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An Analysis of Lead (Pb) Levels in the Urine of Gas Station Operators Based on Individual Characteristics (A Case Study at Kali Rungkut and Panjang Jiwo Gas Station Surabaya)

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Abstract. Improved means of transportation have several positive and negative impacts. The most-occurred adverse effects is a decrease in environmental quality. Emissions from vehicles will continue to increase every single day and will be the dominant source of air pollutants. Pb or lead is one of the contaminants of vehicle mobility. Gas station operators are at risk of having high Pb levels in their bodies. This happened because the gas station operators are exposed to Pb for 8 hours/day from motor vehicle emissions as well as gasoline fumes when consumers refuel. This study aims to analyse and determine the lead (Pb) levels in the urine of gas station operators based on their characteristics at Panjang Jiwo and Kalirungkut gas station Surabaya. This research is quantitative research with a descriptive method that compares the results of measurements in the field with the Decree of the Minister of Health of the Republic of Indonesia Number 1406 / Menkes / SK / XI concerning the Examination Standard of Black Lead Levels in Human Biomarker Specimen. Measurements were made on the urine of twelve gas station operators at two gas stations. The results of the study showed that the analysis of Pb levels in the urine of twelve respondents was below the threshold value of 0.1 mg/l. There is also a tendency that the longer the service life of the operator and the increasing age, the higher the Pb level in the urine of gas station operators.

1. Introduction

The increased means of transportation has negative impacts since it can reduce the environmental quality. Emission from vehicles will continue to increase every single day and will be the dominant source of air pollutants. In big cities like DKI Jakarta, the contribution of pollutants from motor vehicles is around 70%. The primary contaminants found in the emission of motor vehicles are carbon monoxide (CO), various hydrocarbon compounds, different nitrogen oxide (NO_x) and sulfur (SO_x), as well as particulate matters and dust including lead (Pb) [1]. According to Mifbakhuddin, lead is usually used as a mixture of gasoline fuel which serves to improve lubrication power and combustion efficiency so that motor vehicle performance increases [2]. These chemical substances are burned along with gasoline in the engine, and the remaining $\pm 70\%$ comes out with the emission from combustion. Librawati added that every litre of gas in 88 octane number contains lead is usually used as a mixture of gasoline fuel which serves to improve lubrication power and combustion efficiency so that motor vehicle performance increases 0.70 g of Tetraethyl Pb and 0.84 g Tetramethyl Pb compounds [3]. Every one litre of gasoline that was burned will emit 0.56 g Pb to the air. Gas station operators are one of the objects affected by Pb from vehicles. Every day they breathe pollutants from



vehicle exhaust gases in their workplaces. Increased accumulation of Pb in the human body will cause gastrointestinal syndrome, decreased consciousness (cognitive effect), anaemia, kidney damage, hypertension, neuromuscular and psychological consequences, as well as central nerve damage, behavioural changes, and inhibited erythrocytes formation [2].

The gas station is one of the places with high-level Pb exposure and pollution because it is not only due to gasoline containing Pb but also due to many vehicles come in and out to refuel. The gas station operators are at risk of having high Pb level in their bodies. This due to the operators is exposed to Pb for 8 hours/day from the motor vehicle emission and gasoline fumes during consumer refuel process. Also, most gas station operators do not use any PPE (Personal Protective Equipment) while working [3]. This study aims to analyse and determine the lead (Pb) levels in the urine of gas station operators based on their characteristics study case at Panjang Jiwo and Kalirungkut gas station Surabaya. Therefore, research on the relationship between the period of employment and Pb levels in the gas station operator bodies through urine analysis was conducted. This research aims to find out and analyse lead (Pb) levels in the urine of gas station operators based on their characteristics at Panjang Jiwo and Kalirungkut gas station.

2. Literature Review

Pb in the atmosphere comes from incomplete combustion of regular and premium gasoline. Premium gasoline consists of 2-4 grams Pb per gallon with an average of 2.8 grams. Regular gasoline consists of 2.3 grams Pb in average per gallon. On average 70-80% Pb in gasoline is dispensed from the exhaust pipe as particulate. As an air pollutant, Pb is the result of gasoline combustion in the vehicle and lead emission in Co₂ smelting [4]. Pb is already in gasoline fuel. Therefore, Pb becomes an element that is released freely in the air due to the incomplete excretion process in vehicle engine [5]. Pb enters the human body through various means, including through inhalation, gastrointestinal tract, and even dermal contact duct. However, breath it the main pathway of Pb exposure. For more stable pollutants such as Pb, some hydrocarbons-halogen, and polyaromatic hydrocarbons can fall to the ground along with rainwater or settle with dust, and contaminate soil and water. The compound can enter the food chain which eventually enters the human body through raw food [1]. The entry of Pb into the body of gas station operators can be through inhalation. Vehicle emissions are containing Pb and gasoline fumes while refuelling enters the gas station operator body and then distributed by blood to the soft tissues (nervous system, kidneys, liver) and hard tissues (bones, nails, hair, teeth) as well. That 90% of Pb entering the body will be stored in bone, and only a small portion is stored in other tissues [3]. Urine is a residual metabolic fluid produced by the kidney and excreted from the body through urinating. Urine consists of water and materials dissolved in it. These dissolved materials are in the form of body metabolic waste such as urea, evaporated salt, and other organic matters [6].

3. Research Method

This research is quantitative research with the descriptive method by comparing the results obtained from measurements in the field with the Decree of the Minister of Health of the Republic of Indonesia Number 1406/Menkes/SK/XI/2002 concerning Examination Standard of Black Lead Levels in Human Biomarker Specimen. This research was conducted at two gas stations (Panjang Jiwo and Kalirungkut) in Surabaya with urine as the test materials from 12 respondents; 6 respondents from Kalirungkut gas station and 6 respondents form Panjang Jiwo gas station.

4. Result and Discussion

The research was started by doing interviews about respondent characteristics, including age and the period of employment.

Table 1. Respondent Distribution Based on the Age of Gas Station Operators

No	Age (years old)	Frequency (people)	Percentage (%)
1	20-30	6	50
2	31-40	4	33.33
3	> 40	2	16.67
Total		12	100

Based on the research results in Table 1, it is known that 50% of respondents aged between 20-30 years old (6 people) and only 16.67% (2 people) aged more than 40 years old.

Table 2. Respondent Distribution Based on the Period of Employment at Gas Station

No	Period of Employment (year)	Frequency (people)	Percentage (%)
1	1-10	5	41.7
2	11-20	7	58.3
Total		12	100

Based on the research results in Table 2, it is known that 58.3% of respondents have been working for more than ten years (7 people) and only 41.7% have been working for less than ten years (5 people).

Pb Levels in the Urine of Gas Station Operators

Table 3. Pb Levels in the Urine of Gas Station Operators Based on Their Age and Period of Employment

No.	Gas Station	Sample Code	Age (years old)	Period of Employment (year)	Pb Levels in the Urine (mg/l) (SNI<0.150)
1	Kalirungkut Gas Station	A1	24	6	0.096
2		A2	21	4	0.078
3		A3	41	20	0.114
4		A4	48	20	0.128
5		A5	25	7	0.082
6		A6	30	11	0.091
7	Panjang Jiwo Gas Station	B1	31	13	0.102
8		B2	34	16	0.118
9		B3	36	18	0.132
10		B4	22	5	0.108
11		B5	35	15	0.135
12		B6	20	2	0.071
The lowest			20	2	0.071
The highest			48	20	0.135

According to Table 3, all 12 respondents have Pb levels below the threshold value of Permenkes No. 1406/Menkes/SK/XI/2002 which is 0.150 mg/l, with the lowest Pb level of 0.071 mg/l and the highest Pb Level of 0.135 mg/l.

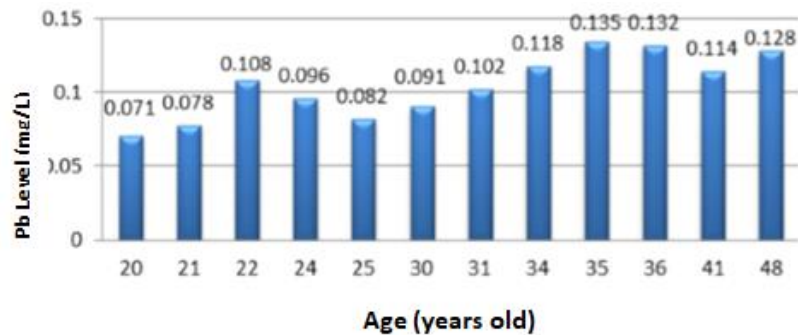


Figure 1. The Relationship between Gas Station Operators' Age and Pb Level in the Urine

According to Figure 1, the oldest respondent is 48 years old with Pb level of 0.128 mg/L and the youngest with 0.071 mg/L. However, the highest Pb level is in the 35-year-old respondent. This difference shows that the longest the exposure time or period of employment may affect the accumulated Pb in the respondent's body. High Pb level may be affected by how much exposure they have got and operators' age is potential to increase Pb levels in the body. Pb content in adults differs due to environmental and geographical factors in which they are living [1-2].

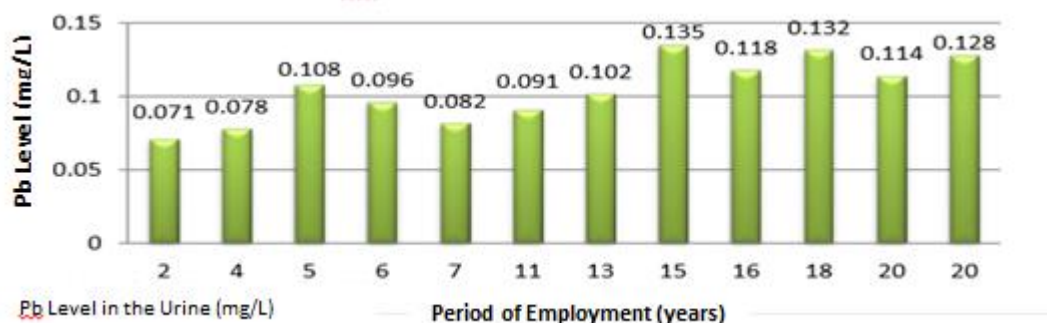


Figure 2. The Relationship between Gas Station Operators' Period of Employment and Pb Level in the Urine

Figure 2 shows the highest Pb level (0.132 mg/L) is in the operator who has been working for 15 years, while those who have been working for 20 years have Pb levels of 0.128 mg/L and 0.114 mg/L respectively. According to Wahyudi [1] in Mifbakhuddin [2] the function of the immune system in the body decreases according to the age. The biological half-life of Pb in human bones is estimated to be 2-3 years. Pb in the blood can be detected in the half-life of 20 days, whereas the total Pb excretion in the body occurred within a half-life of about 28 days. From the blood and the deposit place, Pb then excreted through urine, faeces and sweat [3], while Pb excretion through kidney is through glomerular filtration. This explained that the longer the exposure time or period of employment, the more accumulated Pb in the gas station operators' body. Pb content in the body is used for occupational exposure. In general, Pb excretion runs very slowly [4].

The analysis results showed that all 12 respondents had Pb level of less than 0.150 mg/L, but over time, the source of exposure could be more significant. The length and amount of exposure and the increasing age might increase Pb accumulation in the body. Thus, the gas station executives need to take precautions to minimise the entry of Pb into the operators' organisation such as providing knowledge about the source of exposure, hazardous effects, control of Pb exposure prevention, and the use of mask while working. The gas station executives should review the policy of not allowing the use of cover while working since the effects of accumulated Pb may cause poisoning and fatal consequences [5].

5. Conclusion

Pb levels in the urine of 12 respondents were under the threshold value of Kepmenkes No. 1406/Menkes/SK/XI/2002 concerning Examination Standard of Black Lead Levels in Human Biomarker Specimen which is 0.150 mg/L. There was a tendency in which the longer the period of employment, the higher Pb levels in the urine of gas station operators. There was a tendency in which the older the operator, the higher Pb levels contained in the urine.

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