



ORIGINAL ARTICLE

The Correlation of Blood Xylene Levels and Neurological Disorders among Informal Car Painters

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(Received: 15 October 2021

Accepted: 17 May 2022)

KEYWORDS

Xylene exposure;
Xylene in blood;
Neurologic symptoms;
Painters

ABSTRACT: A provisional study was conducted to analyze the correlation of xylene exposure in the air at the workplace with levels of xylene in blood and neurological symptoms among informal car painting in Surabaya. This research was designed as an observational study and conducted by the cross-sectional technique involving 51 informal car painters. Neurologic symptoms were meant by the German version of the Q18 form while resolving xylene levels within the blood have measured with ELISA. This study has also observed the characteristics of workers and working activity factors. Significant correlations have been shown based on Pearson correlation analysis, which was the age, working period, and duration of work. Meanwhile, Spearman correlation analysis showed that the habit of using a PPE mask, smoking habits, and xylene levels in the blood were strongly considered to have a significant association with neurological symptoms in workers. Simple linear regression s used to analyze the correlation coefficient (R-square), which was 0.718. In conclusion, blood levels of xylene are related to neurological symptoms in informal car painters. The monitoring of xylene levels in the blood and the regular use of PPE masks demonstrated the relationship between xylene exposure and neurological symptoms.

INTRODUCTION

Overpopulation is one of the most significant industry issues facing humanity today. The new population will have to find the right way to live [1]. An era characterized by the accelerated advancement of science and technology makes it easy for people to fulfill their needs [2, 3]. The circumstance is further opening to a variety of jobs. While it is important to open up more fieldwork, on the other hand, it is necessary to identify the issues that need to be considered, which are related to the effect of occupational diseases [4].

The increasing nature of finance has contributed to a

rising array of possible hazards and risks experienced by workers [4]. Possible consequences and threats to the business include several substances that are manufactured goods, over and a range of other risks that may pose a hazard to the workers—moderating effect, for the most part, on the progress of economic development in the type of occupational diseases, which requires significant consideration. Since then, workplace disorder of employees subjected to polar compounds, for instance, becoming another aim, is something that legislation needs to be more vigilant [5]. Generally, informal

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DOI: 10.22034/JCHR.2022.1942679.1432

workers are in severe contact with workplace disease instead of formal workers. Moreover, the absence of a social security issue is a massive challenge because not all workers will be compensated. Mainly as a significant cause, a measure must be taken to resolve the issue, like environmental health surveillance, public health policy research, or some other such initiative due to the enactment of the problem [6]. Informal employees, including painting workers, dockyard workers in manufacturing, automotive repair workshops, and many others, are the most productive workers. They have been regularly exposed to organic compounds, in particular polar compounds. Various health effects, including the possibility of workplace infection, are triggered by exposure to organic solvent-containing substances, some of which are neurological effects [7].

Workers' companies require consideration as increasing levels fluctuate wildly, although the risk of an incurable disease is significant [8]. Not only about 100 automotive paint shops car painting distributed across the region in Surabaya. That percentage increased dramatically last year—car paint procedure with paintings using chemical substances [9]. Exposure to paint compound solvent may irritate skin or damage the eyes, mucosa, the gastrointestinal and respiratory tract, and the skin. Exposure to chemical compounds (xylene, n-hexane, methyl alcohol, etc.) may damage the long-term nervous system [10].

Nervous system disruption may arise due to neurotoxic environmental exposures, and substance use would be neurotoxic or metabolic disorders, including diabetes or uremic. The primary emphasis is on the interaction between environmental protection and the neurological symptoms of toxic chemicals (toxins) present in the workplace. Neurophysiological disorders are one of ten conditions and occupational injuries in the United States. People exposed to harmful chemicals such as arsenic, chemical solvents, and pesticides in workplaces are considered to correlate to the emergence of a neurocognitive allegation [11, 12].

Chemical solvents are commonly used in manufacturing, including in the production of oils, degreasing, adhesives, and paint industries [13]. It is revealed that nearly two million workers (9% of the current workforce) in the United Kingdom often use substances daily [14]. In

Indonesia, the use of such polar compounds is commonly utilized, particularly in industrial business, which linear trend manufactured goods, some of them are in the painting industry [15].

The automotive industry's most common chemicals in spray paint are xylene [16]. Whenever the paint is applied, the worker will be subjected to fumes and highly uncomfortable aerosols inhaled by workers, particularly if they are not wearing masks and suitable work clothes during painting. The amounts of xylene in the blood enter the uppermost exposure pathways, such as nasal, ingestion, or through the skin [11]. Nevertheless, xylene penetration is a significant path via the respiratory tract. Toxicodynamics of xylene in the body as seen in which xylene produces acute toxicity on target organs. The lipophilic characteristics of xylene to the nerve membrane may associate with the function of proteins that play a vital role in regular neurons. Exposure to xylene volatiles may decrease stimulation disruption of axonal transport and a decline in hypothalamus catecholamine quantities intended to cause neurological disorder [17].

The quantities of xylene concentration calculated by the assay are m-xylene (40-65 percent), p-xylene (20 percent), o-xylene (20 percent), and ethylbenzene (6-20 percent). Occupational Safety and Health Administration (OSHA) established a threshold level or permissible exposure limit (PEL) at 100 ppm for xylene at such an exposure concentration of eight hours or even a time-weighted average of eight hours (TWA). National Institute for Occupational Safety and Health (NIOSH) suggested exposure levels xylene is 100 ppm TWA up to ten hours each work day and 40 hours a week and 200 ppm for ten minutes of exposure as a short-term or brief exposure maximum [18].

Some reports indicate health effects related to xylene toxicity, with acute exposure of 200-ppm over 3-5 minutes causing skin, nasal, and throat irritation [19]. Staff exposed to xylene volatiles over two weeks showed symptoms of anorexia, fatigue, and vomiting [20]. Exposure to 10,000 ppm xylene in inhalation indicates kidney function problems defined by excessive concentrations of β -glucuronidase and albumin in the urine and the excretion of red blood cells and white blood cells in the urine [19]—research on several groups of

workers in Turkey. Higher risk to auditory group paint industry workers and casual paint workers in Turkey shows 131 workers were exposed to polar compounds and 85 dB of occupational noise was more significant than those of occupational noise exposure mainly at the same time. Throughout this category, the chemical compounds used for the raw materials were xylene [21]. Certain people frequently deal with environments that cannot be monitored and are regularly exposed to high concentrations of volatile compounds, causing immediate symptoms such as vomiting, fatigue, reduced agility, headache, nausea, dizziness, tremor, and slight depressive symptoms. The study reported in the United States among paint manufacturing companies adequately determines the extent of neurocognitive disorder. The impact review should be assisted daily for many years [22].

The amount of xylene within blood approaches the uppermost route of exposure, i.e., by mouth, inhalation, and were the skin. The primary source of exposure to xylene in the respiratory tract was the upper concentrations of xylene in the blood thirty minutes later [23]. The toxicity of xylene inside the body can be seen in which xylene induces damaging effects on target organs. Liposulability properties (lipophilic) xylene to the nerve membrane may disrupt with the action of proteins that contribute to regular neuronal function. Exposure to xylene volatiles may cause a reduction of impulse related to disturbance and decline in axonal transport and reduced to the extent of catecholamine hypothalamus [19].

The significant hazards of xylene tend to involve a dire situation caused by exposure to extremely high levels of nerve function inhibition gradually, occurring paralysis, respiratory failure, death of brain cells, and the possibility of experiencing cardiac arrhythmia. Since these specificities of exposure to xylene are much more constrained, medium to high exposure to a combination of solvents, like xylene, or other substances that are quite closely related (e.g., toluene) may affect some range of significant organs [24]. It can be most often used in solvent offenders (solvent abusers). Renal function, hydration management, and muscle tissue problems can occur and may be interconnected. There may also be non-specific inflammation of the respiratory tract and the

digestive system and occasionally adverse reactions to on liver [25]. The neurological system is the primary focus organ. At minimal risk upward from the threshold limit value (TLV), mainly reversible neurobehavioral symptoms (may return) were detected. It can be through, for instance, balance and response time problems, which can necessarily lead to a risk of severe work-related disease [25].

MATERIALS AND METHOD

This research was conducted in one field of car paint in Surabaya. One such location became the hub of automotive painting services and welds in Surabaya, Indonesia. This research examines the relationship between exposure of xylene throughout the environment to blood xylene levels and neurological disorders experienced by casual automotive painters in Surabaya. This research was designed as an observational study and obtained using a cross-sectional methodology. There were 93 workers recruited, and based on stratified random sampling methods, 51 workers who worked as painters contributed to this study. This research examined the association of neurological disorders with worker characteristics (age, workout habit, behavior of using safety equipment, smoking habit), blood xylene levels, and occupational factors (period, length of work, and job description).

Principle of the blood assay

The kit measures the quantity of human xylene in a sample, coats microtiter plate wells with purified antigen, creates solid-phase antigen, and then adds xylene to the wells. After washing thoroughly, an antigen that has been combined, the conjugated enzyme Horseradish peroxidase (HRP), HRP-labeled antigen-antibody – enzyme-antigen complex, is formed. When Tetramethylbenzidine (TMB) substrate solution is added, the TMB substrate becomes blue. The reaction is ended at HRP enzyme-catalyzed by adding a sulphuryl acid solution, and the color change is detected spectrophotometrically at 450 nm. The concentration of Human Xylene in the samples is then calculated by comparing the optical density of the samples to the standard curve.

RESULT AND DISCUSSION

The findings of the Spearman study used to analyze the association between independent variables in which the characteristics of workers, the amount concentration of xylene in the blood, and the jobs factor with the dependent variable, which is the neurological symptoms, revealed a substantial relationship between age, working time, the behavior of using PPE mask, smoking behaviors, and concentration of xylene in the blood. It can be shown that the likelihood is less than 0:05. The age correlation test ($p = 0.000$; $r = 0.697$) revealed a correlation between age and neurological symptoms of

workers. The normal usage of personal protective equipment (PPE) like masks ($p = 0.000$; $r = 0.695$) indicated a correlation with neurological complaints among most workers. Smoking cigarettes behaviors ($p = 0.016$; $r = 0.335$) revealed an association with neurological symptoms among workers. Exercise habits ($p = 0.170$; $r = -0.195$) revealed no association with neurological symptoms among workers. Meanwhile, blood xylene concentrations ($p = 0.000$, $r = 0.711$) are known to have a clear correlation with neurological disorders among workers. (Table 1)

Table 1. Variables associated with neurological symptoms. Table highlighting factors associated with neurological symptoms in car painters.

Independent Variables	Dependent variable: neurological symptom	
	(P-value)	Coefficient correlation
Age	0.000	0.697
Job employment description	0.476	0.102
Working period	0.000	0.713
The habit of using a PPE mask	0.000	0.695
Smoking habit	0.016	0.335
Exercise habit	0.170	-0.195
Duration of working	0.471	0.103
Levels of xylene in blood	0.000	0.711

An indication of the relationship between neurological disorders have shown with the data for the period of work ($p = 0.000$; $r = 0.713$). Employment-based on job description factors ($p = 0.476$; $r = 0.102$), showed no relationship between job description with neurological symptoms on workers. Working time or duration of work ($p = 0.471$; 0.103) showed no association between Working time with neurologic symptoms in workers. Simple regression analysis (multivariate analysis) analyzes all independent variables simultaneously with the dependent variable, neurological symptoms. In this

research, simple linear regression, which is known to have demonstrated that the most dominant aspect associated with neurological symptoms is working time, the regular habit of using PPE, including such mask and xylene concentration in the blood. The correlation coefficient (R-square) for this regression test was 0.718. This implies that 71.8% of associated factors of neurological symptoms were determined by the duration of work, the habit of using the PPE, like masks, and concentration of xylene in the blood, meanwhile 28.2% by other variables.

Table 2. Description of Xylene Blood Levels of Respondents.

Variable	Minimum	Maximum	Average	Std. Deviation
Blood xylene levels (m m^{-1})	454	3680	1096.92	737.974

The measurement results by ELISA on xylene levels in the blood obtained the following distribution results described in Table 2 and Table 3. Based on Table 2, the lowest level of xylene in the workers' blood is 454 m m^{-1} . The highest concentration of xylene is 3680 m m^{-1} , which can be grouped by quartile and divided into 4 data groups in Table 3, considered respectively as low ($454\text{-}624 \text{ m m}^{-1}$), Moderate ($625\text{-}765 \text{ m m}^{-1}$), Mild ($766\text{-}1396 \text{ m m}^{-1}$), and high concentration in which more than 1396 m m^{-1} . This grouping of data can make it easier to see the frequency distribution of workers' blood xylene levels in the presence of neurological complaints. Based on a

medical examination by analyzing blood xylene levels for car painting workers, from 51 workers exposed to xylene, the average xylene content in the workers' blood was 1096.92 m m^{-1} . If categorized into four groups, it is known that the group of workers with blood xylene levels of $766\text{-}1396 \text{ m m}^{-1}$ experienced neurological complaints as many as 14 people or 34.1%, while the lowest blood xylene levels, namely $454\text{-}624 \text{ m m}^{-1}$ showed that the most significant number of workers who did not experience neurological complaints, as many as nine workers.

Table 3. Frequency Distribution of Xylene Blood Levels of Respondents with Neurological Disorders

Blood xylene levels (m m^{-1})	With neurological disorders		Without neurological disorders		Total	
	n	%	n	%	n	%
Low (454-624)	4	9.8	9	90	13	25.5
Moderate (625-765)	11	26.8	1	10	12	23.5
Mild (766-1396)	14	34.1	0	0	14	27.5
high (>1396)	12	29.3	0	0	12	23.5

Distinguishing factors of workers are one factor that is suspected of correlating with the incidence of neurologic disorder. Based on the location, most of the car paint was on the edge of the highway and close to the shop turnover completion tools and automotive modification, causing the staining region has become the most significant car painting in Surabaya. This condition causes the frequency of car paint to be relatively high in the area, which indirectly indicates the use of organic solvents and paints. This can lead to exposure to chemicals, one of which is xylene contained in thinner and paint.

The exposure received by workers will demonstrate different effects depending on the characteristics of workers. Worker characteristics include age, smoking habits, exercise habits, and habits using a personal protective equipment-based study some literature that these variables predicted a relationship with health complaints. Risk factors for neurological disorders in workers car painting can be grouped into two groups, namely the direct cause and indirect causes. The natural causes have contributed to the incidence of neurologic complaints at work, for example, in organic solvents, metals, or insecticides, and indirect causes are multiple

variables, including the characteristics of workers and job characteristics [26]. In this study, the direct reason is exposure to xylene, while for factors that are not directly in the form of worker characteristics, such as age, nutritional status, respiratory rate, the habit of using personal protective equipment (PPE) masks, smoking and exercise habits. In contrast, factor includes job tenure, length of employment, and employment section. In addition, biological monitoring of exposure to the xylene index recommended by WHO is the examination of xylene levels in the blood, which is specific to determine the level of exposure to xylene in the body.

The results of statistical tests performed in this study using the Spearman statistical test showed that out of the eight components of the variable, only five elements have a relationship with neurological complaints. To factor in worker characteristics, features that have a significant relationship, and the habit of using PPE masks.

Age

Age also affects the levels of xylene in the human body. The survey results revealed the average age of workers was more than 45 years, precisely 45.82 years. Workers

with the oldest age were 70 years, while the youngest was 25 years old. Research from Baker shows the relationship between age and neurological disorders caused by exposure to organic solvents. Older individuals showed decreased performance, hand and eye diseases, and related neurobehavioral diseases [26].

Age is an important variable in terms of the occurrence of neurological symptoms. The increasing age, especially those accompanied by poor environmental conditions, the chances of developing a disease, and exposure to chemical solvents class especially the possibility of health problems can occur are more significant [27].

Physiologically with age, the ability of the body's organs will naturally decline. This situation will get worse with unhealthy environmental conditions and other factors such as smoking, lack of respiratory protective equipment at the workplace was also indiscipline and long exposure associated with the nervous system. Research [27] mentions that age 20-24 showed an increased incidence of neurological disorders caused by exposure to solvents, kept constant until the age of 40, and then decreased.

Nutritional status

Results in this study stated that the nutritional status has no significant effect on neurological complaints. However, the average Body Mass Index (BMI) of 25.71 kg m²-1 indicates that workers include the obese category. Nutritional status is a state of the body because of the consumption of food and nutrients. The current standard index used to assess healthy development is the Weight (BB) to the Height (TB). In terms of its use is more manageable and more practical and still has a scientific basis for its fundamental research Nutrition Research Department of Health. In this case, the nutritional status can be distinguished: the status of malnutrition (underweight), good dietary status/average, and nutritional status (obese).

The inadequate nutritional performance will weaken an individual's immune response, with a decline throughout the immune system. Consequently, a person will be rapidly infected by microbes or any pathogen. Moreover, the lack of nutrients and antibodies prone to diseases like coughs, colds, and diarrhea may decrease the detoxing ability against harmful contaminants [28]. This is in line with research [29] which states labor nutritional status is

closely related to the soundness of labor and labor productivity. Adequate nutrition can enhance the health status or the dietary intake of the workers so that workers have an excellent physical environment that affects their productivity to maximize the company's profitability [30]. Workers ought to be treated nutrient consumption by consuming balanced nutritious meals. In the meantime, the workers who seem to be overweight should get a balanced diet.

The rate of breathing (respiration rate)

The workers' respiration rate or respiratory rate in this study showed no association with neurological complaints—the respiration rate of workers by an average of 19.57 per minute. The respiratory rate refers to the number of inhalation and exhalation a person takes every minute. The respiration rate is calculated while the worker is resting, which essentially includes measuring the number of breaths in one minute by measuring how often the rise of the chest. Value respiratory examination is one of the indicators used to assess the function of the respiratory system that consists of maintaining the exchange of oxygen and carbon dioxide in the lungs and acid-base regulation. The respiration rate is higher in men than in women. This happens because men have vital lung capacity greater than women. Anatomically, the total lung capacity of men is greater than the full lung capacity of women [27].

Habitual use of PPE

Habitual use of personal protective equipment is a factor that must be considered, given the significant route of exposure is through inhalation of xylene. In this case, the appropriate individual protective equipment masks respiratory protective equipment. The survey results revealed that respondents who do not use personal protective equipment such as masks during work are the most significant number, as many as 34 people. In the group of respondents who sometimes use personal protective equipment, as many as ten people, and the groups with the smallest percentage in the group of respondents who always use personal protective equipment were seven people.

The relationship between chronic use of personal

protective equipment with neurologic complaints showed a significant relationship based on the test results. The probability (p-value) of 0,000 less than 0.05, with a value of 0.680 correlation coefficients. If traced based on distribution relationship habits of use of personal protective equipment such as masks with neurological complaints, it is known that workers who did not use a mask when working complained of neurological complaints amounted to 80.4%, while always using the mask does not feel entirely neurological complaints.

Based on the primary route of xylene exposure through inhalation, then the chances of neurological complaints about workers who do not use masks PPE proved more significant than the worker who wears a mask [31]. However, the respiratory protective equipment used for half the workers in face masks (half-face) is inappropriate. For exposure to vapors of organic solvents, such as xylene, respirators Organic Vapor (OV) are then used to filter specific organic solvent vapor. When connected to the hierarchy controlling health and safety risks such as engineering and administrative controls, expected exposure to organic solvent vapors through the inhalation and the impact can be minimized.

The habit of smoking

Factors smoking habits have a relationship with neurological complaints by Spearman correlation test, in which the probability (p-value) 0,048 less than 0.05. In this study, 94.1% of workers are known to be smokers. A total of 22 workers smoked 5 to 10 cigarettes per day, assumed as moderate smokers. Workers were classified as heavy smokers who spend more than ten cigarettes per day, as many as 21 people or 41.2%. Smoking is one of the lifestyles of workers suspected of influencing the incidence of neurologic disorders.

Tobacco smoke consists of thousands of compounds, including nicotine [32]. Many constituents are known to be toxic (toxic) to the brain, heart, and lung systems. On the other hand, nicotine enters the cholinergic system in the short term and has a positive effect on specific cognitive domains, including working memory and executive function, and may also in certain circumstances, including nerves. Moreover, a substantial amount of xylene is present in cigarette smoke, so smoking is a habit that can contribute to exposure to

xylene, despite being relatively low [33]. Xylene is also contained in cigarette smoke and results from incomplete combustion engine vehicles [11]. Smoking is one of the causes that can accelerate the absorption of xylene in the human body. It is because cigarette smoke is irritant and can cause rigidity of cilia / vibrating hairs in the respiratory tract that are not working correctly [34]. Therefore, smoking is one of the factors in the high blood levels of xylene, given one cigarette component is xylene. People who smoke and inhale the smoke will be exposed to xylene at higher levels than people who are not exposed to smoke. But secondhand smoke can also be exposed to cigarette smoke and contains xylene, thus increasing the potential for neurologic complaints about workers.

Exercise habits

The exercise habits of workers can be assumed to be very low. This is illustrated by the number of workers who do not exercise as much as 36 people, exercising less than three times a week as many as ten people, and often do sports more than four times a week as much as 2 or 3.9%. Exercise can increase the uptake of xylene to about 1210 mg. This is because psychophysiological function began to be affected in uptake between 600-1000 mg. Still, the implications for 8 hours according to the standard set are unclear because of the uncertainty of the rate of metabolism. Exercise habits were measured with a frequency and duration mode or type of exercise [25].

If associated with the incidence of neurologic complaints, it is known that there is no relationship between exercise habits with neurologic complaints among workers. This is evidenced by the Spearman correlation test. The probability (p-value) is more significant than 0.05, which is 0.081, with a correlation of -0.247 coefficient value indicating an inverse relationship between exercise habits and neurological complaints. During exercise, the ability of the lungs to absorb moisture organic solvents will increase until it reaches a point of equilibrium (equilibrium). However, when it has stabilized (steady state), exercise habits no longer affect the body's ability to vapor absorb chemicals or solvents [35].

Furthermore, the accumulation of xylene in workers' blood is a method of biomonitoring used to evaluate xylene intake [19]. Based on the current study, the

association between blood xylene levels and neurological disorders was significant, with a p-value of 0.000 and a correlation coefficient value of 0.869. Studies have shown that the concentration of m-xylene in the venous blood of male mice increased rapidly on exposure in the morning, reaching a maximum level of 43 mol L⁻¹ or 4.56 ng L⁻¹ at 15 minutes of exposure line with any given activity. Similarly, during passive activity, the blood concentration of m-xylene increased gradually to the end of the measurement in the morning [36]. M-xylene levels in the blood are approximately 1.4 to 2.8-fold higher in 20-40 minutes after the initial exposure to the exertion compared with mice not given overactivity [37].

In the study that showed nine male workers exposed to xylene 200 ppm for 3 hours in the morning and 40 minutes in the afternoon with known levels of xylene blood varies, where the exposure to xylene morning showed the levels of xylene blood 637 ng L⁻¹ and in the afternoon as much as 225 ng L⁻¹ [17]. When compared with this study, it can be concluded that exposure to xylene in Surabaya is higher, where the highest blood xylene levels reached 3680 ng L⁻¹ with exposure to 341 ppm for 2 hours in the morning.

Neurological symptoms workers Surabaya car painting is very varied. The interviews using questionnaires showed that most workers complain of perceived Neurological symptoms. Of the ten complaints of neurological, dizziness, headache, leg pain, arm pain, joint pain, back pain, insomnia, nausea, tremors, and decreased ability to recall. In addition, this study also conducted a medical examination by a doctor about any neurological symptoms. Results of the questionnaire concluded the neurologic complaints if nine out of ten workers said Neurological symptoms.

Exposure to xylene in the central nervous system increases exposure to elevated doses of xylene in the short and long term. At such a level of 100-200 ppm, nausea and fatigue occur; 200-500 ppm with dizziness, irritability, exhaustion, vomiting, and sluggish response time; 800-10000 ppm with loss of muscle control, dizziness, agitation, noise in the ears, and otherwise balance changes; and >10,000 ppm for loss of consciousness. Some neurological effects include short-term memory deficiency, inadequate response time, and balance problems [33].

In this study, workers who risk exposure to xylene at a concentration of 200 ppm are at the location of workshops D and E, where the levels of xylene measurability are 271 ppm and 341 ppm. Based on the frequency distribution table relationships work sites with experienced neurologic complaints, most workers at workshops C, D, and E have neurologic complaints. In contrast, nine people complained of neurologic complaints in workshop C, and 4 had no neurological complaints. In contrast, in workshops D and E, all employees have a neurological complaint with xylene exposure levels exceeding the Threshold Limit Value (TLV). Results of research on Neurological symptoms as a result of exposure to xylene are only the initial information, which can be the basis of this study to confirm the diagnosis of occupational diseases as a result of exposure to xylene.

Neurological symptoms that occur in car painting workers because of exposure to xylene vapors can be connected to the lipophilic nature of xylene to the membrane of neurons. In the process toxicokinetic of xylene at the first phase where the oxidation process xylene to methyl benzyl alcohol, and the next, via alcohol dehydrogenase by aldehyde dehydrogenase, to methyl benzaldehyde, which can interfere with the mechanism of action of essential proteins in the nervous system to normal, in the form of environmental disturbances of lipid in the cell membrane to the system microsomal enzymes. This can cause changes in the levels of various neurotransmitters and fat composition as a direct effect of exposure to xylene or secondary modifications [16, 38].

Factors of job characteristics are other factors assumed to have a relationship with neurological complaints that should be considered indirect causes. In this study, respondents involved were workers painting the car, wherein 51 workers were divided into 36 workers in the painting unit and 15 workers in the putty unit. The average working periods of respondents were more than 20 years. This suggests that exposure to xylene against the respondent has lasted long enough so that the accumulation of xylene in the higher body. Of the number of hours worked each day, known to the average worker to work more than 7 hours, 51 workers of car painting respondents, as many as 27 of them working for more than 7 hours/day, and 22 people work between 6-7

hours/day, and two people working less than 6 hours/day. In this study, the characteristic of the work consists of the variable part of the job, years of service, and length of employment or work duration per day is a factor that may be associated with neurological complaints caused by exposure to xylene. Based on the test results using Spearman statistical test showed that there is a significant correlation between working periods with neurological complaints.

Work period

The working period is when car painting workers began working as a car painting until now. The results showed a significant relationship between tenure with neurologic complaints on workers. The minimum employment period of workers repainting the car ranges from 9 to 41 years, indicating exposure to xylene, which workers have long experienced. Research shows that workers in the workplace for at least ten years with exposure to high concentrations of the chemicals in paints show a decline in performance in tests related to neurobehavioral disorders [39]. Moreover, incorporating workers with at least a 10-year tenure on the job with a high level of exposure had a risk of adverse effects on their health. At least ten years of exposure are considered criteria for diagnosing the occurrence of chronic toxic encephalopathy [12].

Today's well-designed experiments indicate that workers exposed to high concentrations of organic compounds can significantly impact cognitive function. Cognitive functions affected by solvent exposure include focus, verbal memory, and even visuospatial capacity. There has been some concrete proof that polar solvents neurotoxicity is typical for at least ten years of exposure to opposite solvents exposure [14].

Parts and length of employment

The length of work referred to in this study is the working time worker in a day. Based on observations and interviews with respondents, among 51 workers car painting respondents, as many as 27 of them work for more than 7 hours/day and 22 people work between 6-7 hours/day, and two people work 5 hours/day the car painting activity started at 08.00 am.

The car painting process begins with rubbing the car to be painted. The next step is caulking, then polishing to be priming. Workers in the putty unit carry out this activity. This initial phase takes varies depending on the surface area of the painting will be done. After that, the car will be painted using spray paint (spray paint) by a worker who served as a painter. In general, the car painting workshop will be closed at 5:00 pm. Duration of work varies because of the frequency of the number of vehicles to be painted. Still, some workers also have reason to rest with a tentative; given the region is an area of informal painting, so there are no special working time rules. The relationship with contingency coefficient test showed no relationship between the works with neurological complaints, wherein the probability (p-value) of 0.05, which is 0.072, and the significant contingency coefficient was 0.496.

These results indicate no correlation between the lengths of work with neurologic complaints with a significance value of less than 0.05. The working time of more than 8 hours a day and 40 hours a week will usually be accompanied by a decrease in efficiency, the onset of fatigue, illness, and accidents, and exposure to hazardous materials in the workplace will increase [40].

CONCLUSIONS

In conclusion, there was a correlation between xylene exposure to blood xylene concentrations and neurological symptoms among informal car-painting workers. The practical advice for shareholders of the business should provide equipment that encourages painting and safety equipment, particularly masks. Furthermore, a guideline should be developed to promote stopping smoking while working. Workers, particularly painters, should enhance their knowledge of the importance of avoiding smoking and using personal protective equipment while working.

ACKNOWLEDGEMENTS

The authors are thankful to USAID -PRESTASI program for granting a scholarship to finish this research.

ETHICAL CONSIDERATION

This research had granted ethical approval from the health research committee of the Faculty of Public

Health, Airlangga University, with the number 426-KEPK.

Conflict of interest

The authors declare no conflict of interest.

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