around the world increases, workers are more at risk of hazardous chemical exposures that may be harmful to their health. The use and storage of chemicals can cause fires and explosions, resulting in widespread deadly and non-fatal injuries. Toxic effects (International Labour Organization, 2021) of occupational chemical exposure include the reproductive, cardiovascular, respiratory, and immunological systems, as well as specific organs such as the liver and brain. One of the organs impacted by toxicant exposure is the respiratory organ. Toxicants that enter the respiratory tract by inhalation can be discharged or linger in the respiratory tract and cause interference. The rate of toxicant absorption via the inhalation pathway is affected by a number of parameters, including the toxicant environment and the ability of toxicants to cross cell membranes.

The process of making batik might be hazardous to workers' health. When making batik, batik workers came into direct contact with chemical material, which was hazardous to their health. There are numerous hazards in the batik industrial region during the process of manufacturing batik. Several risks were found in the batik industrial area, including the *nyanting* room, washing and drying rooms, and the waste management room, with a hazard proportion of 10.26% (Arfiani et al., 2023). Due to body exposure to coloring ingredients, batik workers may be subjected to hot steam inhalation and skin irritation. The stamp room posed a medium category hazard, with a hazard percentage of 30.77%, batik workers may be vulnerable to hot steam inhalation and burns if exposed to hot wax (Arfiani et al., 2023).

Batik Siputri is a home-based batik industry that has been established since 2017. The process of making batik at Batik Siputri includes cutting the cloth according to the specified size, then soaking the cloth in turkey red oil for 3 days (*pemordanan*) to remove chemicals and dirt on the cloth. Next, the cloth is rinsed and dried. After the cloth is dry, the cloth can be given a pattern through the *nyanting* process and the cloth is dyed using natural colors (decoction of ketapang leaves, mahogany wood, jackfruit sawdust, and coffee waste) repeatedly 9 times. To prevent the color from fading easily, the color is locked with a fixing agent, such as limestone, alum and tunjung stone at a rate of 5-10 grams per 1 liter. The next process is *melorot* process to remove the wax and then it is rinsed and dried in the sun. Finally, the fabric can be ironed and folded as the finishing step of the process.

The descriptive research method with population correlation study research design was used in this study, and the data were collected using an interviewer administered structured questionnaire and the measuring of Peak Expiratory Flow Rate (PEFR) using peak flow meter about toxicant exposure and the application of occupational safety and health related to toxicant exposure at Batik Siputri. The variable of this research is the respiratory quality of the workers towards toxicant exposure in the process of batik production. The aim of this research is to analyze the relationship between respiratory quality and toxicant in the process of batik production in Batik Siputri.

METHODS

This research is descriptive research with population correlation study research design. This research was conducted on 5th June 2023 which located in Batik Siputri, Semarang. The samples consisted of 5 batik workers and were taken by total sampling for this research design. The data were collected using an interviewer administered structured questionnaire and the measuring of Peak Expiratory Flow Rate (PEFR) using peak flow meter. In addition, the variable of this research is the respiratory quality of the workers towards toxicant exposure in the process of batik production.

The questionnaire consisted of a few demoFigureic items, respiratory health problems related to the toxicant exposure in the working environment, and the implementation of safety and health at work concerning toxicant exposure in the work environment. This questionnaire is created using simple language so that workers can easily understand the content of this questionnaire. This questionnaire also consists of yes-no instruments regarding respiratory health problem symptoms along with their perspective.

To collect data using a peak flow meter, there are several steps involved. First, set the red indicator to the bottom of the scale then, stand up and take a deep breath, place the mouth around the peak flow meter, and hold it horizontally, ensuring your lips form a tight seal. Next, blow the air out as hard and as fast as possible. The number where the indicator stops is your peak measurement (Note: Coughing and spitting into the meter will adversely affect your reading and should be avoided) and the last, repeat the steps two or more times to obtain the result, and record the highest reading in the record chart.

Peak flow rates are often divided into three zones. The three zones are represented by the colors of a traffic light: green, yellow, and red. In general, a normal peak flow rate might vary by up to 20%. Red zone which below 50% of the user's personal best indicates a medical emergency, the yellow zone which contains 50-79% of the user's personal best indicates caution, and the last is green zone which 80-100% of the user's personal best signals good control (American Lung Association, 2023).

RESULT AND DISCUSSION

Various factors are affecting human lung function, based on the literature review done by Talaminos, et al (2018), factors such as age, height, weight, sex, body position, and race or ethnic groups all affect the human lung function (Talaminos Barroso et al., 2018). While those are the internal factors that affect lung function, there are also external factors such as occupation (Vil'ians'ka & Rodionova, 2006). Several acute and chronic pulmonary diseases are caused by inhaling hazardous chemical agents at the workplace, including dust and toxic particles, metal fumes, gases and vapors, and other air-borne pollutants (Kachel, 2003).

Based on our observation in Batik Siputri, we found that workers were exposed to several chemical agents from batik wax and smoke from the wood-burning activity. Pollutants contained in batik wax smoke contain NO_2, SO_2, CO, CO_2, HC, H_2S, and particle gases (Fauzia, 2015), while smoke from wood burning activity contains formaldehyde (CH_2O), carbon monoxide (CO), sulfur oxide (SO_x), nitrogen oxide (NO_x), hydrocarbons (HC) and greenhouse gases (CH_4, CO_2, and N_2O) dispersed in percentage values of primary sources.

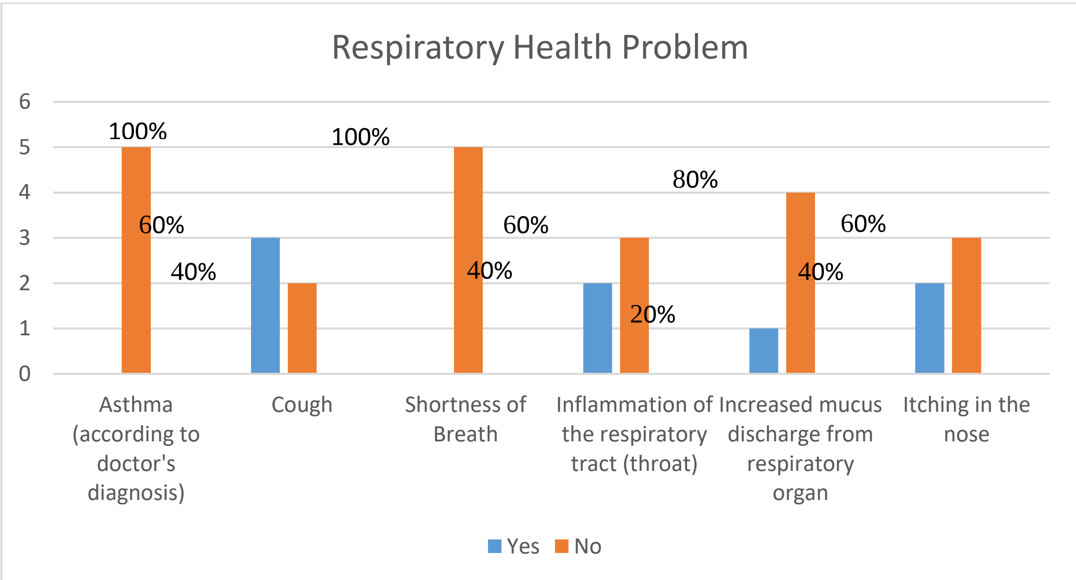

Figure 1. Respiratory Health Problem

Based on the Figureic image above, during observation found several clinical symptoms in the study subjects, among others: Cough, found in 3 subjects (60%). Sore throat as many as 2 people (40%). Increased phlegm from the respiratory tract by 1 person (20%) and itching in the nasal area by 2 people (40%). No history of asthma was found in all study subjects and also no symptoms of shortness of breath (dyspneu) in all subjects.

Table 1. Characteristics of subject and test result

Subject	Sex (M/F)	Age	Months of working	1st test	Result	2nd test	Result
1	M	25	60	600	GREEN	640	GREEN
2	F	44	60	330	YEELOW	260	YELLOW
3	M	17	1	520	GREEN	450	YELLOW
4	F	50	60	160	RED	230	RED
5	M	24	1	250	YELLOW	360	YELLOW

One of the contents of wax used in batik making materials is paraffin. Paraffin are hydrocarbons with the general formula C_nH_{2n+2}. And pharmaceutical paraffin is used for various purposes. After aspiration, paraffin is deposited in the alveoli and may cause a wide variety of reactions, ranging from no distress to acute respiratory distress syndrome. The usual radioFigureic findings of exogenous lipoid pneumonia are heterogeneous airspace opacities, mostly in both lower lobes, with possible superimposed reticular opacities. Occasionally, a localized consolidation can be seen (Weinberg & Fridlender, 2010).
Based on data on the characteristics of research subjects, in this study obtained 3 male patients (60%) and 2 female patients (40%). Age 17-50 years and duration of exposure 1 – 60 months.

Sex

In this study, there was no difference in lung function test results with *peak flow meters* in male and female subjects. These results are consistent with research conducted by Kjell, et al. Kjell Toren et al conducted research on COPD, airflow limitation, chronic airflow limitation, and emphysema in relation to different occupational exposures, There were significant associations between occupational exposure to VGDF and COPD (OR 2.7, 95% CI 1.4–51), airflow limitation (OR 1.8, 95% CI 1.3–2.5) and emphysema (OR 1.8, 95% CI 1.1–3.1) When stratified for gender, the interaction terms for gender and occupational exposure were not statistically significant in any model (Torén et al., 2017).

In this study, there were not any observation of the relationship between lung function tests and smoking history, according to Kjell et al , among never-smokers, the risk for COPD was 11.8 (95% CI 2.4–58.7). The OR for chronic airflow limitation among never-smokers was lower, 2.9 (95% CI 1.2–7.2). For the other outcomes, airflow limitation were also related to current smoking, but the relationship to former smoking was less marked and without formal statistical significance for any outcomes except emphysema.

Age

There was no difference in lung function test results at different age ranges. Alejandro et al in their research reported that age has historically been one of the major factors in the evalua-tion of lung function. Pulmonary maturity is reached at about 20–25years of age,after which lung function progressively begins todecline. The variables most affected are forced vital capacity (FVC) and forced expiratory volume in 1 second (FEV1); these decline with age due to decreased compliance of the chest wall, loss of expiratory muscle strength, and the growing tendency of the smaller airways to close during forced expiration. Specifically, FEV1declines by around 20 ml/year between the ages of 25 and 39years, a rate which gradually increases until it reaches 35 ml/year after the age of 65. The FEV1/FVC ratio also decreases with age,with the steepest decline occurring between the ages of 3 and 10years, due to the marked increase of FVC compared FEV1 that occurs to during that period. This trend is temporarily reversed during childhood, when the FEV1/FVC ratio rises slightly until the age of 16, after which the decline is continuous. This decline is presumably due to the gradual loss of lung elasticity. In contrast, volumes and capacities, such as residual volume (RV) and functional residual capacity (FRC) increase, while vital capacity (VC) and inspiratory capacity (IC) fall as a result of airway closure, progressive hardening of lung tissue, and loss of elastic recoil pressure. Finally, total lung capacity (TLC) generally remains constant in the absence of disease. Gas exchange tends to decrease with age due to the loss of alveolar surface and reduced blood volume (Talaminos Barroso et al., 2018).

Exposure

Related to the results of pulmonary function tests, in this study one research subject was found with good pulmonary function test results while 4 others obtained poor and not good results, these results were based on the green-yellow and red markings on the tool. Green means good, yellow is not good and red means bad.

Eva at al, in her research conducted in 2008 reported a relationship between exposure to batik wax smoke on changes in lung function even though it was statistically meaningless. The group exposed to batik wax smoke had a risk of lung function abnormalities 4.67 times greater than the unexposed group. The average lung function score of the exposed group was lower than that of the unexposed group. Statistically meaningful differences were obtained in the mean values of KVP and VEP1. Workers with impaired lung function had an average of longer working time than workers with normal and statistically significant lung function. There is a significant relationship between exposure to batik wax smoke and clinical abnormalities. Most likely batik wax smoke is not a risk factor for occupational asthma because exposure to batik wax smoke does not cause a significant effect on the occurrence of occupational asthma in traditional batik industry workers and the magnitude of the effect is weak (Eva Lydia Munthe et al., 2014).

Limitation

There are several limitation on this study: The number of research subjects recruited in this study was small and the criteria for inclusion and exclusion were not clearly mentioned and defined. The time of the study was short, which was only 24 hours, so the observation data obtained was limited.The study was conducted only at one location, one institution and one type of exposure, so the results could not be used widely / generally

CONTROLLING

In this study, several problems were found due to exposure to chemicals in the Siputri Batik Industry related to the respiratory system, such as coughing, shortness of breath, inflammation, increased discharge of mucus, and itching in respiratory disorders. For that, we have several control steps that can be done. Control is the elimination or inactivation of a hazard in a manner such that the hazard does not pose a risk to workers who have to enter into an area or work on equipment in the course of scheduled work (Department of Occupational Safety and Health, 2008)

Administrative Control

In the administrative control section, there are several steps that can be taken to reduce the effect of toxicant exposure in respiratory quality at Batik Siputri workers by safe work procedures, job rotation to limit individual exposure to high toxicant exposure (batik wax) areas and provide personal protective equipment like mask and gloves (Apsari & Purnomo, 2020). Safe work procedures can be required to use standardized safety practices (Asumeng et al., 2015). The employer is expected to ensure that workers follow these practices. Work procedures must be periodically reviewed with workers and updated.

Training Program

The occupational safety and health (OSH) experts' education and training, as well as the workforce's, will be significantly impacted by the quick and deep changes that are envisaged in the future of work (Felknor et al., 2020). According to the statement, we are increasingly convinced that we will use the training method, as our educational method which begins with the presentation of material related to toxicant exposure effect in respiratory system especially, followed by the direct implementation of the solutions that have been presented to build new habits in the workers' environment at Batik Siputri. Workers should be provided with training programs that educate about hazard they may be exposed and how to protect themselves (Rosita Sigit Prakoeswa et al., 2021). Training could create a positive safety culture in the workplace. Although the introduction of health and safety management systems has further decreased the incidence of occupational injuries and diseases, these systems are not effective unless accompanied by a positive safety culture in the workplace (Kim et al., 2016).

CONCLUSION

Based on our research, we can conclude that there exist both positive and negative correlations between exposure to toxic substances and the workers at Batik Siputri, depending on their age, sex, and duration of exposure. However, it is important to note that we cannot assert this information with 100% certainty due to the limitations in our study, particularly the insufficient number of subjects we had available for analysis. However, we recommend implementing control measures to improve the quality of work for the workers, considering the potential for exposure to toxic substances. This can be achieved by providing personal protective equipment such as masks and gloves, as well as conducting training and education programs related to toxic exposure for all workers.

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