COMPARISON OF BLOOD LEAD LEVELS OF ADOLESCENT CONVENTIONAL SMOKERS AND ELECTRIC SMOKERS IN THE EAST SURABAYA AREA

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Abstract. The smoking habit in society is very high, causing teenagers to be intereted in trying it. The increasing number of smokers every year causes the types of cigarettes consumed and circulated in the community to be more diverse. The various types of cigarettes can be divided into conventional cigarettes and e-cigarettes. Apart from the influence of the environment, the reason teenagers try is the assumption that e-cigarettes are less harmful than conventional cigarettes. In fact, both types of cigarettes contain the same harmful ingredients, one of which is heavy metal lead. Lead that accumulates due to exposure to cigarettes in East Surabaya. The type of research used was a cross-sectional study with a total of 30 blood samples from convetional smokers and e-cigarettes smokers in East Surabaya. This study was conducted at the Surabaya Industrial Research and Standardization Center from October 2022 to May 2023 using the AAS (Atomic Absorption Spectrophotometry) tool with the suitability of ethical number No.EA/1666/KEPK-Poltekkes_Sby/V/2023 issued by the Poltekkes Kemenkes Surabaya. The results showed that the average blood lead level of 16 conventional smokers was 0.127 µg/dL, while the average blood lead level of 14 electric smokers was 0.398 µg/dL.

Keywords: Conventional smoker, Electric Smoker, Lead Levels, AAS (Atomic Absorption Spectrophotometry)

1 INTRODUCTION

Surabaya City has a population of 2.88 million people, according to the 2020 Population Census results. Men account for 49.57% of the total pollution, while women account for 50.43%. Surabaya's dense population carries out activities that contribute to pollution. According to (Agus, B, 2020), air pollution can come from cigarette smoke, industrial smoke, and vehicle fumes. Smoking is a very widespread and common habit (Gregorczyk-Maga et al, 2019). It is actually very difficult to quit smoking, only a small percentage of people realize that smoking is a form of

unhealthy habit (Kartika F, 2013). According to WHO Global Report on Trends in Prevalence of Tobacco Use third edition 2000 – 2025, there will be approximately 24 million (6.5%) adolescents worldwide aged 13 to 15 years who smoke, with 17 million (9%) men and 7 million (4%) women. 57.6 million men and 2.3 million women are estimated to smoke in Indonesia, according to a 2018 WHO report titled Global adult tobacco survey. According to WHO, smoking will increase by 8 million people each year (WHO, 2011). The use of e-cigarettes is considered a new trend in Indonesia. The use of e-cigarettes by active smokers is expected to reduce dependence on conventional cigarettes (Kavousi, M et al, 2021). In recent years e-cigarettes are often used among people in all countries including Indonesia. According to research conducted (Wirsal et al, 2013) identified a number of risk factors, such as smoking habits and gender factors, which can have an impact on blood lead levels. Research conducted by (Ardinya et al, 2019) showed that harmful toxic substances contained in e-cigarette vapor circulating in the air to Ambient air quality are exposed to the body through breathing, having a significant impact on the accumulation of lead in the body. While the results of research on blood lead levels in a person exposed to lead every day by (Niman, 2019) found blood lead levels of 41 µg/dL in active smokers, this indicates that heavy metal lead accumulates in the body due to smoking habits and the body is often exposed to cigarette smoke.

2 METHODS

This study was declared ethically feasible in accordance with WHO 2011 standards referring to the 2016 CIOMS guidelines, with number No. EA/1666/KEPK-Poltekkes_Sby/V/2023 issued by the Poltekkes Kemenkes Surabaya on May 02, 2023 was conducted at the Surabaya Industrial Research and Standardization Center.

This study used a glass jar, tourniquet, syringe, dry cotton, 70% alcohol swab, EDTA tube, erlenmeyer, Whatman No. 41 paper, hot plate, cooling rod, volume pipette, bulp, funnel, plaster, EDTA tube rack, Atomic Absorption Spectophotometry (AAS). The materials used in this study are distilled water, $Pb(NO_3)_2$, HNO_3.

This study uses comparative research with quantitative analysis using a cross-sectional research design that aims to determine differences in lead levels in the blood of adolescent conventional smokers and electric smokers in the East Surabaya area. samples used were 30 samples from the population of conventional smokers and electric smokers in the East Surabaya area. samples were obtained using purposive sampling techniques and criteria including male adolescents aged 18 – 22 years, adolescents who only actively smoke conventional types for more than 1 year, adolescents who only actively smoke electric types for more than 1 year. Atomic Absorption Spectrophotometry (AAS) is a technique for determining lead concentration. The Shapiro Wilk test was combined with the normality test as part of the data analysis technique. Independent sample t-test was used if the data were normally distributed, otherwise Mann-Whitney test was used.

After taking blood, pipette a 2 mL sample and put it in an erlenmeyer. Add 5 mL of HNO3 and give a cooling rod. Place on a hot plate until it smokes with temperatures ranging from 100°C – 200°C. The solution was removed and cooled in the acid

chamber to room temperature. Filter the solution with Whatman filter paper no. 41 in a 100 mL volumetric flask and then add distilled water to the limit mark of the volumetric flask (Harningsih, 2020). Atomic Absorption Spectrophotometry (AAS) calibration curve is made by measuring the standard concentration solution. The calibration curve equation will appear in the computer software. The calibration curve equation is $y = 0.03740x + 0.0203$ and the value of r^2 is 0.9972, with x is the concentration of lead content and y is the absorbance of the sample.

3 RESULT AND DISCUSSION

Data from the study of blood lead levels of adolescents who are conventional smokers and electric smokers in the East Surabaya Region were obtained from the results of interviews, filling out questionnaires and analyzing blood lead concentrations at the Surabaya Industial Service Standardization and Services Center Laboratory using the AAS (Atomic Absorption Spectrophotometry) method. The data obtained are data on the age of smokers, length of smoking, types of cigarettes consumed and the concentration of lead levels in the blood of respondents from the calculation of the linear regression equation $y = ax + b$ obtained from the calibration curve..

Exposure to lead in the body can be diagnosed by conducting a blood lead test. The lead exposure indicator is used as the concentration level of lead in the blood and is related to external exposure. This study used a questionnaire to obtain the characteristics of respondents who fit the criteria of the research subjects, especially based on the type of cigarette consumed by the respondents.

Table 1. Blood Lead Levels of Adolescent Conventional Smokers

No.	Sample Code	Average Level Lead (µg/dL)	Normal Value Level Lead (µg/dL)	Description
1	P1892	0,068	10 - 25	Normal
2	P1893	0,052	10 - 25	Normal
3	P1894	0,055	10 - 25	Normal
4	P1895	0,035	10 - 25	Normal
5	P1896	0,045	10 - 25	Normal
6	P1897	0,056	10 - 25	Normal
7	P1898	0,041	10 - 25	Normal
8	P1899	0,106	10 - 25	Normal
9	P1900	0,129	10 - 25	Normal
10	P1901	0,163	10 - 25	Normal
11	P1925	0,051	10 - 25	Normal
12	P1927	0,019	10 - 25	Normal
13	P1929	0,021	10 - 25	Normal
14	P1932	0,0059	10 - 25	Normal

15	P1933	0,055	10 - 25	Normal
16	P1949	1,34	10 - 25	Normal
	Average Level Lead	0,137		

Table 1 shows that the highest average lead level based on cigarette type in conventional smokers is sample P1949 with a level of 1.34 µg/dL. Meanwhile, the lowest lead level based on cigarette type in conventional smokers was in sample P1932 at 0.0059 µg/dL.

Table 2. Blood Lead Levels of Adolescent Electric Smokers

No.	Sample Code	Average Level Lead (µg/dL)	Normal Value Level Lead (µg/dL)	Description
1	P1922	1,44	10 - 25	Normal
2	P1923	0,916	10 - 25	Normal
3	P1924	1,46	10 - 25	Normal
4	P1926	0,016	10 - 25	Normal
5	P1928	0,209	10 - 25	Normal
6	P1930	0,032	10 - 25	Normal
7	P1931	1,202	10 - 25	Normal
8	P1934	0,109	10 - 25	Normal
9	P1947	0,042	10 - 25	Normal
10	P1948	0,0068	10 - 25	Normal
11	P1950	0,03301	10 - 25	Normal
12	P1951	0,02741	10 - 25	Normal
13	P1952	0,03904	10 - 25	Normal
14	P1953	0,02797	10 - 25	Normal
	Average Level Lead	0,398		

Table 2 shows that the highest average lead level based on the type of cigarette for e-cigarette smorkers is found in sample code P1924 with a lead level of 1,46 µg/dL. While the lowest average lead level based on cigarette type in e-cigarette smokers, sample P1948, was 0.0068 µg/dL.

Table 3. Characteristics of conventional smokers by age and average lead levels

No.	Age	Sample Code	Average Level Lead (µg/dL)
1	20 years old	P1897	0,056
		P1899	0,106
		P1900	0,129
		P1932	0,0059

		P1933	0,055
		P1892	0,068
		P1893	0,052
2	21 years old	P1898	0,041
		P1901	0,163
		P1929	0,021
		P1894	0,055
		P1895	0,035
3	22 years old	P1896	0,045
		P1925	0,051
		P1927	0,019
		P1949	1,34
		Average lead level	0,137

Table 3 shows that the highest average lead level based on age in conventional smokers is blood sample with sample code P1949 with a level of 1.34 µg/dL at the age of 22 years. While the lowest lead level by age in conventional smokers is in blood samples with sample code P1932 with a level of 0.0059 µg/dL at the age of 20 years.

Table 4. Characteristics of Electric Smokers by Age and Average Lead Levels

No.	Age	Sample Code	Average Level Lead (µg/dL)
1	20 years old	P1926	0,016
		P1947	0,042
		P1948	0,0068
		P1951	0,02741
		P1953	0,02797
		P1922	1,44
		P1924	1,46
		P1928	0,209
2	21 years old	P1930	0,032
		P1931	1,202
		P1934	0,109
		P1950	0,03301
		P1952	0,03904
3	22 years old	P1932	0,916
		Average lead level	0,398

Table 4 shows that the highest average lead level in e-cigarette smokers was found in sample P1924 in the age range of 21 years with a lead level of 1.46 µg/dL. While

the lowest average lead level of sample code P1948 was 0.0068 µg/dL in the age range of 20 years.

Table 5. Characteristics of conventional smokers by length of smoking against average lead levels

No.	Leght of Smoking	Sample Code	Average Level Lead (µg/dL)
1	1 - 2 years	P1892	0,068
		P1893	0,052
		P1898	0,041
		P1932	0,0059
		P1933	0,055
		P1894	0,055
		P1895	0,035
		P1897	0,056
2	3 - 5 years	P1899	0,106
		P1900	0,129
		P1901	0,163
		P1927	0,019
		P1929	0,021
		P1949	1,34
3	6 - 8 years	P1896	0,045
		P1925	0,051
		Average lead level	0,137

Table 4.5 shows that the highest average lead level of conventional smokers based on length of smoking was found in sample P1949 at 1.34 µg/dL with a smoking range of 3-5 years. While the lowest average lead level of conventional smokers based on length of smoking within 1-2 years was in sample P1932 at 0.0059 µg/dL.

Table 6. Characteristics of Electric Smokers by Length of Smoking against Average Lead Levels

No.	Lenght of Smoking	Sample Code	Average Level Lead (µg/dL)
1	1 - 2 years	P1923	0,916
		P1926	0,016
		P1928	0,209
		P1930	0,032
		P1931	1,202
		P1934	0,109
		P1947	0,042
		P1948	0,0068

		P1950	0,03301
		P1951	0,02741
		P1952	0,03904
		P1953	0,02797
2	3 - 4 years	P1922	1,44
		P1924	1,46
		Average lead level	0,398

Table 4.6 shows that the highest average lead level of e-cigarette smokers in the range of 3 - 4 years of smoking is sample P1924 with a level of 1.46 µg/dL. While the lowest average lead level of electric smokers in sample P1948 with lead levels of 0.0068 µg/dL in the range of 1-2 years of smoking

Tests of Normality

		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Kelompok	Statistic	df	Sig.	Statistic	df	Sig.
Hasil	Konvesional	0.405	16	0.000	0.382	16	0.000
	Elektrik	0.342	14	0.000	0.675	14	0.000

Fig. 1. Shapiro Wilk Normality Test Results

a. Lilliefors Significance Correction

The results state that the significance value (sig) is 0.000 because the sig value (*p*) <0.05, which concludes that the research data values are not normally distributed or do not meet the normality test requirements.

Ranks

	Kelompok	N	Mean Rank	Sum of Ranks
Hasil	Konvesional	16	16.02	239.50
	Elektrik	14	16.11	225.50
	Total	30		

Test Statistics[a]

	Hasil
Mann-Whitney U	103.500
Wilcoxon W	239.500
Z	-0.353

Asymp. Sig. (2-tailed)	0.0724
Exact Sig. [2*(1-tailed Sig.)]	0.0728[b]

a. Grouping Variable: Kelompok

b. Not corrected for ties.

Fig. 2. Mann-Whitney Test Results

It is known that the sig value generated from the Mann Whitney test is 0.0724. Since the value is greater than α (α = 0.05), it can be concluded that H0 is accepted and H1 is rejected. This means there is no significant difference between blood lead levels in conventional smokers and e-cigarette smokers.

The results of the examination of lead levels in 30 blood samples of conventional smokers and electric smokers resulted in the highest average lead level for conventional smokers of 1.34 µg/dL as shown in table 4.1. Meanwhile, based on table 4.2, the highest average lead level for e-cigarette smokers was 1.46 µg/dL. The results of this study state the presence of lead levels in the blood of smokers who are in line with research conducted (Niman, 2019), it is known that the highest level of lead in the blood of active smokers is 41 µg/dL due to several influencing factors, including irregular sleeping hours, frequent delays in eating due to activities carried out, and lack of appetite. These factors include symptoms and side effects caused by high levels of lead in the body.

Examination on 16 blood samples of conventional smokers based on table 4.3 obtained the highest average lead level by age in conventional smokers is 1.34 µg/dL with the age of 22 years. And the examination of 14 blood samples of electric smorkers based on table 4.4 obtained the highest average lead level in electric smorkers at the age of 21 years with lead levels of 1,46 µg/dL. This is in accordance with research (Eka, B, 2014) stating that age affects driver blood lead levels. Due to the body's inability to neutralize incoming toxins, the concentration of Pb accumulated in a person's tissues increases with age (Ortega, DR et al, 2021).

According to (Adiwijayanti, 2015) there is a significant relationship between blood lead levels and smoking habits, the longer smoking the blood lead levels increase. Based on table 4.5, it is known that the highest average lead level of conventional smokers based on smoking duration is 1.34 µg/dL with a smoking range of 3-5 years. Meanwhile, the highest average lead level based on table 4.6 for electric smokers in the range of 3 - 4 years of smoking is 1.46 µg/dL. There results are in line with research conducted (Dyah Wulandari et al, 2016), starting that people with smoking habits have the potential to be exposed to lead (Pb) in the cigarette it self of 13.391 µg/mL.

An indicator to identify and recognize ongoing exposure in the body can be the examination of blood lead levels. Exposure, absorption, distribution, and excretion can reflect a dynamic reflection of lead concentration in the body (Grant, L.D, 2020). Absorbed lead is then distributed to blood cells, soft tissues and bones. In blood lead is

excreted after 25 days, in tissues lead is excreted after 40 days, and in bones lead is excreted after 25 years (Abadin et al, 2020).

From the data analysis using the Mann-Whitney statistical test, it was concluded that blood lead levels between conventional smokers and electric smokers had an insignificant difference, so that the content of lead metal could be assessed as equal in the blood of conventional smokers and electric smokers. Furthermore, research conducted (Wulandari et al, 2020) said that factors that affect blood lead levels are due to smoking habits, age, gender and genetics. So it can be concluded that blood lead levels in the blood of adolescents who are conventional smokers and electric smokers can be influenced by age, long exposure to smoke, long smoking frequency, gender and environmental influences that cause lead accumulation in the body and endanger health in the future.

4 CONCLUSION AND RECOMMENDATION

1. The average lead level in 16 conventional smokers was 0.137 µg/dL. The highest lead level was 1.34 µg/dL, while the lowest lead level was 0.0059 µg/dL.
2. The average lead level in 14 e-cigarette smokers was 0.398 µg/dL. The highest lead level was 1.46 µg/dL, while the lowest lead level was 0.0068 µg/dL.
3. There was no significant difference between blood lead levels of adolescents smoking conventional cigarettes and e-cigarettes.

The question of what difference there is in the blood lead levels of adolescents who smoke regular cigarettes and those who smoke e-cigarettes is answered by the results and findings of the present study discussed. The findings of the present study on blood lead levels in smokers of conventional and e-cigarettes are expected to contribute to science and serve as a reference for future researchers. Future studies should investigate the concentration of heavy metals such as cadmium, nickel, and arsenic in the blood samples of conventional and e-cigarette smokers by adding variables that may affect the concentration of heavy metals in the body.

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