Factor Associated with Urine Trans, Trans-Muconic Acid (tt-MA) levels of Gas Station Workers

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Abstract*—Benzene is a dangerous chemichal compounds that can cause haematological effects. Gasoline contains approximately 5% carcinogens benzene. Gas station employees, particularly fueling operators are working population that have a high risk of benzene exposure. Within the continuous exposure. The purpose aim of this study is to analyze the relationship of urine trans, trans-Muconic Acid (tt-MA) levels with haematological profile of Gas Station Workers. The study was designed as an observational study and conducted by cross sectional method with 33 samples (12 samples administrative workers and 21 samples in fueling operator). The research showed that average concentration of benzene in the air is 0,58 ppm. The result of Spearman analysis showed a significant correlation the amount of fuel fill and the duration of filling the fuel with the level of tt-MA in urine (p=0,000). From this research can be concluded, that more fuel is fill and the longer the duration of filling the fuel by respondent, the higher levels of tt-MA in urine. Therefore, works should use PPE and that medical surveillance conducted continuously every year.*

Keywords— urine tt-MA levels, haematological profile, gas station employees

I. INTRODUCTION

Gasoline is a liquid mixture derived from petroleum and is mostly composed of hydrocarbons and used as a fuel in internal combustion engines. In the United States, gasoline contains carcinogens benzene as much as 0.5% - 2%, in the UK 2% - 3%, whereas in other countries can reach 5% concentration[1]. In Indonesia, gasoline contained carcinogens benzene as much as 1%-5% depending on the octane number and the type of fuel. Higher concentration of benzene in indoor and outdoor will be found in the vicinity of emission sources such as gas stations[2]. The average benzene exposure of workers to the gas station area is 0.12 ppm[3]

The trans, trans-muconic acid (tt-MA) is the result of oxidation of the muconaldehyde (MUC). Muconaldehyde a diene compound and dialdehid with six carbon chain is thought to be the cause of the toxicity of benzene to the bone marrow. The urine trans, trans-Muconic Acid (tt.MA) levels can be used as a sensitive and specific indicator for biological monitoring, especially for low exposure benzene[4]. The urine trans, trans-Muconic Acid (tt-MA) levels can detect exposure to benzene at concentrations of up to 0.1 ppm[5].

In gas stations, fueling operator has more chance of exposure to benzene, especially through inhalation in a continuous exposure. During daily work, gas station worker have direct contact with gasoline product, so occupational exposure to benzene cannot be avoided. Exposure to benzene can cause haematological effects.

II. METHODS

The study was designed as an observational study and conducted by cross sectional method with 33 samples (12 samples administrative workers and 21 samples in fueling operator). The purpose aim of this study is to analyze the relationship of characteristic of workers (age, sex, body mass index, smoking habits), and occupational factors (working period, the amount of fuel fill, the duration of filling the fuel) and urine trans, trans-Muconic Acid (tt-MA) levels with haematological profile of Gas Station Workers.

In this study the variables were characterictics of workers (age, sex, body mass index, smoking habits), occupational factors (working period, the amount of fuel fill, the duration of filling the fuel), and urine trans, trans-Muconic Acid (tt-MA) levels.

The technique of collecting data using interview technique with help of questionnaires, observations with the help of a checklist, and laboratory test to measurement urine tt-MA levels.

III. RESULT

This research was conducted at the gas station in Surabaya. Total gas station as a place of research in this study are six stations. Average number of retail outlets

selling up to 1.5 million liters per month, this amount includes an average of largest sales in Surabaya.

Table 1. Urine trans, trans-Muconic Acid (tt-MA) levels

Variabel	Average (SD)		*t-test*
	Office Area	Operator Area	
Urine tt-MA Levels (µg/g Creatinin)	229,96 (127,80)	480,74 (219,65)	0,001

Biological Exposure Indices 500 (µg/g Creatinin)

Result of the **table 1** show that urine tt-MA levels in the respondents at the office area averaged 229,96 (127,80) µg/g Creatinin. However, the urine tt-MA level in the respondents at the operator area is 480,74 (219,65) µg/g creatinin was significantly elevated in comparison to workers at the office area.

Table 2 Relationship of characterictics of workers (age, sex, body mass index, smoking habits), occupational factors (working period, the amount of fuel fill, the duration of filling the fuel), and urine trans, trans-Muconic Acid (tt-MA) levels.

Characteric tic	Variabel Dependen: Urine tt-MA levels			
	Office Area		Operator Area	
	p	*r*	*p*	*r*
Sex	0,921	0,029	0,055	0,387
Age	0,799	0,083	0,293	0,241
Body Mass Index	0,674	0,136	0,483	-0,162
Smoking Habbits	0,491	-0,220	0,560	-0,135
Working Period	0,847	0,062	0,407	0,191
Amount of Fuel Fill*	-	-	0,000*	0,805
Duration of Fill*	-	-	0,000*	0,805

**Only for responden at operator area*

Pearson Correlation result is known that there is no significant relationship between age and levels of urine tt-MA level, either on the respondents in the office area and in the area of the operator, it can be seen from the p-value of each variable odds greater than 0.05.

Spearman correlation results are known well among respondents in the office area and operator area is known that BMI and smoking does not have a relationship with the content of tt-MA in uriin. That is because the probability is greater than 0.05. Coefficient contingency test results can be seen both in the respondents in the office area and the area operator that gender had a significant relationship with the tt-MA levels in the urine because the probability is greater than 0.05.

Pearson Correlation test results showed that no significant relationship exists between tenure with tt-MA levels in the urine, either on the respondents in the office area and in the area of the operator, it can be seen from the probability of each variable over 0.05.

Spearman correlation test results between a variable amount of fuel required and the duration of filling the fuel levels in the urine tt-MA on the operator can respond in an area known to have significant relationships, it can be seen from the probability of each variable is less than 0.05.

IV. DISCUSSION

The results of measurements of the levels of trans, trans-Muconic Acid (tt-MA) in the urine conducted researchers in collaboration with Prodia Occupational Health Institute (OHI) International Laboratory Jakarta prove the occurrence of benzene exposure to gas stations workes. Results of measurements of urine tt-MA levels the workers in the office area shows the average value of urine tt-MA levels 229.96 ug / g creatinine, whereas the workers in the operator area 480.74 ug / g creatinine. This means urine tt-MA levels of the respondents at office area higher than the workers at operator area. In the operator area there are seven workers who have urine tt-MA levels exceeded the value of Biological Exposure Indices (BEI) set by ACGIH (500 ug / g creatinine). While 14 workers were below the Biological Exposure Indices (BEI). But that does not mean the workers secure against the adverse effects of exposure to benzene.

The Biological Exposure Indices (BEI) is a reference value which is intended to be used in the practice of industrial hygiene as guidelines or recommendations to assist in the control of potential health hazards in the workplace[5]. Reference value is given as a recommendation for good practice with no guarantee that these values provide a clear boundary between safe and unsafe conditions. So these conditions should still be a concern, because the risk to the occurrence of adverse health effects remain a threat for employees of gas stations.

The trans, trans-Muconic Acid (tt-MA) is a minor metabolite of benzene which is excreted through the urine. The metabolism of benzene into a compound muconaldehyde (MUC) is the first step in the formation of compounds tt-MA dala urine. Muconaldehyde a diene compound and dialdehid with six carbon chain is thought to be the cause of the toxicity of benzene to the bone marrow[6].

Result of the **table 2** Pearson Correlation test results on the respondents in the office area and in the area of the operator, it is known that the age variable does not have a

significant relationship with the urine tt-MA levels. Based on the survey results revealed the value of the average age of the workers in the office area is 31.92 years, while the average age of respondents was 29.90 years opearator area. Person's age will affect the body's resistance to exposure to toxic substances/chemicals[7]. States that age can affect the toxicity because at a certain age are elderly (>45 years) decreased organ function that affects the metabolism and decreased muscle work. So the age under 45 years of age have no relationship to the toxicity because at that age has not been a decline in organ function that affects the metabolism[8]. However, based on the results of measurements of urine tt-MA level indicates that the workers were aged under 30 years had higher levels of urine tt-MA in the urine is high, as well as workers aged above 40 years.

The body mass index does not have a significant relationship to the content of tt-MA in the urine. Based on the results of measurements of body mass index on the respondents, the average value of the body mass index of respondents in the office area 24.26 (obese category), and the respondents in the operator area had an average body mass index value of 23.10 (obese category). However, based on the results of measurements of urine tt-MA levels indicates that respondents who had a normal body mass index values have urine tt-MA levels is relatively high, as well as the respondents were obese body mass index values also had higher levels of urine tt-MA. Poor nutritional status will basically cause a person's endurance is decreased, with a decrease in the immune system will be easily infected person, for example by microbes. In addition, one caused by malnutrition can lower immunity and antibody so eseorang susceptible to infections such as coughs, colds, diarrhea, and reduced the body's ability to detoxify against foreign objects such as gas and dust into the body[9]. Benzene is a compound with small molecules that are readily soluble in fat. Toxicant that is high in fat solubility allows low concentration in the target organ, so it can be considered as a protection mechanism. The toxicity of these substances in the fat becomes lower when compared to thin people[10].

Based on recent research results can be seen the average value of the body mass index of respondents in the office area and in the area of the operator is at 24.26 and 23.10 value relative are in the normal value, This is one factor that can minimize the degree of toxicity of benzene, in this case is minimal urine tt-MA levels. Nonetheless, the use of BMI as an indicator of nutritional status has not been able to reflect the overall nutritional history during the previous period. Whereas benzene poisoning occurs chronically and accumulative so as influenced by a person's history of nutrition, therefore, need to continue monitoring the nutritional status during the benzene workforce.

Factors smoking habit relations with urine tt-MA levels in of both the workers in the office area and in the operator area. In this study, respondents can be seen in the office area, 83.3% of non-smokers, smokers were 8.3% and 8.3% of heavy smokers. Respondents in the area known operator 47% nonsmokers, light smokers 4.8%, 19.0% moderate smokers, and 28.6% are heavy smokers. A number of benzene contained in cigarette smoke, so smoking is a behavior that can be considered role increase the risk of benzene exposure even in very small quantities[3]. (Smoking is one of the factors that contribute to high levels of tt-MA in the urine[2].

Based on the research results can be known workers that do not have smoking habits obtained value urine tt-MA levels are relatively the same as the respondents who smoke. Although smoking is a causative factor urine tt-MA high levels, but in this study found no significant association between smoking and urine tt-MA levels.

Gender factor has no relationship with the urine tt-MA levels of both the respondents in the office area and in the operator area. In this study, in the area office to know the number of women as many as 7 people, and men 5 people. While in the area operator, the number of women as many as five people, and men 16 people. Urine tt-MA levels of female workers and male known to be relatively equal, it is known that there respondents with female sex had higher levels of tt-MA in the urine were higher than male respondents. Likewise, there are urine tt-MA levels of male respondents is higher than the female respondents. In this study, respondents in the office area and operator area both women and men have high levels of benzene exposure and interaction with different. Individuals other factors such as liver function is a benzene metabolism and tt-MA on the respondent is unknown. This becomes a limitation in this study, because the liver function will affect the metabolism of a chemical.

Pearson Correlation test results on variable working lives both on respondents in the office area and in the area of the operator does not have a significant relationship with the urine tt-MA levels. Based on this study, the average age of respondents working in the office area was 7.83 years, while the average age of the respondents in the operator area is 7.19 years. Benzene is entered into the human body through the lungs and into the body and through the process of metabolism is then stored in the bone marrow da in fatty tissue. Benzene is converted into metabolites in the liver and bone marrow. The harmful effects of benzene exposure are caused by these metabolites. Most benzene out of the human body in the form of urine, one is urine tt-MA levels, at least 48 hours

after exposure[3]. Urine tt-MA excretion in the urine is at its peak after exposure, with a half-life of 4-5 hours, so that the urine sample should be collected soon after exposure occurs[2]. Based on this study, it can be concluded that the period of employment does not have a significant relationship with the urine tt-MA levels due to the measurement of urine tt-MA in the urine is only done on the day of the study course. Urine tt-MA levels is a biomarker to determine how much benzene content of benzene in the body after exposure. This is because the majority of benzene metabolites will soon be in excrete at least 48 hours after exposure. Although benzene metabolite partly stored in the bone marrow which is fakotr makes benzene toxic to the body.

Test the relationship between a variable amount of fuel that is filled with high levels of urine tt-MA is only done on the respondent in the operator area. This is because only respondents in the operator area that acts as a saleswoman retail outlets. Spearman's test results found that the amount of fuel that is filled with high levels of tt-MA in the urine has a significant connection. Based on the observations to each respondent in the area during a shift operator obtained the average amount of fuel filled in by the respondent is 1976.26 liters. The average levels of urine tt-MA levels of respondents in the area operator was 480.74 mg/g creatinine. Inhalation is the dominant pathway for benzene exposure, benzene odor threshold concentration of 0,025 ppm is generally provide sufficient warnings about exposure to benzene[3]. Urine tt-MA levels in the urine is a result of metabolism of benzene, benzene inhaled the more the greater the benzene into the body and excreted[4]. Higher concentration of benzene can be found at the pump that comes from the evaporation of fuel containing 1-5% benzene[11]. Based on this study, the average fuel filled in by the respondents in the operator area is 1976.26 liters filled with the lowest number of respondents is 1180.80 liters, and the most you are filled 2606.45 liters. It is known that respondents with higher levels of tt-MA in the urine of the highest 1197.88 mg / g creatinine. It can be concluded that the more sales activities or the amount of fuel required by the respondent, the more benzene vapor that is inhaled by the respondent during the process of filling the fuel lasts. Each respondent in this study can not be in control of the type of fuel filled, due to the division of labor at the pump is not based on the type of fuel. This resulted in levels of benzene inhaled by respondents varies depending on the type of fuel product.

Spearman test result is known that the duration of filling the fuel levels in the urine tt-MA levels has a significant relationship. Based on the observations to each respondent in the area during a shift operator obtained an average duration of total filling the fuel for one shift by the respondent was 262.67 minutes. The average levels of tt-MA in the urine of respondents in the area operator was 480.74 mg / g creatinine. The duration of benzene exposure a person depends on the job and the longer a person interacts with benzene[3]. Urine tt-MA levels is a result of metabolism of benzene, benzene inhaled the more the greater the benzene into the body and excreted[5]. Higher concentration of benzene can be found at the pump that comes from the evaporation of fuel containing 1-5% benzene[11]. The average duration of filling the fuel that made respondents in the area operator was 262.67 minutes. The shortest duration was 157.13 minutes and the longest was 346.86 minutes. Duration filling the fuel in this study directly proportional to the amount of fuel required by each respondent. It is known that respondents with higher levels of tt-MA in the urine is highest 1197.88 mg / g creatinine. It can be concluded that the longer the duration of the fuel filling done by respondents during the sales activity, the more benzene vapor that is inhaled by the respondent during the process of filling the fuel lasts. Each respondent in this study can not be in control of the type of fuel filled, due to the division of labor at the pump is not based on the type of fuel. This resulted in levels of benzene inhaled by respondents varies depending on the type of fuel product.

V. CONCLUSION

A conclusion in this study can be concluded the following:

1. There is no significant relationship between characterictics of workers (age, sex, body mass index, smoking habits) and occupational factors (working period) with urine trans, trans-Muconic Acid (tt-MA) levels.
2. There is a significant relationship between occupational factors (working period, the amount of fuel fill, the duration of filling the fuel) with urine trans, trans-Muconic Acid (tt-MA) levels.

Recommendation given to the gas station managements and the respondents are :

1. As a recommendation, gas station management needs to consider the provision of personal protective equipment (PPE) in the form of an organic vapor respirator. The use of personal protective equipment to employees in the area to minimize operator exposure to benzene to employees. In addition, management of gas stations must conduct regular health checks in an attempt yan early detection of health problems caused by exposure to benzene at gas stations.
2. Gas station employees need to raise awareness to lifestyle such as smoking. Smoking habit can be a factor that will exacerbate the adverse effects of

exposure to benzene to employees

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