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The Influence of Airborne Lead (Pb) and Individual Characteristics on Subjective Complaints Among Petrol Station Operators in Surabaya: A Cross-Sectional Study

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ABSTRACT Lead (Pb) is an air pollutant present in particulate form, often known as metallic powder. Gas station operators are one of the groups at risk of exposure to lead from motor vehicle emissions, which is harmful to health because it can accumulate in the body. This study aims to analyse the effect of airborne lead (Pb) and individual characteristics on the subjective complaints of petrol station operators in Surabaya. This study is an analytical observational study with a cross-sectional approach with a sample size of 28 respondents. Data were collected through measurements, observations and interviews, which were then processed and analysed using chi-square test. The results showed that airborne Pb measurements at two points met the NAB based on Permenaker No. 5 of 2018, which is less than 0.05 mg/m^3. Based on the chi-square test, it was found that the variables of working time and the habit of using PPE had an effect on subjective complaints with a p-value <0.05. The variables airborne Pb, age and smoking habits had no effect on subjective complaints. The conclusion of this study is that the length of service and the habit of using PPE have an effect on subjective complaints of gas station operators. It is recommended for gas station operators to always use N95 masks while working and routinely check their health with health services.

INDEX TERMS lead, gas station operator, subjective complaints

I. INTRODUCTION

Lead (Pb) is an air pollutant that is often found in the form of small particles, often known as metallic powders. These particles can enter the human body through food or inhalation. Although in small amounts, exposure to these lead particles can cause poisoning through inhalation (breathing), oral (through the digestive tract) or dermal (skin contact) [1]. A person can be exposed to lead by breathing, and the effects of inhaled lead depend on the size of the particles inhaled [2]. Road-side workers, such as parking attendants in traditional markets, petrol station attendants and street vendors, are exposed to higher levels of lead (Pb) than industrial workers [3].

Gas station operators are one of the high-risk groups for exposure to chemicals hazardous to health, especially lead from gasoline vapor during refueling and emissions from motor vehicles queuing or leaving the petrol station after refueling [4]. In the Regulation of the Minister of Manpower of the Republic of Indonesia No. 5/2018 on Occupational Safety and Health of the Work Environment, the threshold value of lead (Pb) in the work environment was set at 0.05 mg/m^3 [5]. If the NAB is exceeded, there is a risk of health problems. Approximately 85% of human lead contamination occurs through inhalation, 14% through oral consumption, and only 1% through skin absorption [6]. Exposure limited to the contact area is called a local effect. When lead is absorbed and enters the bloodstream, it will spread to various organs of the body and cause systemic effects. Lead can also cause diseases such as hematology, neurological disorders, cardiovascular disorders, and reproductive problems [7]. Adults with lead poisoning experience dizziness, decreased appetite, headaches, anemia, difficulty concentrating, insomnia, fatigue, and risk of miscarriage [8] [9]. This is similar to the research of

Charkiewicz who also found that the symptoms of lead poisoning in adults with blood lead levels of 41 - 70 µg/L experienced symptoms of fatigue, irritability, fertility disorders, chronic hypertension, and blood lead levels of 71Adults with lead poisoning experience dizziness, decreased appetite, headaches, anemia, difficulty concentrating, insomnia, fatigue, and risk of miscarriage [8]

Preliminary studies conducted by researchers found that the location of the gas station is located near the highway with a high density of traffic with the number of vehicles entering the gas station with an average of 150 units of motorcycles / hour and 80 units of cars / hour. From the results of interview conducted with 8 gas station operators, the results obtained as many as 50% of the gas station operators experience complaints in the form of fatigue, headache and irritability. While 75% of petrol station operators experience complaints of sleep disturbance and 62.5% experience complaints of difficulty in concentrating, they often ignore the use of PPE in the form of masks while working. Based on the description of the above problems, research is needed on the effect of airborne lead (Pb) and individual characteristics on subjective complaints of gas station operators in 2024.

II. METHODS

This study used analytical observational research with cross-sectional approach. The research site was at the gas station in Surabaya, which was conducted from January to May 2024. The sample size was 28 respondents taken by simple random sampling from 30 populations. Data were collected through measurements, observations, and interviews which were then processed and analyzed using the chi-square test.

Air Pb measurements used filter paper and were analyzed using an Atomic Absorption Spectrophotometer (AAS) which was carried out for 2 days with 4 repetitions at each point. Observations were made through direct observation to obtain an overview of the location of the gas station and interviews were conducted with gas station operators by distributing questionnaires to determine age, length of service, habits of using PPE, smoking habits, and subjective complaints felt by gas station operators. The selection of the chi-square test was used to determine whether or not there was an influence of air Pb and individual characteristics on subjective complaints of gas station operators.

III. RESULT

A. INDIVIDUAL CHARACTERISTICS OF GAS STATION OPERATORS

1) AGE

TABLE 1
Age Frequency Distribution of Gas Station Operators

No	Age	N	Precentage (%)
1.	≤ 30 year	19	69
2.	> 30 year	9	32
	Total	**28**	**100**

[9]. This is similar to the research of Charkiewicz who also found that the symptoms of lead poisoning in adults with blood lead levels of 41 - 70 µg/L experienced symptoms of fatigue, irritability, fertility disorders, chronic hypertension, and blood lead levels of 71 - 100 µg/L experienced symptoms of headache, abdominal pain, insomnia, and memory loss [10]

TABLE 1 shows that the majority of gas station operators are ≤ 30 years old with 19 people (69%), while operators aged > 30 years are 9 people (32%).

2) WORKING PERIOD

TABLE 2
Frequency Distribution of Working Period of Gas Station Operators

No	Working Period	N	Precentage (%)
1.	≤ 2 year	13	46
2.	> 2 year	15	54
	Total	**28**	**100**

Based on the research results in TABLE 2, it is known that 54% of gas station operators have been working for more than 2 years (15 people) and 46% have been working for less than 2 years (13 people).

3) USING PERSONAL PROTECTIVE EQUIPMENT (PPE)

TABLE 3
Frequency Distribution of PPE Habit

No	Using PPE	N	Precentage (%)
1.	Not Using PPE	15	54
2.	Using PPE	13	46
	Total	**28**	**100**

TABLE 3 shows that the majority of gas station operators do not use PPE with a total of 15 people (54%) and the rest use PPE as many as 13 people (46%).

4) SMOKING HABITS

TABLE 4
Frequency Distribution of Smoking Habits of Gas Station Operators

No.	Smoking Habits	N	Precentage (%)
1.	Non Smoker	16	57
2.	Smoker	12	43
	Total	**28**	**100**

Based on the distribution of smoking habits of gas station operators in TABLE 4, it shows that the majority of gas station operators do not smoke as many as 16 people (57%) and the rest smoke as many as 12 people (43%).

B. AIR LEAD (Pb) MEASUREMENTS

The process of taking Pb air samples was carried out for 1 hour at each location point and repeated the next day with the same time and location point. After the sampling was completed, the samples were taken to the laboratory and analyzed using an Atomic Absorption Spectrophotometer (AAS). Based on TABLE 5, it can be concluded that the results of air lead (Pb) measurements at gas stations were carried out at 2 points with each point carried out 4 measurements (2 days) in the morning at 07.30 - 08.30 WIB and afternoon at 16.00 - 17.00 WIB. The

measurement results show that the average overall air lead (Pb) level is 0.00043725 mg/m^3. This finding shows that the overall air lead (Pb) level is still below the permitted NAB in accordance with Permenaker No. 5 of 2018 of 0,05 mg/m^3.

TABLE 5
Air Pb Measurement Results at 2 Points at Gas Stations

No	Measurement Date	Point	Pb Measurement Result (mg/m^3)		Average
			Morning	Afternoon	
1	March 7, 2024	1	0,0008064	0,0002710	0,0005387
		2	<0,00043	<0,00043	<0,00043
2	March 8, 2024	1	0,0002706	<0,00043	0,0003503
		2	<0,00043	<0,00043	<0,00043
Overall Average					0,00043725

Differences in lead (Pb) levels in the air can be influenced by different human activities, which cause changes in ambient air quality. One of the main factors is the transportation sector, especially emissions from motor vehicles. Several factors that affect motor vehicle emissions include increasing number of vehicles, routine vehicle maintenance, vehicle age, vehicle speed, engine capacity, and fuel consumption. More vehicles mean more exhaust gas produced, while routine maintenance can reduce the amount of exhaust gas [11].

C. SUBJECTIVE COMPLAINTS OF GAS STATION OPERATORS

Subjective complaints are a person's recognition of the symptoms or health problems they are experiencing based on personal perception. Subjective complaints in this study are complaints felt by gas station operators during work. The results of questionnaires that have been distributed to 28 gas station operators about subjective complaints are presented in Figure 1 and the types of subjective complaints are presented in Figure 2 below:

1) SUBJECTIVE COMPLAINTS

Based on Figure 1, it shows that 17 respondents have subjective complaints due to airborne lead (Pb), with 11 people in the no complaints category and 17 people in the complaints category.

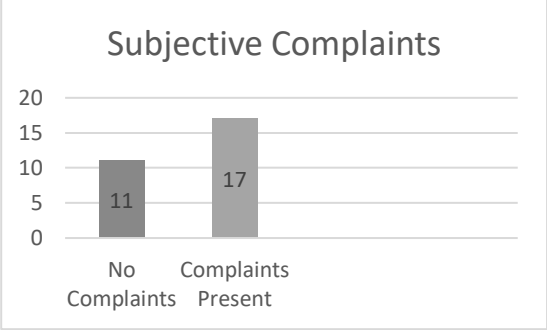

FIGURE 1. **Subjective Complaints of Gas Station Operators Regarding Lead (Pb) in the Air.**

Air Pb contributes to subjective complaints after becoming a gas or small particles that are spread in the air and then settle on the ground. About 80% of lead (Pb) enters the body through breathing and reaches the blood vessels in the lungs. There, lead binds to the blood and spreads to various tissues and organs [12]. More than 90% of lead absorbed by the blood is bound to red blood cells. The rate of lead absorption is greatly influenced by the size of the Pb compound particles and the amount of air inhaled. Smaller dust particles and larger air volumes increase the amount of lead that can be absorbed by the body [13]. The rate of lead absorption is greatly influenced by the size of the Pb compound particles and the amount of air inhaled. Smaller dust particles and larger air volumes increase the amount of lead that can be absorbed by the body [13].

This study only asked about subjective complaints of gas station operators related to air Pb, namely fatigue, sleep disturbances, headaches, difficulty concentrating, and irritability without asking about subjective complaints about respiratory disorders. This is because air lead enters the body of gas station operators through cumulative inhalation. Furthermore, lead will enter the blood vessels of the lungs and bind to red blood cells.

2) TYPE OF SUBJECTIVE COMPLAINTS

Based on Figure 2, it shows that gas station operators with subjective complaints due to airborne lead (Pb) report the following types of complaints: fatigue in 17 people (61%), sleep disturbances in 10 people (36%), headaches in 16 people (57%), difficulty concentrating in 10 people (36%), and irritability in 8 people (29%). In conclusion, the most common subjective complaints experienced by gas station operators due to lead (Pb) exposure among the respondents are fatigue (61%) and headaches (57%).

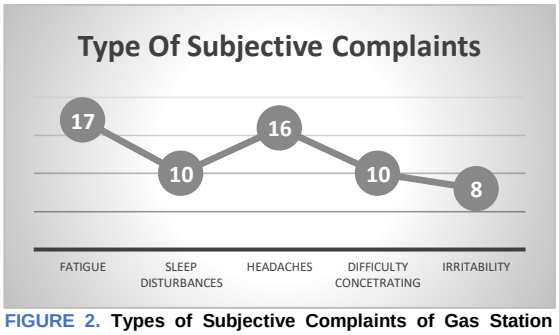

FIGURE 2. **Types of Subjective Complaints of Gas Station Operators Regarding Lead (Pb) in the Air**

D. ANALYSIS OF THE EFFECTS OF AIRBORNE LEAD, AGE, WORK TENURE, PPE USAGE HABITS, AND SMOKING HABITS ON SUBJECTIVE COMPLAINTS

The results of the analysis of the effects of airborne lead (Pb), age, work tenure, PPE usage habits, and

smoking habits on subjective complaints among gas station operators are shown in the following TABLE 6:

1) THE EFFECT OF AIR Pb ON SUBJECTIVE COMPLAINTS OF GAS STATION OPERATORS

TABLE 6
Chi-Square Test Results of the Effect of Pb on Subjective Complaints

No	Air Pb	Subjective Complaints				Total	
		No Complaint		Complaint Present			
		n	%	n	%	n	%
1	Meets NAB	11	39	17	61	28	100

Based on TABLE 6, it is shown that the air Pb measurement results still meet the NAB, so that the air Pb data is homogeneous, which means that air Pb has no effect on the subjective complaints of gas station operators

2) THE EFFECT OF AGE ON SUBJECTIVE COMPLAINTS OF GAS STATION OPERATORS

TABLE 7
Chi-Square Test Results on the Effect of Age on Subjective Complaints

No	Age	Subjective Complaints				Total		*p - value*
		No Complaint		Complaint Present				
		n	%	n	%	n	%	
1	≤30 year	9	47	10	53	19	100	0,249 > 0,05
2	>30 year	2	22	7	78	9	100	

Based on TABLE 7 above, it can be seen that subjective complaints are more commonly experienced by gas station operators over 30 years old (78%) compared to those 30 years old or younger (53%). The p-value from the statistical test is 0.249 > 0.05, indicating that H0 is accepted. This means that age does not have a significant effect on the subjective complaints of gas station operators.

3) THE EFFECT OF WORKING PERIOD ON SUBJECTIVE COMPLAINTS OF GAS STATION OPERATORS

TABLE 8
Chi-Square Test Results on the Effect of Work Period on Subjective Complaints

No	Working Period	Subjective Complaints				Total		*p - value*
		No Complaint		Complaint Present				
		n	%	n	%	n	%	
1	≤ 2 years	10	77	3	23	13	100	0,001 ≤ 0,05
2	> 2 years	1	7	14	93	15	100	

Based on TABLE 8, it is shown that subjective complaints are more commonly experienced by gas station operators with a work tenure of over 2 years (93%) compared to those with a work tenure of 2 years or less (23%). The p-value from the statistical test is 0.001 ≤ 0.05, resulting in the rejection of H0, which means that work tenure has a significant effect on the subjective complaints of the operators at Pertamina Gas Station 54.601.127 in Surabaya.

4) THE EFFECT OF USING PPE ON SUBJECTIVE COMPLAINTS OF GAS STATION OPERATORS

Based on TABLE 9, it is shown that subjective complaints are more commonly experienced by gas station operators who do not use PPE (87%) compared to those who do use PPE (31%). The p-value from the statistical test is 0.008 ≤ 0.05, resulting in the rejection of H0. This means that the use of PPE has a significant effect on the subjective complaints of gas station operators

TABLE 9
Chi-Square Test Results on the Effect of PPE Use on Subjective Complaints

No	Using PPE	Subjective Complaints				Total		*p - value*
		No Complaint		Complaint Present				
		n	%	n	%	n	%	
1	Not Using PPE	2	13	13	87	15	100	0,008 ≤ 0,05
2	Using PPE	9	69	4	31	13	100	

Based on TABLE 9, it is shown that subjective complaints are more commonly experienced by gas station operators who do not use PPE (87%) compared to those who do use PPE (31%). The p-value from the statistical test is 0.008 ≤ 0.05, resulting in the rejection of H0. This means that the use of PPE has a significant effect on the subjective complaints of gas station operators.

5) THE EFFECT OF SMOKING HABITS ON SUBJECTIVE COMPLAINTS OF GAS STATION OPERATORS

TABLE 10
Chi-Square Test Results of the Effect of Smoking Habits on Subjective Complaints

No	Smoking Habitss	Subjective Complaints				Total		*p - value*
		No Complaint		Complaint Present				
		n	%	n	%	n	%	
1	Non-Smoker	6	37	10	63	16	100	1,000 > 0,05
2	Smoker	5	42	7	58	12	100	

Based on TABLE 10, it is shown that subjective complaints are experienced by 63% of gas station operators who do not smoke compared to 58% of those who do smoke. The p-value from the statistical test is 1.000 > 0.05, leading to the acceptance of H0. This means that smoking habits do not have a significant effect on the subjective complaints of gas station operators.

IV. DISCUSSION

A. THE EFFECT OF AIR Pb ON SUBJECTIVE COMPLAINTS OF GAS STATION OPERATORS

Airborne lead (Pb) can contaminate the environment through direct or indirect contact with pollution sources [14]. Variations in airborne lead levels can be influenced by various human activities, resulting in changes in

ambient air quality [15] [16]. People who work near pollution sources are at greater risk of lead exposure. The type of work also affects the level of contamination, but in general, the closer the work position is to the pollution source, the higher the risk of lead exposure [17].

Airborne lead (Pb) sampling at the station was conducted at two fuel dispensers: stations 11-12 and 19-20. Based on these measurements, the lead levels at both locations were below the established thresholds. This resulted in homogeneous data indicating that there is no significant effect of airborne lead on the subjective complaints of gas station operators. This finding is consistent with Nurwahida's research, which analyzed the risk of airborne lead exposure in elementary school children, showing lead levels <0.01 mg/m³, which is within the safe category. The risk assessments for all respondents were also found to be safe [18].

Husna's study showed an association between airborne lead (Pb) levels and health disorders among street vendors, with a p-value of 0.015 using the chi-squared test [13]. The results of the current study differ from Husna's because airborne lead measurements were taken at only two points over two days, with a measurement duration of one hour. As a result, the subjective complaints of the gas station operators could be influenced by other factors such as age, job tenure, PPE usage habits, and others.

B. THE EFFECT OF AGE ON SUBJECTIVE COMPLAINTS OF GAS STATION OPERATORS

Age is a measure of time elapsed since a person's birth. As age increases, the function of body organs tends to decline, which can lead to higher accumulation of lead in body tissues [19]. Based on the chi-square test results regarding age and subjective complaints among gas station operators, the p-value obtained is 0.249 > 0.05. This indicates that there is no significant effect of age on the subjective complaints experienced by these operators. This finding is consistent with Laia's study, which found no significant relationship between age and work fatigue among gas station operators in Kecamatan Percut Sei Tuan, with a chi-square p-value of 0.061 > 0.05 [20].. Similar findings were also reported by Gusti, who stated that age was not significantly related to work fatigue in gas station operators, with a p-value of 0.210 > 0.05 [21].

Older workers tend to be more susceptible to subjective complaints such as fatigue, headaches, difficulty concentrating, sleep disturbances and irritability due to decreased physical strength, which affects productivity [22]. However, this study did not find a significant relationship between age and the subjective complaints experienced by service station operators. Although the majority of operators were ≤ 30 years old (19 individuals), 10 individuals (53%) of them still experienced health complaints. Many young operators are selected by the service station with the expectation of optimal performance in their role.

C. THE EFFECT OF WORKING PERIOD ON SUBJECTIVE COMPLAINTS OF GAS STATION OPERATORS

Working period refers to the duration of time an employee has spent working at a particular place [23]. Working period can influence subjective complaints because the longer a person is exposed to risks and hazards in the work environment, the more likely they are to experience such complaints [24]. Based on the chi-square test analysis of the effect of work tenure on subjective complaints among gas station operators, a p-value of 0.001 ≤ 0.05 was obtained. This indicates a significant effect of work tenure on the subjective complaints experienced by the operators. This finding is consistent with previous research, such as Lating's study, which found a significant relationship between work duration and fatigue complaints among gas station workers, with a chi-square p-value of 0.027 ($p < \alpha = 0.05$) [25]. Other studies by Ardiyanti and Handjaya also support this finding, showing a significant relationship between work duration and work fatigue in gas station operators with p-values $< \alpha = 0.05$ [26] [27].

The working period of most gas station operators is > 2 years 2 years, with a total of 15 people. Of the 15 people, 14 people (93.3%) experienced subjective complaints with the most common type of complaint being fatigue. The longer a person works, the risk of fatigue levels tends to increase because factors such as monotonous work can cause feelings of boredom [22]. In addition, the longer a person works, the more exposed he or she will be to the risks and dangers of the work environment which can increase the risk of health problems experienced.

To minimize health disturbances as their work tenure increases, gas station operators should manage their rest periods effectively, ensure adequate sleep, and regularly check their health with healthcare services.

D. THE EFFECT OF USING PPE ON SUBJECTIVE COMPLAINTS OF GAS STATION OPERATORS

Operators at gas stations are frequently exposed to motor vehicle emissions and airborne dust particles. Proper health protection is essential to reduce the risk of exposure to exhaust gases that may enter their systems. One important preventive measure against occupational diseases and accidents is the use of Personal Protective Equipment (PPE), such as masks. Wearing masks helps protect gas station operators from exposure to airborne lead (Pb), especially from vehicle emissions and fumes during fuel dispensing [28].

Based on the chi-square test analysis using SPSS regarding the impact of PPE usage on subjective complaints among gas station operators, a p-value of 0.008 ≤ 0.05 was obtained. This indicates that the use of PPE has a significant effect on the subjective complaints experienced by the operators. This finding aligns with previous research, such as Andriani's study, which found a significant relationship between PPE use and work fatigue, with a chi-square p-value of 0.019 ($p < 0.05$) [29].. Another

study by Ida also supports this finding, showing a significant relationship between PPE use and health disturbances, with a chi-square p-value of 0.00 ($p < 0.05$) [28].

Using PPE, such as masks, is crucial for gas station operators to protect themselves from the risks associated with vehicle emissions and airborne particles while serving customers. Operators are advised to select masks appropriate for their job risks. N95 masks are known to be more effective in reducing exposure to dust particles, including airborne lead. Choosing the right mask can enhance protection effectiveness and comfort while working in high-risk environments like gas stations. Gas station managers are also advised to conduct routine health checks for gas station operators at least once every 6 months to ensure that their health conditions are maintained.

E. THE EFFECT OF SMOKING HABITS ON SUBJECTIVE COMPLAINTS OF GAS STATION OPERATORS

Smoking reduces oxygen levels in the blood, inhibits carbohydrate metabolism, and leads to the accumulation of lactic acid, which affects work fatigue [30]. Smoking habits are also a factor that can increase blood lead (Pb) levels. Both active and passive smokers exposed to cigarette smoke can experience elevated Pb levels in the blood, with effects ranging from 0.017 to 0.98 µg [31].

Data on smoking habits and subjective complaints among gas station operators were analyzed using SPSS with a chi-square test. The statistical analysis yielded a p-value of $1.000 > 0.05$, indicating no significant effect of smoking habits on the subjective complaints experienced by the operators. This finding is consistent with MJ's research, which found no relationship between smoking and hypertension in gas station operators in Aceh Barat, with a p-value of $1 > 0.05$ [32]. The study results indicate that most gas station operators do not smoke, either at work or outside of it. Those who are active smokers during breaks avoid smoking in the workplace due to the risk of fire and explosions from sparks generated by cigarettes.

V. CONCLUSION

The results of the study showed that the length of service and the habit of using PPE affected the subjective complaints of gas station operators. Meanwhile, Pb Air, age, and smoking habits did not affect the subjective complaints of gas station operators. Gas station operators are ≤ 30 years old as many as 19 people (69%), work period > 2 years as many as 15 people (54%), do not use PPE as many as 15 people (54%), and do not smoke as many as 16 people (57%). Measurement of air lead (Pb) showed that the level of lead (Pb) in the air was still below the permitted NAB according to Permenaker No. 5 of 2018.

3. Gas station operators as many as 17 people (61%) experienced subjective complaints with the most common types of complaints being fatigue (61%) and headaches (57%). The chi-square test showed that the length of service and use of PPE had a significant effect on the subjective complaints of gas station operators with a p-value ≤ 0.05. Meanwhile, air lead (Pb), age, and smoking habits did not have a significant effect on subjective complaints of gas station operators with a p-value > 0.05.

Recommendations for management include ensuring that all gas station operators consistently use PPE, such as N95 masks, during work and conducting health checks for operators at least every 6 months. Operators are encouraged to enhance their awareness of mask use, manage their rest periods, and maintain their health by regularly consulting healthcare services..

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