ORIGINAL ARTICLE

Working Hours and Personal Protective Equipment Effect on Blood Cholinesterase Levels of Tobacco Plantation Workers

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ABSTRACT

Introduction: Tobacco production is increasing in certain regions of Indonesia due to its high economic value. Tobacco and its products can have harmful effects on the health of consumers, producers and processing workers. Analysis of blood samples has shown that tobacco farmers are at risk of developing occupational diseases related to pesticide exposure and nicotine absorption through the epidermis of wet tobacco leaves. The aim of this study was to compare blood cholinesterase levels in tobacco plantation workers in relation to their working hours and use of personal protective equipment (PPE). **Methods:** This cross-sectional observational study was conducted in ten sub-districts in Jember district, Indonesia, and included 50 participants selected using proportional sampling. Spearman's test was used to analyse the relationship between variables. **Results:** The significance value of the relationship based on Spearman's test between working hours and blood cholinesterase levels of tobacco farmers in Jember was 0.058 > α (0.05). Meanwhile, the significance value of the relationship between working hours and complete blood count, specifically mean corpuscular haemoglobin concentration (MCHC), was 0.00 < α (0.05), and between PPE use and blood cholinesterase levels was 0.035 < α (0.05). **Conclusion:** Working hours were not associated with blood cholinesterase levels, but were associated with blood MCHC levels. Meanwhile, the use of PPE was found to be associated with cholinesterase levels in tobacco farmers.
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INTRODUCTION

Around 1.2 billion adults or one in three of the world's population smoked in 2000, and it was predicted that the number of smokers will continue to rise to 1.6 billion by 2025 as a result of rising adult human populations (1-2). Increased cigarette consumption will inevitably result in increased global tobacco output. There are almost 100 countries that manufacture tobacco worldwide, but 12 countries serve as the primary producers. Indonesia, one of the 12 countries, had exports worth more than 156 million US dollars in 2015 (3).

Indonesia produces tobacco in 15 provinces distributed across many islands. The Director General of Plantations at the Ministry of Agriculture (3) reports that the production of tobacco in 2015 reached 150,343 tons in Java, 35,773 tons in Nusa Tenggara, 5,081 tons in Sumatra, 1,570 tons in Sulawesi, and 1,024 tons in Bali. East Java, with a total production of 99,743 tons, is the province that produces the most tobacco in Indonesia. Jember Regency is the region of East Java Province that contributes the most to the total production volume of tobacco. With a productivity level of 5,059 tons/ha, the Jember Regency was able to produce 18,558 tons of tobacco overall in 2015. (3). Jember Regency is a tobacco city with a tobacco emblem in various attributes used by its residents due to the significant tobacco production.

Although cigarettes and other tobacco products have a high economic value commercially, there is significant resistance to their use from a wide range of groups due to their detrimental impact on both human health and the environment (4). Consumers of tobacco and processed products are not the only ones affected by health issues related to tobacco; industrial workers are also at risk. For instance, tobacco farmers are susceptible to occupational disease brought on by nicotine absorption via the skin of wet tobacco leaves and pesticide exposure (green tobacco sickness, or GTS) (5).

Acute pesticide poisoning is the most frequent occupational health issue associated with pesticide exposure that has been identified by various research findings. According to the Centers for Disease Control and Prevention (CDC) data, there were 2,606 acute pesticide-related illnesses and health injuries reported in the United States between 2007 and 2011 across 12 states. Acute poisoning incidents among agricultural industry personnel are 37 times more common (18.6 / 100,000) than among non-farm workers (0.5 / 100,000). (6). It is anticipated that the number of cases of acute pesticide poisoning will be substantially higher in developing countries.

Pesticide poisoning of humans has long been considered a serious public health issue and it is known that acute pesticide poisoning not only poses a threat to farmers but also to agricultural families who are not in direct contact with pesticides (7). This is demonstrated by data that indicates 71.02% of the farmers' spouses who participated in the study as respondents had acute pesticide poisoning. According to the same study, knowledge variables, storage techniques, mixing procedures, and how to treat post-spray pesticides are all associated with the occurrence of acute pesticide poisoning. A study by Hutter et al. (8) on male workers showed the link to occupational pesticide exposure on coffee plantations in the Dominican Republic which reported several health issues including neurotoxicity, parasympathetic effects, acetylcholine esterase inhibition, excessive salivation, dizziness, and stomach ache. Another study by Hamka et al. (9) on horticulture farmers in Indonesia using pesticides revealed that the use of pesticides affected the farmers' health and the degree of hazard to human health may be influenced by pesticide spraying time, frequency of spraying, daytime, and wind direction.

Pesticides have the potential to cause several chronic health issues, including pulmonary physiology, in addition to acute health effects. The use of personal protective equipment (PPE), personal hygiene, and spraying time were found to be factors in the prevalence of acute pesticide poisoning or health problems such as excessive fatigue, excessive salivation, hard breathing, frequent urination, blurred vision, dizziness, and finger pain, according to research by Joko et al. (10) on onion farming workers in the Central Java Province of Indonesia. Similar information was obtained from the Sandra et al. (11) study findings, which showed a relationship between lung function and acetylcholinesterase levels in the blood of farmers exposed to chronic organophosphate exposure; the lower the level of acetylcholinesterase, the lower the lung function. Pesticides are also known to cause multiple myeloma, sarcoma, prostate and pancreatic cancer, uterine, pancreatic, and Hodgkin's diseases, among other health issues (12-14). Therefore, this study aimed to examine how blood cholinesterase levels in tobacco plantation workers in Jember Regency relate to working hours and PPE use.

MATERIALS AND METHODS

This study was an observational study that employed a cross-sectional research design. This study was conducted in 10 districts of the Jember Regency, which became the center of the tobacco farming industry. Pakusari, Kalisat, Mayang, Sukowono, Arjasa, Wuluhan, Ambulu, Tempurejo, Gumukmas, and Balung districts are all included in the ten sub-districts. The population of this research is tobacco farmers in Jember Regency. Since the agricultural system in Indonesia does not follow a centralized system, data regarding the precise population of tobacco farmers in the Jember Regency have not been recorded accurately, and the number is constantly fluctuating, so the population of tobacco farmers used in 2018 is infinite or inverse population.

Samples

The research sample was selected according to the research inclusion criteria which included: (a) working as a tobacco farmer, (b) the working hours is at least 6 months, and (c) being willing to participate in research. The working hours is the length or total amount of time when the respondent first actively worked with pesticides until the time when this study was conducted. The Lemeshow stratified sampling formula was used to select the sample size in this investigation, which included up to 50 farmers (15). Furthermore, by using proportional sampling, the sample distribution in the ten districts that served as the study's site was established, allowing researchers to know that each district had five tobacco farmers who participated in the study as samples.

Types of blood levels obtained for this study include haemoglobin, leukocytes, lymphocytes, monocytes, hematocrit, platelets, erythrocytes, Mean Corpuscular Volume (MCV), Mean Corpuscular Haemoglobin (MCH), Mean Corpuscular Haemoglobin Concentration (MCHC), red blood cell distribution width expressed as coefficient of variation (RDW-CV), as standard deviation (RDW-SD), and Mean Platelet Volume (MPV).

Statistical analysis

The dependent variable in this study is the level of cholinesterase in the blood that has been exposed to pesticides during work tested using the Test-mate ChE Cholinesterase Test System (Model 400), and the independent factor is the working hours since the respondent is active as a farmer until the time the research is conducted in units of years and the behaviour of using PPE on tobacco farmers which includes knowledge, attitudes and actions in Jember Regency. The data in this study were obtained through measurement of cholinesterase and pulmonary physiology levels, observation, and interviews using a questionnaire sheet. The data obtained were analysed univariately and bivariately using IBM SPSS Statistics 25 software, with Spearman's test to analyse the relationship between variables and descriptive analysis to describe the frequency distribution of each variable.

Ethical considerations

Ethical approval for this study was obtained from the Research Ethics Committee of the Universitas Jember, Indonesia with number 106A/UN25.8/KEPK/DL/2018. All methods were carried out in accordance with relevant guidelines and regulations.

RESULTS

Relationship of work hours with tobacco farmers' cholinesterase levels in Jember Regency

The majority of tobacco farmers had a normal cholinesterase level of 90%. Table I shows that the majority of tobacco farmers have worked for more than 10 years. The study findings indicates that there is no correlation between tobacco farmers' blood cholinesterase levels and the number of years they have been working as tobacco farmer in the Jember Regency ($p < 0.05$, p (rho value) = 0.058). The working hours of tobacco farmers in the Jember Regency was found to be correlated with their blood MCHC levels ($p < 0.05$, p = 0.00), while no correlations were found with other variables (haemoglobin, neutrophils, monocytes, hematocrit, platelets, erythrocytes, MCH, RDW-SD, and MPV) as shown in Table II.

Table I: Working Hours of Tobacco Farmers in Jember Regency

Working years	Total farmers	Percentage (%)	Spearman test (Cholinesterase level)
<6 years	4	8	
6-10 years	6	12	0.058
>10 years	40	80	
Total	50	100	

Table II: Relationship of Working hours with Complete Blood Level of Tobacco Farmers in Jember Regency

Blood levels parameters	Working hours (p-value)
Hemoglobin	0.659
Leukocytes	0.225
Neutrophils	0.776
Lymphocytes	0.274
Monocytes	0.517
Hematocrit	0.718
Platelets	0.670
Erythrocyte	0.814
Mean corpuscular volume (MCV)	0.379
Mean corpuscular hemoglobin (MCH)	0.989
Mean corpuscular hemoglobin concentration (MCHC)	0.00*
RDW-CV	0.481
RDW-SD	0.620
Mean platelet volume (MPV)	0.964

Note: Red blood cell distribution width (RDW) expressed as coefficient of variation (RDW-CV) and as standard deviation (RDW-SD); * *p*-value is significant at less than 0.05

Relationship of PPE usage to tobacco farmers' cholinesterase levels in Jember Regency

The use of PPE is a form of self-protection by wearing a complete set of personal protective equipment consisting of gloves, safety shoes, a mask, a cap, and body armor (clothes and pants). The results of research on the use of PPE in tobacco farmers in Jember Regency show that most of the tobacco farmers have employed PPE effectively (Table III). Table III shows that the results of the statistical analysis of the relationship of PPE use with cholinesterase levels were 0.035. This value is less than 0.05 so it can be concluded that there is a connection between the usage of PPE and the blood cholesterol levels of tobacco farmers in Jember Regency.

Table III: Use of personal protective equipment (PPE)

PPE use	Total	Percentage (%)	Spearman test (Cholinesterase level)
Not good (3 PPE)	10	20	0.035
Good (3 PPE)	40	80	
Total	50	100	

DISCUSSION

In this study, there was no relationship due to working hours and the use of time was efficient and productive. According to Rahman et al. (16), one of the variables influencing the amount of cholinesterase in a respondent's blood is their working hours. The longer the working hours, the lower the amount of cholinesterase in the respondent's blood, increasing the risk of pesticide poisoning. If someone is exposed to or in contact with pesticides for less than four hours a day, poisoning does not occur (17). This result supports Purba's (18) findings that working hours have no effect on blood cholinesterase levels; rather, it is the time away from work (pesticide spraying) that causes cholinesterase activity to return to normal.

MCHC or Mean Corpuscular Haemoglobin Concentration is the concentration of haemoglobin per red blood cell, expressed in grams per deciliter (g/dl) (19). It is used to assess the possibility of different types of anaemia. There is a correlation between blood MCHC levels and length of service. A person who has worked for more than 6 years with prolonged exposure to pesticides may experience a decrease in the ability of the blood to produce MCHC, which can cause dizziness and low blood pressure (anaemia) (20). There was a decrease in haematological parameters (total erythrocytes, leukocytes, platelets and hematocrit) during occupational exposure to pesticides (21). In another study on the haematological picture in workers exposed to pesticides, it was found that the mean MCHC value was higher in greenhouse workers compared to the control group, while other haematological parameters decreased compared to the control group (22). An elevated MCHC level indicates large (macrocytic) erythrocytes, a clinical condition known as megaloblastic anaemia. Megaloblastic anaemia is caused by a disruption in DNA synthesis during the maturation of red blood cell nuclei in the bone marrow and ersuly in slow cell division (23-24).

Disruption of DNA synthesis can be caused by the reaction pesticide metabolites which bind to nucleic acids (25). This leads to mutation (gene duplication) at the glycophorin A (GPA) locus. When the mutation rate at the GPA locus was measured, the frequency of somatic cells with the NN genotype increased (26). This suggests that blood cell precursors only have the ability to produce compounds for gene duplication, while the compounds used to inactivate the mutation are not produced by cells in the bone marrow. This leads to an increase in the number of duplicated genes, causing genetic damage to the blood cell precursor's DNA. This genetic DNA damage inhibits the maturation of erythroid precursors (red blood cell buds). Although DNA synthesis is disrupted, RNA synthesis continues normally, leading to an accumulation of cytoplasmic components in the cell. This imbalance in the maturation process of the nucleus and cytoplasm of red blood cells results in the production of red blood cells that are larger than normal (27). In addition, red blood cells tend to break down easily in the bone marrow before entering the bloodstream, resulting in anaemia (28).

The use of PPE during spraying can affect the amount of pesticide particles that enter the sprayer's body. Personal protective equipment that must be used when spraying includes masks, hats, body protectors (clothing and trousers), gloves and safety shoes. The more complete the PPE used during spraying, the less likely it is that cholinesterase levels will be abnormal. The results of this study indicate that there is a significant relationship between the level of PPE and cholinesterase in tobacco growers in Jember. The results of other studies on the use of PPE have shown that there is a relationship between the use of PPE and cholinesterase (29). This study is in line with the theory proposed by Rosanti et al. (30) that pesticide poisoning may occur due to excessive exposure to pesticides or due to disregard of occupational health and safety procedures and inadequate work equipment. Farmers who do not use at least three PPEs experience cholinesterase abnormalities. Pesticides can enter the human body through inhalation, respiration and digestion. Farmers are therefore required to use personal protective equipment such as masks, hats, long-sleeved shirts and long trousers when spraying. This is recommended to reduce the risk of pesticides entering the body, which can affect cholinesterase levels.

There are a number of limitations to this study that make the results of this study not as expected. This study did not examine other factors that may affect blood cholinesterase levels, namely nutritional status, dietary patterns, vitamin and mineral intake, and other sources. A more accurate test to determine the effects of chronic exposure to pesticides is to analyse pesticide levels in bones, hair and teeth. The number of people who can be included in this study is smaller, so the data is less varied and the results of data analysis are not as expected. This research requires a lot of work and cost, so the number of respondents cannot be maximised and the results are less able to provide conclusions that are thoroughly applicable. The study was carried out at one point in time, so it does not reflect the respondents' condition, chronic exposure and blood pesticide levels.

CONCLUSION

This study demonstrates that the majority of tobacco farmers in Jember Regency who have been working for more than ten years have no association between their working history and blood cholinesterase levels, but they do have a relationship with blood MCHC levels. Although most tobacco farmers use PPE effectively, there is a correlation between the use of PPE and the level of cholinesterase among tobacco farmers in the Jember Regency, according to the findings of statistical analysis. The recommendation is that there is a need for routine monitoring of blood MCHC levels and regular monitoring of PPE to minimize illnesses caused by pesticide contamination. Further studies are necessary to measure the pesticide residue in the human body including blood or urine metabolites to investigate the hazardous effect on health safety.

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