Analysis of the Relationship Between Toluene Exposure and Liver Function in "X" Printing Workers in Makassar City

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Abstract

Long-term use of toluene exceeding the specified threshold value will result in health problems and the development of occupational diseases. It can even interfere with liver function. This study aims to determine the factors associated with liver function disorders of the "X" printing's workers in Makassar. This research used a case-control study design. The sample was 20 workers consisting of 10 case groups and 10 control groups at "X" Printing in Makassar. Purposive sampling is used in the data collection method. Data were analyzed by using the Pearson test. The results showed that there was no relationship between toluene levels (p value=1,000), length of work (p-value=0.314), age (p value=1.000), and length of use of personal protective equipment (p-value=0.400) with the liver function of "X" Printing's workers in Makassar. The factors of toluene levels, length of work, age, and length of use of personal protective equipment were not significantly related to liver function of "X" printing's workers in Makassar.

1. Introducion

The development of Industry in Indonesia is currently growing rapidly. It is a response to consumer demand for various products. As a result, many industries have been established from large-scale to home-scale to meet consumer needs. As the industry grows, the amount of chemical use; As raw materials or mixed materials in the production process also increase [1]. The printing industry is one that is developing rapidly. In 2011, the growth of the printing industry in Indonesia reached 4.7%. This growth is higher than the world average growth of only around 1.6%. This indicates that the need for production and printing services in Indonesia is very increasing. Based on data from the Makassar City Industry and Trade Office (2016), the development of the printing industry in Makassar City from year to year is increasing. It is evidenced by the printing industry in 2008 there were only 24 and in 2016 there were already 173 printing industries. This indicates that print media is not influenced even though people are starting to

turn their attention to the electronics industry such as the internet and smartphones. To meet the demands of increasing production certainly requires a more productive workforce. Labor-intensive industrial procedures, especially industries that use chemicals in their manufacturing processes, put workers in serious danger [2]. According to the European Inventory of Existing Commercial Substances (EINECS) About 100,000 types of chemicals are traded, but only 4,000-8,000 of them are characteristically recognized and have undergone safety testing; many of these have been shown to cause health problems in humans; In fact, about 900 of them are known to cause cancer in humans. Based on data from the Ministry of Industry and Trade of the Republic of Indonesia, the printing industry is one of 45 industries that use hazardous materials.[3].

Ari's research describes the complaints of printing workers in Makassar, 78.1% of printing operator workers experience complaints of health problems such as shortness of breath and coughing [4]. The complaint is a sign of

exposure in the work environment that can be caused by inhaled chemicals due to the volatile nature of the material. This is due to printing activities that use a lot of metal chemicals and organic solvents, one of which is toluene [5]. Toluene ($C_6H_5CH_3$) is an organic solvent used in various printing processes because it is volatile organic compound at a pressure of 3000 Pa and at a temperature of 25°C, thus providing the advantage of fast-drying printing materials and useful on high-speed printing machines [6]. Chemicals are needed as one of the byproducts of technology. However, if not managed properly, these substances can pose a risk to humans and the environment. The number of uses of toluene in Indonesia is increasing. Based on statistical data, in 2015 the use of toluene amounted to 108.302 tons and increased in 2018 to 117.077 tons [7]. In the printing industry, the use of toluene chemicals dominates the use of metal chemicals with a percentage of 75% of all printing processes. The use of toluene is widely used in the automatic cleaning process around 50-200 ppm. Toluene can enter the body through ingestion, skin contact, or inhalation; However, inhalation exposes a person to the largest amount of the three. About 20% of inhaled toluene is eliminated from the body through the respiratory system in its intact form, while the remaining 80% is metabolized into benzoic acid, which then combines with glycine in the liver to form hypuric acid, which is excreted through urine. Whole O-cresols and toluene make up less than 1% of the substance excreted in the urine. Hypuric acid is almost entirely excreted through urine in less than 24 hours, mostly through the proximal tubules of the kidneys [8]. ACGIH (2011) point outs the threshold value of toluene is 20 ppm for 8 hours / day, while according to the Kepmenaker RI (2018) the threshold value for the use of toluene is 50 ppm. In addition to measuring toluene exposure through contaminated air, biological monitoring can also be carried out through examination of hypuric acid biomarkers which are metabolites of toluene in urine with normal values of ≤1.6 g / g creatinine [9]. The National Institute for Occupational Safety and Health (NIOSH) reports that organic solvents expose 9.8 million workers in the United States and 400,000 workers in Denmark. Annual reports from the American Association of Poison Control Centers and the National Occupational Exposure Survey (NOES) reveal that toluene exposure may have affected two million workers in the United States, resulting in 856 deaths [10]. Excessive use of toluene for a long time can lead to health problems and the development of occupational diseases. An estimated 2.78 million workers die each year due to diseases and accidents in the workplace; 380,000 (13.7%) of these were occupational accidents, and about 2.4 million (86.3%) were occupational diseases [11]. Toluene has high lipophilic activity so that it can be distributed quickly in the body due to its rapid perfusion through the membranes of liver and brain tissue which then accumulates and causes toluene-induced hepatotoxicity [12]. The liver is an important internal organ that regulates many bodily functions, including hormone production, metabolic control, coagulation, detoxification of substances entering the body, and a balance of immune responses between pro- and anti-inflammatory responses, allowing the liver to effectively clear pathogens. Reactive oxygen groups (ROS), which are free radicals, are

produced when the liver detoxifies toluene. Liver cell injury can result from an excess of reactive oxygen species [13] [14]. Masoud, et al found an increase in SGOT and SGPT levels in workers exposed to toluene [15]. An experiment conducted on mice injected with a sublethal dose of 0.2 mL toluene 5 mM for 30 days, found signs of liver parenchyma tissue damage characterized by increased levels of SGOT and SGPT and symptoms of hyperbilirubinemia [16]. Then conducted again experiments on rats injected 346 mg / kg intraperitoneal toluene body weight once a day for 3 days, from this study found the expression of CYP2E1 which is an isoform of cytochrome p-450 which can cause ROS formation in liver tissue. It also appears on histopathological examination that there are areas of liver tissue that experience necrosis [17]. Law of The Republic of Indonesia Number (No.) 36 of 2009 concerning health in article 164 states that "Occupational health efforts are aimed at protecting workers to live healthy lives and be free from health problems and adverse influences caused by work". Article 165, paragraph 1, also mandates that managers oversee health initiatives in the workplace, including prevention, improvement, treatment, and rehabilitation of workers. Further, as stated in paragraph 2, employees have the responsibility to maintain a safe and healthy working environment and follow workplace policies. A car body industry in Magelang with more than 100 workers who also use toluene chemicals, most of the workers have complaints such as shortness of breath, dizziness, weakness, and nausea, and there are some workers who have icteric eyeballs which are indications of impaired liver function. However, in the industry there is no special supervisor in the field of K3 and no periodic health checks are carried out on workers [10]. The results of a survey conducted by researchers at three randomly selected printing houses in the Makassar City area found the use of ink types that use toluene solvents, health complaints to workers, working hours that exceed 8 hours, inappropriate printing room air circulation and the absence of K3 personnel as well as periodic and specific health checks according to the work area. Therefore, the reserachers argue this study is needed to see the effect of toluene chemical exposure assessed from urine hypuric acid biomarkers with liver function in printing workers in Makassar.

2. Method
2.1. Research Design and Location

In this studym the researchers applied a quantitative research design using analytical observational methods and case control approaches by identifying patients who had an effect (case) and patient groups who did not (control). This research conducted at Printing "X" on May 22 - June 22 in Makassar City in 2023.

2.2 Sampels

In this study, the population consisted of all employees who worked as printing machine operators at Printing X in Makassar City, totaling 40 people. Research samples were selected based on inclusion criteria and exclusion criteria. Based on the results of population selection, 20 workers were sampled. The subjects in this study were all selected cases and controls in a ratio of 1:1. Cases were

subjects who had high levels of SGOT and SGPT, while controls were subjects who had normal levels of SGOT and SGPT.

2.3 Instruments dan prosedures

The instrument is a questionnaire that contains a list of questions needed by researchers. The questionnaire was distributed to 10 workers as sample cases, and 10 workers as control samples. The amount of toluene exposure to workers is measured through the concentration of hypuric acid in urine conducted at the laboratory of Prodia Occupational Health Institute (PT. Prodia OHI International) uses High Performance Liquid Chromatography (HPLC) with NIOSH 8301 method. Liver function was assessed through measurements of Serum Glutamic Oxaloacetic Transaminase (SGOT) and Serum Glutamic Pyruvic Transaminase (SGPT) conducted by analysts from Pratama Medika Makassar Clinical Laboratory using kinetic methods in accordance with recommendations from IFCC (International Federation of Clinical Chemistry). This research was conducted with Ethical Approval from the Faculty of Public Health, Hasanuddin University with number 3435/UN4.14.1/TP.01.02/2023.

2.4 Data Analysis

Data processing and analysis applied by using SPSS through the process of Editing, Coding, Data Entry, Data Cleaning, and Data Presentation (Tabulation). Univariate analyses were selected to assess the quality of each research variable. Research data are presented in the form of narratives and visual tables. The frequency of each variable and the percentage of its distribution are known based on the findings of the analysis. Bivariate Analysis is Two variables that are assumed to be related or related to bivariate analysis. Pearson's analysis was used in this study.

3. Results and discussion
3.1. Results

Questionnaires were distributed to 10 workers with high levels of SGOT and SGPT as cases and 10 workers with normal levels of SGOT and SGPT as controls. The following are the characteristics of the research sample based on the age and length of service of respondents. From Table 2 it can be seen that the age of respondents is mostly in the non-risk category, namely ≤40 years, 8 respondents (80%) in the case group and 8 respondents (80%) in the control group. The rest in the risk category are >40 years, namely 2 respondets (20%) in the case group and 2 respondents (20%) in the control group. Based on Table 3, it was detected that tenure was mostly in the new working period category, namely ≤3 years, as many as 8 respondents (80%) in the control group and 5 respondents (50%) in the case group. While other respondents in the category of long service >3 years, 5 respondents (50%) in the control group and 2 respondents (20%) in the case group. From the Table 4, the percentage shown the length of use of respondents' PPE is mostly in the category during

working hours, namely 8 hours, namely as many as 7 respondents (70%) in the control group and 3 respondents (30%) in the case group and the rest in the category of less than working hours, namely < 8 hours, namely 7 respondents (70%) in the control group and 3 respondets (30%) in the case group. According to Table 5, it can be seen that the respondents' hypuric acid levels were mostly in the normal category, namely ≤1.6 g / g creatinine, which was 8 respondents (80%) in the case group and 8 (80%) in the control group and the rest in the high category of > 1.6 g / g creatinine which was 2 respondents (20%) in the case group and 2 respondents (20%) in the control group. Table 6 presents the history of visits to respondents' health facilities is mostly to Puskesmas/Clinics, which is 6 respondents (60%) in the case group and 9 respondents (90%) in the control group and the rest in the hospital, namely 4 respondents (40%) in the case group and only 1 respondent (10%) in the control group. Table 7 shows that the health complaints of respondents in the case group were mostly cough, dizziness and fever (10% each) and nausea (20% each) in the control group, followed by other complaints such as right upper abdominal pain, nausea, hand cramps and low back pain (10% each) in the case group and cough 10%, dizziness 10%, hand cramps 20% and low back pain 20% in the control group. Table 8 clarifies that of the 20 respondents, who had normal hypuric acid levels as many as 8 respondents (80%) who had impaired liver function or high SGOT and SGPT levels and as many as 8 respondents (80%) with normal liver function or normal SGOT and SGPT levels, and 2 respondents (20%) with high hypuric acid levels who had impaired liver function high SGOT and SGPT levels and who had normal liver function as many as 2 respondents (20%). Based on Pearson's statistical test, it found that p-value = 1,000 > 0.05 it means that there is no relationship between toluene exposure assessed from hypuric acid levels and liver function of workers.

Based on Table 9, information was obtained that workers with a working period of ≤ 3 years as many as 8 respondents (80%) with normal liver function or normal SGOT and SGPT levels, and 5 respondents (50%) had problems with liver function. While for workers with long work > 3 years, 2 (20%) of them have normal liver function or normal SGOT and SGPT and 5 respondents (5%) have impaired liver function or high levels of SGOT and SGPT. Based on Pearson's statistical test obtained p-value = 0.314 > 0.05, it can be concluded that there is no relationship between the length of work and the liver function of workers. Based on Table 10 it can be indentified that of the 20 respondents, including age not at risk (≤40 years) as many as 8 respondents (80%) with impaired liver function or high SGOT and SGPT levels and as many as 8 respondents (80%) with normal liver function or normal SGOT and SGPT levels, and 2 respondents (20%) with age at risk (>40 years) who have impaired liver function high SGOT and SGPT levels and who have normal liver function as many as 2 respondents (20%). Based on Pearson's statistical test, the value of p-value = 1,000 > 0.05 means that there is no relationship between age and liver function of workers.

Table 1. Distribution of Respondents based on Age and Working Period Characteristics of X Priting's Workers in Makassar

Characteristics	Category	Frequency	Persentage
Age	≤ 40 years	16	80%
	> 40 years	4	20%
	Total	**20**	**100%**
Length of Service	≤ 3 years	16	80%
	> 3 years	4	20%
	Total	**20**	**100%**
Liver Fuction	Normal	10	50%
	High	10	50%
	Total	**20**	**100%**

Source: Data Primer, 2023

Table 2. Distribution of Respondents based on Age of X Printing's Workers in Makassar

Age	Frequency				Total	
	Case		**Control**			
	n	**%**	**n**	**%**	**n**	**%**
≤ 40 years (Not at risk)	8	80%	8	80%	16	80%
> 40 years (At rsik)	2	20%	2	20%	4	20%
Total	**10**	**100%**	**10**	**100%**	**20**	**100%**

Source: Data Primer, 2023

Table 3. Distribution of Respondents based on The Length of Service of X Printing's Workers in Makassar

Length of Service	Frequency				Total	
	Case		**Control**			
	n	**%**	**n**	**%**	**n**	**%**
≤ 3 years New Employment Period)	5	50%	8	80%	16	80%
> 3 tyears (Long Service Period)	5	50%	2	20%	4	20%
Total	**10**	**100%**	**10**	**100%**	**20**	**100%**

Soruce: Data Primer, 2023

Table 4. Distribution of Respondets based on The Length of PPE Use of X Priting's Workers in Makassar

Length of PPE Use	Frequency				Total	
	Case		**Control**			
	n	**%**	**n**	**%**	**n**	**%**
8 hours (During working time)	3	30%	7	70%	10	50%
< 8 hours (Less than working time)	7	70%	3	30%	10	50%
Total	**10**	**100%**	**10**	**100%**	**20**	**100%**

Source: Data Primer, 2023

Tabel 5. Distribution of Respondents based on Toluene Exposure of X Printing's Workers in Makassar

Hippuric Acid Level	Frequency				Total	
	Case		**Control**			
	n	**%**	**n**	**%**	**n**	**%**
≤1,6 g/g creatinine (Normal)	8	80%	8	80%	16	80%
>1,6 g/g creatinine (High)	2	20%	2	20%	4	20%
Total	**10**	**100%**	**10**	**100%**	**20**	**100%**

Source: Data Primer, 2023

Table 6. Distribution of Respondents based on History of Visits to Health Facilities of X Printing's Workers in Makassar

Health Facilities Visits	Case		Control		Total	
	n	%	n	%	n	%
Halth Center/Clinic	6	60%	9	90%	15	75%
Hospital	4	40%	1	10%	5	25%
Total	**10**	**100%**	**10**	**100%**	**20**	**100%**

Source: Data Primer, 2023

Table 7. Distribution of Respondents based on Helath Complaints of X Printing'

Helath Complaints	Case		Control		Total	
	n	%	n	%	n	%
Cough	2	20%	1	10%	3	15%
Dizziness	2	20%	1	10%	3	15%
Fever	2	20%	0	0%	2	10%
Upper Right Abdominal Pain	1	10%	0	0%	1	5%
Nausea	1	10%	4	40%	5	25%
Hand cramps	1	10%	2	20%	3	15%
Lower back pain	1	10%	2	20%	3	15%
Total	**10**	**100%**	**10**	**100%**	**20**	**100%**

Source: Data Primer, 2023

Table 8. Relationship between Toluene Exposure and Liver Function of X Printing's Workers in Makassar

Hippuric Acid Level	Case		Control		Total		p-value
	n	%	n	%	n	%	
≤1,6 g/g creatinine (Normal)	8	80%	8	80%	16	80%	
>1,6 g/g creatinine (high)	2	20%	2	20%	4	20%	1,000
Total	**10**	**100%**	**10**	**100%**	**20**	**100%**	

Source: Data Primer, 2023

Table 9. Relationship between Length of Service and Liver Function of X Pritning's Workers in Makassar

Length of Service	Case		Control		Total		p-value
	n	%	n	%	n	%	
≤ 3 years (New Employement Period)	5	50%	8	80%	13	65%	
> 3 tahun (Long Employement Period)	5	50%	2	20%	7	35%	0,314
Total	**10**	**100%**	**10**	**100%**	**20**	**100%**	

Source: Data Primer, 2023

Table 10. Relationship between Age and Liver Function of X Printing's Workers in Makassar

Age	Case		Control		Total		p-value
	n	%	n	%	n	%	
≤ 40 years (Not at Risk)	8	80%	8	80%	16	80%	
> 40 years (At risk)	2	20%	2	20%	4	20%	1,000
Total	**10**	**100%**	**10**	**100%**	**20**	**100%**	

Source: Data Primer, 2023

Table 11. Relationship between The Length of PPE Use and Liver Function of X Printing's Workers in Makassar

Length of PPE use	Frequency				Total		p-value
	Case		Control				
	n	%	n	%	n	%	
8hours (During working time)	3	30%	7	70%	10	50%	
< 8 jam (Less than working time)	7	70%	3	30%	10	50%	0,400
Total	**10**	**100%**	**10**	**100%**	**20**	**100%**	

Source: Data Primer, 2023

According to the information from Table 11, 20 respondents, who used PPE during work time (8 hours) as many as 3 respondents (30%) who had impaired liver function or high SGOT and SGPT levels and as many as 7 respondents (70%) with normal liver function or normal SGOT and SGPT levels, and 7 respondents (70%) with PPE use less than working time (< 8 hours) who had impaired liver function high SGOT and SGPT levels and who had normal liver function as many as 3 respondents (30%). Based on Pearson's statistical test, the p-value = 0.400 > 0.05 means that there is no relationship between the length of PPE use and the liver function of workers.

3.2. Discussion

a. Relationship between Toluene Exposure with Liver Function

The body receives toluene through inhalation, ingestion, and skin contact. 95% of toluene is metabolized when it enters the body. Hypuric acid, which includes 60-70% of toluene, is excreted rapidly in the urine, mostly through the proximal tubules of the kidneys, almost completely within 24 hours. [18]. Research on toluene exposure was conducted by De Oliveira et al on workers in the paint industry, the results showed that hypuric acid levels in workers exposed to toluene were higher than those in the control group. In line with the study, in this study found toluent in the urine of workers with different levels [19]. However, based on the results of the analysis obtained, there was no significant relationship between hypuric acid levels and liver function (p-value: 1,000 > 0.05). The results of this study are in line with the research of Da-Hong, et al (2006) found no significant direct causative relationship between toluene exposure and liver function of workers, this is due to several confounding factors such as sex and alcohol consumption. According to research, nonpolar compounds will easily dissolve in tissues containing fat (adipose tissue) which is more likely to be owned by women, this also explains the relationship between Body Mass Index (BMI) and toluene levels in the body. This explains that sex is related to toluene levels in the body which is associated with toluene metabolism. In Gyorgy's study, which used toluene exposure concentrations above NAB in rabbits and rats, there was no increase in hepatic enzymes or anatomical damage to hepatic tissue. [20]. The experiment was conducted on two age groups of rabbits and mice with similar concentrations of toluene exposure. M. Neghab, et al in their study also obtained the results of SGOT and SGPT measurements in workers exposed to toluene were not significantly related, but in other parameters, namely serum albumin, significant results were obtained [15]. The presence of hepatocyte degeneration assessed from abnormalities in liver function tests through several mechanisms, such as increased oxidative stress and CYP2E1 makes liver function decrease. The main target of oxidative stress in the liver is endothelial sinusoids which have a unique structure and are also called "liver-sieve". This structure provides filtration and protection functions. However, in some studies mentioned the etiology is multifactorial, so the potential hepatotoxicity of toluene can have different effects on each individual. This explains the results of this study, there was no difference in the number of samples between the case group and the control of normal and high levels of hypuric acid. Ogunbileje et al conducted a study on a small group of workers in Nigeria (29 workers exposed to organic solvents and 22 workers not exposed to organic solvents). They found that parameters such as SGOT, total protein, total bilirubin, and albumin were the same in both the exposed and control groups, except for a significantly lower SGPT in the exposed group. No one knows why there are these inconsistencies. However, variations in sample size, exposure concentration, confounders, statistical analysis, and personal protective equipment can at least partially explain those differences. [21].

b. Relationship between Working Period with Liver Function

The length of service of a person is related to the duration of exposure to toxicants, in this case toluene. This increases the risk that employees are exposed to toluene, one of the hazardous materials, during their time at work. Although the concentration of toluene is below normal limits, continuous inhalation can have an impact on the amount of toluene entering from the hazardous material [1]. Sutomo explains that the length of a person's work is directly proportional to the amount of exposure to pollutants obtained. The longer a person works, the higher the exposure to pollutants that the person gets, so workers who have a longer working period will have higher urinary hypuric acid levels [22]. Based on the results of the analysis, the results of p-value 0.314 > 0.05 mean that there is no relationship between working time and liver function of workers. Evidence of hepatotoxicity caused

by toluene from workplace studies is limited. The extent of toluene exposure and variations in the length of the work period are generally unknown, but some case studies in humans have shown an impact on the liver. A 26-year-old woman who was exposed to toluene in glue for at least two months developed acute fatty liver disease. Changes in the cytoplasm in hepatocytes are seen on liver biopsy. However, there is no clinical or biochemical evidence that, one month later, there is liver disease [23]. A case series report there were twenty patients with acute toluene poisoning; half of these patients had a history of drug addiction, including marijuana and cocaine, in addition to toluene inhalation; the average SGOT and SGPT levels were also higher than the reference range [8]. From several studies, it was concluded that there were intervention factors other than working time involved in the effects of liver disorders experienced by workers. In line with Lee's research, et al who conducted a large-scale survey of workers with variations in age, sex, smoking habits, BMI, and working period to assess the relationship of working time with hepatic enzymes found no significant relationship between liver function abnormalities assessed from SGOT and SGPT enzymes with working life [24]. The working period of the sample in this study is at least 1 year with a work duration of 8 hours per day (day shift). According to research conducted by Lin & Chen, working time is often associated with impaired hepatic function for workers with night shifts, working hours above 6 p.m. This is due to the circadian rhythm of the hepatic which is disorganized due to body work activities at night [25]. Evidenced by research conducted by Wang, et al through a prospective cohort study on workers of the same working period with different work shifts (day shift, night shift) obtained the results of a significant increase in SGOT and SGPT in night shift workers (OR: 1.19 p = 0.031) [26]. In this study, in the case group the distribution of samples with a new working period (≤3 years) and a long service period (>3 years) was the same, each 5 (50%). According to Andersen et al (1983), chronic effects will occur interference after a period of work of 6-8 years. Another opinion of Lundberg in Rusdy, including workers with at least 10 years of service in jobs with high exposure rates has a risk of adverse effects on their health [27].

c. Relationship between Age with Liver Function

In this study, the results of the analysis were obtained p-value = 1,000 > 0.05. This means that there is no relationship between age and liver function of workers. Physiologically, increasing a person's age decreases the ability of organs, so the negative impact of toluene vapor on health is also getting bigger, such as a decrease in liver function [28]. Laboratory indicators of liver disease (liver function tests SGOT, SGPT, bilirubin, and albumin) do not change with age. The enzyme hepatic alcohol dehydrogenase also did not experience an age-related decline in function. However, it should be noted that hepatic alcohol dehydrogenase is found in lower levels in the elderly [29]. Age-related chages including increased oxidative stress, increased inflammatory response, accelerated cellular aging, and progressive organ dysfunction significantly affect cellular responses to injury by pathogenic microorganisms and toxicants [30]. In addition, In

experiments involving intraperitoneal ethanol injection in young mice, mitochondrial dysfunction has been shown to increase the susceptibility of old mice to acute liver injury. [31]. The metabolism and detoxification process of toluene occurs in the liver. Among cell damage, oxidative stress is primarily damaging the parenchyma of ROS-producing cells in microsomes, mitochondria and peroxisomes whereas hepatic stellates, kupffer cells and endothelial cells are easily sensitized by ROS molecules. Organic solvents such as toluene can cause the formation of ROS which can induce an increase in Malondialdehyde (MDA) which plays a role in the production of peroxidizing lipids. This lipid peroxidation mechanism then causes cell/tissue damage [32]. The pathophysiological mechanism is found at the age of over 40 years, which is the age at risk. However, in this study, the control group and cases were dominated by respondents under 40 years of age. Amien, et al in their research found an increase in SGOT and SGPT in workers exposed to toluene with predominantly characteristic (53.8%) aged more than 40 years [10]. The same thing in the research conducted by dr. Lelitasari points out that >40-year-old workers who are exposed to organic solvents will be at six times higher risk for organ disorders [33].

d. Relationship between PPE Use with Liver Function

Workers' awareness of the importance of wearing personal protective equipment (PPE) while working needs to be considered because PPE can minimize the risk of toluent in the air inhaled. According to research conducted by Irmasari, workers who wear personal protective equipment (PPE) while working as many as 14 workers (46.7%) while those who do not wear personal protective equipment while working as many as 16 workers (53.3%) do not wear PPE while working can increase exposure to toluene that enters the body through inhalation and results in increased urinary hypuric acid levels and the risk of health problems experienced by workers [5]. Based on the analysis, the p-value = 0.400 > 0.05 means that there is no relationship between the length of PPE use and the liver function of workers. In addition to inhalation, toluene can enter the body through direct contact with the skin. In these cases, employees seem to be practicing safe work practices by maintaining personal hygiene and using PPE according to their work schedules (8 hours per day). This reduces the body's exposure to toluene [34]. The degree of poisoning of workers to chemicals or toxic substances in the workplace is strongly influenced by the level of personal hygiene of employees. Such as not wearing gloves and then eating food without washing your hands can increase the amount of toxicants that enter the body through oral exposure [33]. In the environment there are several potential hazards that need to be considered such as air humidity, air temperature, and air circulation. Air humidity and unstable air temperature and poor air circulation can affect the evaporation rate of volatile toluene [35]. Based on observations at the research location, ventilation in the production room meets standards and good air circulation, coupled with the use of PPE in the form of standardized masks.

4. Conclusions

Based on the findings and discussion of the research conducted, it can be concluded that toluene levels, age, length of work, and length of use of PPE have no relationship with the liver function of X printing's workers in Makassar City.

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