Received: 20 October 2024 | Revised: 02 December 2024 | Accepted: 02 February 2025
DOI: 10.48309/JMPCR.2025.482391.1460
Journal of Medicinal and Pharmaceutical Chemistry Research
SAMI

FULL PAPER

Impact of toluene exposure on MDA, creatinine, and BUN levels in printing workers at Airlangga University Press, Surabaya

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The concentration of toluene in the industry has been above the threshold. This study aims to analyze the effect of toluene exposure on MDA, creatinine and BUN levels in Airlangga University Press Surabaya printing workers. This type of study is observational. The design of this study was *cross sectional*.The location of this research was carried out in the printing industry of Airlangga University Press Surabaya starting in October 2022 – January 2023.The sample size is a total population of 14 respondents. Research variables include respondent characteristics, toluene, bun, creatinine. Primary data collection on respondents' characteristics was conducted through interviews using questionnaires and observations. Data Analysis is used Descriptive analysis, Crosstabulation, Strong Analysis of the impact. The maximum value of the toluene concentration obtained is 3.4465 ppm and the minimum value is <0.0516 ppm. Theaverage level of *Malondialdehyde* (MDA) is 4.184 nmol/ml with the maximum value is 5.134 nmol/ml while the minimum value is 3.284 nmol/ml. The standard deviation for MDA levels is 0.517. Workers who had MDA levels ≥ 1.076, workers aged <37 years and ≥ 37 years had abnormal MDA levels. Workers had a maximum creatinine level value of 1.17 mg/dL and a minimum value of 0.65 mg/dL. Ror the average value of BUN levels is 35 ng / dL. The most influential toluene exposure on BUN levels was obtained Standard Coeficient (Beta) value of 0.788 then MDA levels with Standard Coeficient (Beta) value of 0.762 and finally creatinine levels showed a value of 0.586. Blood tests showed that the worker had high levels of MDA, and for creatinine levels and BUN levels in the normal category. Toluene exposure has the most effect on BUN levels, then MDA levels, and creatinine levels.

KEYWORDS

Toluene; kreatinin; bun; MDA; safe to work.

Background

In various work industries today, it's very common to use chemicals in the production process which are used chemicals as solvents, one of which is toluene. Based on research conducted by Laelasari *et al.* (2018) suggests that the shoe industry in the use of yellow glue contains benzene and toluene by 0.1% and 55%, respectively, while white glue only contains toluene, which is 55% [1]. Another study conducted by Habibie *et al*. (2015) about the relationship between exposure to toluene levels in the air with kidney function in painting workers of the Magelang X body company showed the results that there was a relationship between toluene concentration and creatinine p-value levels of 0.039 [2].

The concentration of toluene in the industry has been above the threshold. This is evidenced by research conducted by (Anggraini *et al*., 2022) showing that the concentration of toluene measured at 3 different points where 2 points whose measurement results exceed the threshold value (> 20 ppm), namely location measurement point 1 is in the painting room and location measurement point 2 is in the oven chamber while for 1 other measurement point in the caulking and sanding room is still below the threshold value (< 20 ppm) [3]. Another research conducted by Ayu *et al.* (2021) that the measurement of toluene concentration in the printing work environment at 9 points gets results, namely there is 1 point of 4.7 – 28.1 ppm [4].

The use of chemicals such as toluene in industrial production often exceeds the set threshold, resulting in various health impacts on workers [5]. Toluene can cause health problems, such as oxidative stress, characterized by increased Malondialdehyde (MDA) levels, as well as impaired renal function indicated by creatinine and Blood Urea Nitrogen (BUN) levels [6]. This study found that toluene exposure significantly affected BUN, followed by MDA, and creatinine levels in workers. In addition, several factors, such as age, length of service, nutritional status, smoking habits, and the use of personal protective equipment (PPE), also influence the level of exposure and health effects in printing industry workers.

According to the Regulation of the Minister of Manpower No. 5 of 2018 concerning the Work Environment, the threshold value is a standard of hazard factors in the workplace as a time-weighted average level/intensity that can be accepted by workers without causing illness or health problems, in daily work for time not exceeding 8 hours a day or 40 hours a week. The threshold value for toluene set in the Regulation of the Minister of Manpower No. 5 of 2018 is 20 ppm [7].

Toluene can cause effects on health if continuous exposure to toluene such as dizziness, vertigo, eye irritation, skin irritation, respiratory disorders, liver function disorders, kidney function disorders, and central nervous system disorders [8]. According to research conducted by Laelasari *et al*. (2018) It is known that health complaints experienced by workers vary, namely respiratory disorders (nausea, cough, runny nose, shortness of breath), disorders of the central nervous system (headaches, tremors, tingling, burning eyes, difficulty concentrating), irritation of membranes caused by direct contact with harmful chemicals (skin irritation and eye irritation) [1]. Based on research by Sahri *et al.* (2022) It was found that respondents experienced neurotoxic symptoms, where the complaints experienced were caused by various kinds of hazard risks that exist in the workplace, including solvent vapors, dust, fume, mist, smoke, and other solid particles containing several chemicals at the printing stage process, including benzene, toluene, ethylbenzene, xylene, 2-butane, methanol, isopropanol and n-butanol [9]. The results of research conducted by Rahmat (2019) regarding the impact of toluene exposure on urine hypuric acid levels in automotive oven

painting workers are that there is an increase in hypuric acid in the afternoon occurring after workers are exposed to toluene vapors more than ppm [10]. Other research conducted by Neghab *et al.* (2015) in Shiraz gas station employees found that levels of BUN, serum creatinine, alanine aminotransferase (ALT), aspartate aminotransferase (AST), direct bilirubin levels were significantly higher in the exposed group than the control group [11].

Toluene is volatile so it is absorbed through inhalation and then diffuses passively through cell membrane lipids [12]. Because toluene is also a fat-soluble nonpolar compound, the absorbed toluene will be distributed to lipid-rich and highly vascular tissues such as the brain. At the time of metabolism in the liver, toluene oxidized via catalics CYP1A2, CYP2E1, and CYP2B6 produces 2,3-toluene epoxide and 3,4-toluene epoxide [8]. This can increase *reactive oxygen species* (ROS). This ROS can cause lipid chain peroxidation reactions [13,51]. The process of lipid peroxidation disrupts the integrity of the cell membrane which can cause changes in the arrangement of the membrane structure. The result of lipid peroxidation is lipid radicals that will react with oxygen to form peroxyl radicals. Peroxyl radicals are compounds that initiate chain reactions and convert *Polyunsaturated Fatty Acid* (PUFA) into hydroperoxyd lipids that are unstable and easily broken down into secondary products such as aldehydes and *malondialdehyde* (MDA).

An increase in free radicals such as ROS during their metabolism in the liver can cause an imbalance between ROS and antioxidants called oxidative stress [14]. The level of oxidative stress can be predicted through the method of determining *malondialdehyde* (MDA) in blood plasma or homogenal tissue [15]. Based on research conducted by Dwicahyo (2020) on Car Painting Workshop Workers in Surabaya who were exposed to toluene, there is a relationship between toluene intake and LDL and MDA levels with significance (0.05%) of 0.038 and 0.039 [16]. In research conducted by Giyanti (2018) on shoe craftsmen exposed to toluene, the mean value of serum MDA levels in the exposed group was higher (5.95 nmol/mL) than the group not exposed to toluene (1.11 nmol/mL) [17].

European Dialysis and Transplant Accociation (EDTA) in 1994 found 4% of patients in Europe who experienced symptoms of kidney failure due to toluene exposure. EDTA also reports that the jobs most at risk of toluene exposure are painting and printing (Maissonvennueve *et al.,* 2000). In 1996 in Germany there were 156 patients on dialysis and kidney transplants due to toluene inhalation. The results of research by Frei & Schober-Halstenberg (1999) in Denmark there were 60 workers and 81 workers in France performing dialysis and kidney transplants due to toluene exposure [18]. According to the *International Programme on Chemical Safety* (IPCS), the consequences of toluene exposure to the kidneys will cause renal tubular acidosis in the distal part [19,20]. Symptoms experienced include muscle weakness, nausea, and vomiting which is believed to be the result of electrolyte imbalance accelerated by the presence of acidosis in the kidneys [12].

Previous studies have examined the impact of toluene exposure on biomarkers such as MDA, creatinine, and BUN, particularly in industrial settings involving chemical solvents. These studies have provided a basis for understanding the health implications of toluene exposure, but the specific focus on printing industry workers at Airlangga University Press Surabaya provides a unique and localized perspective.

Several studies have been conducted on toluene in the printing industry. Based on the results of the study (Sahri *et al.*, 2022) of XYZ printing industry workers get results 5 out of

20% of respondents were positive for neurotoxic symptoms [9]. The results of research conducted by Irmasari (2018) found that there was a significant relationship between toluene levels in the air and urine hypuric acid levels in Offset Printing workers in Rungkut Surabaya [21]. Urinary hypuric acid levels are major metabolites of toluene and have long been considered a biomarker of toluene exposure.

Toluene exposure in printing workers of Airlangga University Press Surabaya has a significant effect on Malondialdehyde (MDA), creatinine, and Blood Urea Nitrogen (BUN) levels with the greatest effect on BUN levels, followed by MDA, and creatinine. This study aims to analyze the effect of toluene exposure on MDA, creatinine, and BUN levels in printing workers of Airlangga University Press Surabaya. Future research could explore other factors that could potentially affect MDA, creatinine, and BUN levels in workers in industrial settings, such as lifestyle, nutritional consumption, or exposure to other chemicals that may interact with toluene. In addition, longitudinal studies are needed to understand the cumulative impact of toluene exposure on workers' long-term health. Further efforts may also include evaluating the effectiveness of various interventions, such as increased use of personal protective equipment (PPE) and implementation of work environment controls to reduce health risks

Research methods

This type of study is observational. In this study, researchers only measured natural phenomena that exist in the environment and workers without intervening with variables. Based on the type of data and analysis, this research is a quantitative research.

Design research used

The design of this study is *cross sectional* where all data are taken at the same time with the aim of describing and analyzing the situation at a certain period of time, namely the effect of toluene exposure on MDA, creatinine and BUN levels in Airlangga University Press Surabaya printing workers.

Location and time of research

The location of this research was carried out in the printing industry of Airlangga University Press Surabaya starting in October 2022 – January 2023.

Population and sample

The population in this study is all workers of the printing production unit Airlangga University Press Surabaya which amounts to 14 people. The number of research samples was 14 people.

Research variables

Research variables include respondent characteristics, toluene**,** bun, creatinine. Primary data collection on respondents characteristics was carried out through interviews using questionnaires and observations to determine respondents' characteristics, namely age, length of service, nutritional status, smoking status and PPE use, Measurement of air toluene concentration in the work environment was carried out using the Gas Chromatography (GC) method**,** Measurement of MDA, Creatinine and BUN chromatography levels.

Data Aanalysis

The research data were analyzed using SPSS. The following data analysis tests are used Descriptive Analysis, Cross-tabulation (*crosstab*), Strong Analysis of the impact.

Research results

Toluene concentration at work

The results showed that the average toluene concentration was 0.67715 with the median value for toluene concentration was 0.05160 and the standard deviation was 1.2683. The

maximum value of the toluene concentration obtained is 3.4465 ppm and the minimum value is <0.0516 ppm. Based on the Regulation of the Minister of Manpower No. 5 of 2018 for the threshold value (NAV) of toluene, which is 20 ppm, so that in this study the concentration of toluene was found to be within the threshold [7].

Based on the results of research that in Airlangga University Press Surabaya printing workers, the average value of *Malondialdehyde* (MDA) levels was 4.184 nmol/mL with the maximum value was 5.134 nmol/mL while the minimum value was 3.284 nmol/mL. The standard deviation for MDA levels is 0.517.

Description of worker's MDA levels

TABLE 1 Overview of worker characteristics and MDA levels

Characteristics of workers		Up to MDA < 1,076		≥ 1,076		Total	
		F	%	F	%	f	%
Age	< 37 years old	0	0	7	100	7	100
	≥ 37 years old	0	0	7	100	7	100
Length of service	< 11 years old	0	0	5	100	5	100
	≥ 11 years old	0	0	9	100	9	100
Nutritional status	Normal	0	0	8	100	8	100
	Fat	0	0	6	100	6	100
Smoking Status	Smokers	0	0	8	100	8	100
	Nonsmokers	0	0	6	100	6	100
Use of PPE	Ever	0	0	3	100	3	100
	Sometimes	0	0	11	100	11	100

Based on Table 1, all workers had an MDA level of ≥ 1.076. The results showed workers who had MDA levels ≥ 1,076, workers aged <37 years and ≥ 37 years had abnormal MDA levels. MDA levels ≥ 1.0.76 are more owned by workers who have a working period of ≥ 11 years as many as 9 workers. Furthermore, MDA levels ≥ 1.076 in workers who have nutritional status mostly owned by workers with normal nutritional status as many as 8 people. MDA levels ≥ 1.076 are found in workers who are smokers of 8 people. And it is known that MDA levels ≥ 1,076 are mostly found in workers whose PPE use is sometimes as many as 11 people.

Description of worker's creatinine levels

Airlangga University Press Surabaya printing workers have an average creatinine level value of 0.9557 mg / dL. The maximum value is 1.17 mg/dL and the minimum value is 0.65 mg/dL with a standard deviation from the worker's creatinine level is 0.12321 mg/dL.

The results in Table 2 showed that in the age variable, workers aged <37 years were dominated by creatine levels of 0.67-1.17 and workers aged ≥ 37 years all had creatinine levels of 0.67-1.17. Then, it was found that workers who had a working period of > 11 years all had creatinine levels of 0.67-1.17. Furthermore, the results showed that workers who had normal nutritional status and were obese dominated by creatinine levels of 0.67-1.17. Then, it was found that workers who had nonsmoking status mostly had creatinine levels of 0.67-1.17. Meanwhile, workers who have never used PPE and sometimes use PPE, both are dominated by workers whose creatinine levels are in the range of 0.67-1.17.

Description of worker's bun levels

Examination of BUN levels in printing workers Airlangga University Press Surabaya found that the average value of BUN levels was 35 ng / dL. The minimum value of respondents' BUN content is 20 ng/dL while the maximum value is 55 ng/dL with a standard deviation value of 9.59166.

TABLE 2 Overview of worker characteristics and creatinine levels

Characteristics of workers		Creatinine Levels				Total	
		< 0.67		0,67-1,17			
		F	%	f	%	f	%
Age	< 37 years old	1	14,3	6	85,7	7	100
	≥ 37 years old	0	0	7	100	7	100
Length of service	< 11 years old	0	0	5	100	5	100
	≥ 11 years old	1	11,1	8	88,9	9	100
Nutritional Status	Normal	1	12,5	7	87,5	8	100
	Fat	0	0	6	100	6	100
Smoking Status	Nonsmokers	1	12,5	7	87,5	8	100
	Smokers	0	0	6	100	6	100
Use of PPE	Never	0	0	3	100	3	100
	Sometimes	1	9,1	10	99,10	11	100

TABLE 3 Overview of worker characteristics and BUN levels

Characteristics of workers		Up to BUN 17-43		> 43		Total	
		F	%	f	%	f	%
Age	< 37 years old	6	85,7	1	14,3	7	100
	≥ 37 years old	5	71,4	2	28,6	7	100
Period of Service	< 11 years old	5	100	0	0	5	100
	≥ 11 years old	6	66.7	3	33,33	9	100
Nutritional Status	Normal	7	87,5	1	12,5	8	100
	Fat	4	66,7	2	33,3	6	100
Smoking Status	Nonsmokers	8	100	0	0	8	100
	Smokers	3	50	3	50	6	100
Use of PPE	Never	1	33,3	2	66,7	3	100
	Sometimes	10	90,9	1	9,1	11	100

The results of this study in Table 3 showed that workers aged < 37 years and ≥ 37 years had BUN levels of 17-43. Then, workers who have a working period of < 11 years and ≥ 11 years are dominated by BUN levels of 17-43. Workers who have normal nutritional status and are obese are dominated by BUN levels of 17-43. All workers had BUN levels of 17-43, while smokers 50% of workers had BUN levels of 17-43 and the other 50% had BUN levels of >43. Furthermore, it is known that workers who do not use PPE mostly have BUN levels of >43 with a percentage of 66.7%, while workers who sometimes use PPE have BUN levels in the range of 17-43 with a percentage of 90.9%.

TABLE 4 Analysis of the Effect of Toluene Exposure on MDA, Creatinine and BUN Levels

Independent Variables	Dependent Variables	Standardized (Beta)	CoeficientR. Square
Toluene concentration	Up to BUN	0,788	0,622
	malondialdehyde up (MDA)	0,762	0,581
	Creatinine Levels	0,586	0,343

Strong analysis of the effect of toluene exposure on MDA, creatinine levels and BUN on workers

Based on Table 4, it is known that the effect of toluene exposure on MDA, creatinine and BUN levels can be seen through Standard Coeficient (Beta). The test results showed that toluene exposure most affected BUN levels obtained a Standard Coeficient (Beta) value of 0.788 then MDA levels with a Standard Coeficient (Beta) value of 0.762 and finally creatinine levels showed a value of 0.586.

Discussion

Toluene concentration at work

The measurement results of toluene concentrations vary where the highest concentration is 3.4465 ppm and the lowest concentration is <0.0516 ppm with an average value of 0.67715 ppm. The average value of the concentration of toluene is below the threshold value. According to ACGIH (2019) for the threshold value of toluene (TLV), which is 20 ppm based on working time of 8 hours / day 40 hours / week [29]. This study obtained a higher average toluene concentration compared to the previous study conducted by Ningrum (2020) located at Airlangga University Press Surabaya which measured toluene at 3 different points in the production room and obtained toluene concentration results with an average of 0.3476 ppm (below the threshold value) [30]. The increase in the average concentration of toluene obtained in the workplace is estimated because the method used in this study is personal sampling so that each worker is measured at their respective job locations. Another study showed that the average concentration of toluene in the printing industry work environment was 10.15 ppm and was still below the threshold value [31]. This is in line with the research of Sahri *et al.* (2021) in the printing industry shows an average toluene concentration of 11.3 ppm [32]. Another study obtained the average measurement of toluene exposure in 6 printing industries of 6.97 ppm with the lowest concentration of 0.0185 ppm [33]. Research conducted by Sutanti (2020) in the printing industry showed that the toluene concentration value measured at 6 points in 2 Surabaya printing houses got results below the threshold value (NAB) with the highest value of 8.89 ppm [34].

Worker's MDA levels

Based on this study, all workers had MDA levels ≥ 1.076. The age of workers divided into categories aged <37 years and ≥ 37 years obtained abnormal MDA levels. The health impact of chemical exposure can be affected by a person's age because it can be related to the physical and physiological condition of the individual when receiving chemical exposure. Research by Fatimah & Utomo (2020) states that workers aged more than 32 years are at risk of having higher MDA levels when compared to workers aged less than 32 years [35]. According to Suma'mur (2009) that the human body's resistance to exposure to toxic chemicals is also influenced by age [36]. Increased risk of disease, gradual decline in physical and mental capacity are conditions resulting from aging. According to the *Australian Department of Health*, (2012) that decreased physiological and psychological system function can be caused by aging [37]. The aging process is also often associated with several degenerative diseases in old age. This can trigger several conditions such as oxidative stress caused by an imbalance between free radicals formed from the aging process with antioxidant capacity from within the body and intake from outside, chronic noninfectious inflammation due to increased production of adipokine and cytokines, changes in fatty acid metabolism including increased release of free fatty acids into plasma so as to induce insulin resistance, as well as the accumulation of various metabolic end products that can interfere with normal cell function, such as *Advance Gycation and Product* (AGE) [38]. Free radicals accumulated are associated with aging [39]. High levels of free radicals can cause lipid damage through lipid peroxidation which causes the formation of *malondialdehyde* (MDA). Winarsih (2007) also mentioned that a person's increasing age is always accompanied by an increase in MDA [40].

Worker's creatinine levels

This study showed that in the age variable, workers aged <37 years and workers aged ≥ 37 years all had normal creatinine levels. Physiologically, as a person ages, the ability of body organs will decrease. The older a person is, it is estimated that the negative impact of toluene vapor on his health is also likely due to the vital function of organs decreased such as the liver and kidneys [41]. According to Martono & Satino (2014) that as we get older, the kidney organ will experience a decrease in kidney mass as a result of losing several nephrons resulting in a decrease in the rate of glomerular filtrate [42]. This causes the older a person is, the possibility of decreased kidney function is higher [3]. Research conducted by Widiawati (2015) on gas station officers in Jombang city that respondents aged 40-50 years with a total of 12 respondents (75%) had abnormal creatinine levels [43]. Based on another study conducted by Aini *et al*. (2017) that the age range of 25-30 years does not affect creatinine levels [44]. This is because the age range is still categorized as a productive age range and is also supported by body immunity in the group which is still good enough so that the detection of kidney disorders has not been seen. The productive age according to the Ministry of Health (2019) is ranging from 15-64 years. So based on these criteria, workers in printing houses in this study are included in the productive age category [17].

Workers who had > 11 years of service all had normal creatinine levels. The effect of working time on workers' creatinine levels gets weak and positive results. This means that if there is an increase in working time, there may also be an increase in creatinine levels. According to Warsito (2007) that working with toluene exposure for 6 to 8 years can cause chronic effects [45]. This is in line with Al-Ghandi's research (2011) suggesting that there is a significant relationship in the group of car painting workers who work >10 years to increased creatinine levels [46]. The longer the working period, the more likely it will be exposed to toluene so that it accumulates in the worker's body and will cause health problems [21].

BUN levels

This study conducted showed that workers aged < 37 years and ≥ 37 years had BUN levels in the normal category. Research conducted by Haidar (2021) regarding the relationship between age and creatinine levels in Surabaya car painting workshop workers is weak and positive [22]. Another study conducted by Ahamed *et al.* (2013) which states that the concentration of urea levels differs significantly in all four age groups [23]. An increase in a person's BUN levels can be influenced by several other factors such as consuming large amounts of protein.

The working period of workers who have a working period of < 11 years and ≥ 11 years is dominated by normal BUN levels. A study conducted by Nwanjo & Ojiako (2010) on gas station workers in Nigeria showed a significant increase in BUN levels in the group of workers who had a working period of 6-10 years compared to the group of workers with a maximum working period of 5 years [24]. Research conducted on car painters who worked for more than 10 years had higher BUN rates compared to painters who worked less than 10 years.

The effects of toluene exposure on MDA levels

Based on the influence test that has been done, it was found that toluene exposure has a strong effect on MDA levels after BUN levels. The study was conducted by Tualeka *et al*. (2020) found that there is a strong relationship between toluene concentrations and MDA in printing workers exposed to BTX (benzene, toluene, and xylene) [25]. In line with Dwicahyo's (2020) research on car painting workshop workers, it is stated that

there is a relationship between toluene levels and MDA [16]. Another study was conducted by P. S. Ayu *et al*. (2020) in printing workers shows a relationship between toluene concentrations in the air and MDA levels but is weak [26].

Malondialdehyde (MDA) is an indicator of oxidative stress that results in damage to a cell or tissue [27]. Oxidative stress is defined as a disruption of the balance between free radicals and antioxidant capacity resulting from excess oxidative products [28]. Free radicals that reside in the body can be produced from metabolic processes and exogenous compounds or states originating from outside the body [47]. Exogenous compounds that cause free radicals can come from motor vehicle exhaust emissions, organic solvent vapors and other exogenous compounds that cause free radicals [48]. This study shows that there is oxidative stress characterized by the emergence of *malondialdehyde* (MDA) caused by the presence of free radicals from organic solvent vapors, namely toluene derived from chemicals in the workplace.

The effect of toluene exposure on creatinine levels

Toluene exposure found in the work environment of the printing industry has a concentration that is below the threshold value (NAV) of 20 ppm. Most workers have normal creatinine levels [49, 50]. Based on the effect test conducted on the concentration of toluene on creatinine levels showed a moderate and positive directional effect. This means that if there is an increase in variable toluene exposure, it will cause an increase in variable creatinine levels.

Research conducted by Anggraini *et al*. (2022) in car painting workshop workers in Surabaya showed a relationship between toluene exposure and creatinine levels with a correlation coefficient value of 0.244 [3]. This is in line with the research of Habibie *et al.* (2015) which states that there is a relationship between toluene concentration and creatinine levels in painting workers of Karoseri x Magelang Company with a p-value of 0.039 [2]. Another study on car painting workers in Makkah, Saudi Arabia stated that the group exposed to organic solvents had higher creatinine levels when compared to the control group [46]. Neghab *et al.* (2015) stated that creatinine levels in the group exposed to organic solvents were higher when compared to the control group [11]. This suggests a link between toluene exposure and increased creatinine levels in workers. There are several other factors that can affect toluene metabolism in the body with creatinine levels, namely age, length of work and smoking habits [21].

The effect of toluene exposure on BUN levels

The printing industry is one of the workplaces that uses chemicals such as toluene in the work process. Toluene exposure comes from the ink used during the production process. An effect test has been conducted in this study with the results that toluene exposure has the strongest effect on BUN levels compared to MDA levels and creatinine levels.

Research conducted by Al-Ghamdi (2011) on car painting workers in Makkah that blood urea nitrogen (BUN) levels were scientifically higher in the tested group than the control group [46]. The corresponding research is Neghab *et al.* (2015) stated that BUN levels in the group exposed to organic solvents were higher than the control group [11]. Another study conducted by Anggraini *et al*. (2022) in car painting workshop workers in Surabaya who were exposed to toluene had a weak relationship with BUN levels with a coefficient value of 0.042 [3]. However, there is another study that is not in line, namely that conducted by Habibie *et al*. (2015) in workers of the painting section of Karosesi x Magelang Company showed no relationship between the concentration of toluene to ureal levels with a p-value of 0.670 [2].

Conclusion

Based on the results of research and discussion on the effect of toluene exposure on MDA, creatinine, and BUN levels in Airlangga University Press Surabaya printing workers, conclusions can be drawn. Most workers are less than 37 years old, have 11 years of service or older, normal nutritional status, are nonsmokers, and occasionally use PPE. Measurement of toluene concentration in printing using personal sampling shows results below the threshold value. Blood tests indicate that workers had high MDA levels, while creatinine and BUN levels were within the normal category. The description of the distribution of individual characteristics based on MDA, creatinine, and BUN levels revealed that all workers, regardless of age, length of service, nutritional status, smoking habits, or PPE use, had abnormal MDA levels. Most workers had normal creatinine and BUN levels across various demographic categories. Toluene exposure showed the most significant effect on BUN levels, followed by MDA and creatinine levels.

Acknowledgments

The authors would like to thank all parties who contributed to the work of this study.

Funding

There was no specific funding for this study.

Authors' Contributions

All authors contributed to the study, encompassing study conception and design, data collection, analysis and interpretation of results, draft manuscript, reviewed and approved the final version.

Conflict of Interest

The authors declare no conflict of interest.

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How to cite this article: Abdul Rohim Tualeka, Gurendro Putro, Aceng Ruyani, Susmiati Susmiati, Aris Santjaka, Aisy Rahmania, Tri Niswati Utami, Ellyza Setya Maryiantari, Dewi Rokhmah, Farhana Syahrotun Nisa S, Dimas Rahadian Aji Muhammad, Roy Januardi Irawan, Rizky Rahadian Wicaksono, Mintje Maria Nendissa, Sunardi Sunardi, Iswari Hariastuti, Nur Mukarromah, Dina Keumala Sari, Nana Dyah Siswati, Rizaldy Fathur Rachman, Velu Perumal, Suardi Zurimi, Salsabila Novianti, Juliana Jalaludin, Rachmy Rosyida, Eko Nurmianto, Ikhram Hardi Syamsuddin, Umi Salmah, Impact of toluene exposure on MDA, creatinine, and BUN levels in printing workers at Airlangga University Press, Surabaya. *Journal of Medicinal and Pharmaceutical Chemistry Research*, 2025, 7(10), 2334-2347. **Link:** https://jmpcr.samipubco.com/article_215212.html