The Risk of Sulfur Dioxide Exposure to The Incidence of Hypertension on Street Sweepers In Samarinda City (Tropical Rain-Forest Area)

by Ayudhia Rachmawati

Submission date: 04-Jun-2025 08:17AM (UTC+0700)
Submission ID: 2691668322
File name: 68159-241356-2-ED.docx (404.84K)
Word count: 4536
Character count: 26272

The Risk of Sulfur Dioxide Exposure to The Incidence of Hypertension on Street Sweepers In Samarinda City (Tropical Rain-Forest Area)

Ayudhia Rachmawati[1*], Erri Larene Safika[2], Syamsir Syamsir[1]

[1] Department of Environmental Health, Faculty of Public Health, Mulawarman University, Samarinda, Indonesia

[2] Department of Nutrition, Faculty of Public Health, Mulawarman University, Samarinda, Indonesia

[*]Corresponding author: rachmawatiayudhia@fkm.unmul.ac.id

*Info Artikel:Diterima ..bulan…20XX ; Disetujui ...bulan .... 20XX ; Publikasi ...bulan ..20XX *tidak perlu diisi*

ABSTRAK

Latar belakang: Emisi gas buang kendaraan bermotor merupakan sumber pencemaran udara yang paling signifikan, terutama di wilayah perkotaan. SO_2 merupakan salah satu polutan yang dihasilkan oleh emisi gas buang kendaraan bermotor. Kota Samarinda terkenal dengan pesatnya peningkatan jumlah kendaraan pribadi, terutama kendaraan berbahan bakar fosil, yang berpotensi meningkatkan konsentrasi SO_2 dan dapat berdampak pada kesehatan. Penelitian ini bertujuan untuk mengetahui risiko paparan konsentrasi SO_2 pada penyapu jalan dan hubungan antara kejadian hipertensi dengan asupan SO_2.

Metode: Penelitian ini menggunakan pendekatan penilaian risiko kesehatan lingkungan. Pendekatan EHRA akan memperkirakan risiko yang diterima oleh penyapu jalan akibat paparan SO_2 di jalan raya Kota Samarinda. Populasi dalam penelitian ini mencakup seluruh pekerja penyapu jalan yang bertugas pada empat lokasi jalan raya yang telah ditentukan. Sampel penelitian berjumlah 61 orang dan diperoleh melalui teknik total sampling. Teknik pengukuran konsentrasi SO_2 menggunakan impinger dengan analisis spektrofotometer. Tekanan darah diukur secara *real-time*. Uji chi-square digunakan untuk menunjukkan perbedaan proporsi antara variabel asupan dan hipertensi.

Hasil: Konsentrasi SO_2 masih di bawah batas baku mutu lingkungan yang dipersyaratkan (< 150 $\mu g/Nm^3$) yakni 18,18 $\mu g/Nm^3$. Hasil uji chi-square menunjukkan tidak ada perbedaan proporsi kejadian hipertensi dengan asupan SO_2 (nilai p = 1.000). Akan tetapi, pekerja dengan asupan SO_2 >0,0012 mg/kg/hari memiliki peluang lebih besar untuk mengalami hipertensi dibandingkan penyapu jalan dengan asupan >0,0012 mg/kg/hari (OR = 1,111).

Simpulan: Kualitas udara di jalan raya Kota Samarinda masih tergolong aman dan sehat, terutama pada parameter sulfur dioksida. Petugas penyapu jalan tidak berisiko mengalami gangguan kesehatan khususnya kejadian hipertensi.

Kata kunci: SO_2; EHRA; Transportasi; Penyapu Jalan; Hipertensi

ABSTRACT

Title: The Risk of Sulfur Dioxide Exposure to The Incidence of Hypertension on Street Sweepers In Samarinda City (Tropical Rain-Forest Area)

Background: *Vehicle exhaust emissions are the most significant source of air pollution, especially in urban areas. SO_2 is one of the pollutants produced by car exhaust emissions. Samarinda City is famous for the rapidly increasing number of private vehicles, especially fossil fuel vehicles, which have the potential to increase SO_2 concentrations and can have an impact on health. This study aims to determine the risk of exposure to SO_2 concentrations among street sweepers and the relationship between the incidence of hypertension and SO_2 intake.*

Method: *This study used an environmental health risk assessment approach. The EHRA approach will estimate the risk received by street sweepers due to exposure to SO_2 on Samarinda City highways. This study's population consists of all street sweepers working at four specified roadway location. The sample, comprising 61 participants, was obtained using a to tal sampling technique. The SO_2 concentration measurement technique uses an impinger with spectrophotometer analysis. Blood pressure is measured in real-time. The chi-square test was used to show differences in proportions between intake and hypertension variables.*

Result: *The SO_2 concentration is still below the required environmental quality standard limit (< 150 $\mu g/Nm^3$) measured at 18.18 $\mu g/Nm^3$. The results of the chi-square test showed no difference in the proportion of hypertension incidents with SO_2 intake (p-value = 1,000). However, workers with SO_2 intake >0.0012 mg/kg/day have a greater chance of developing hypertension than street sweepers with an intake of >0.0012 mg/kg/day (OR = 1.111).*

Conclusion: *The air quality in Samarinda City's highways is categorized as still safe and healthy, especially in the sulfur dioxide parameter. Street sweepers are not at risk of experiencing health problems.*

Keywords: SO_2; EHRA; Transportation; Street Sweepers; Hypertention

BACKGROUND

Population growth has an impact on increasing the need for the availability of transportation to support their activities, mainly in urban areas. The produced vehicle emissions contribute greatly to environmental pollution and have the potential to cause a greenhouse effect.[1] Apart from the use of transportations, air pollution can also be triggered by industrial development.[2] Air pollution is defined as a condition where air quality deteriorates due to the entry of various elements, such as particles, gases and organic atoms, causing damage to the ozone layer and even global warming. Both natural and human activities can cause air pollution.[3]

Some studies explained that the transportation sector dominates air pollution, especially in metropolitan areas.[4] According to the emissions inventory of the Ministry of Environment and Forestry of the Republic of Indonesia, the transportation sector contributes 70%-80% of the total pollutant load in metropolitan areas.[5] The continued use of fossil raw materials as vehicle fuel, the increasing number of vehicles due to increasingly rapid population growth, office activities, a centralized economy which has an impact on urban traffic patterns, and other factors all contribute to air pollution from vehicle exhaust emissions.[6] Lead (Pb), Suspended Particulate Matter (SPM), Nitrogen oxides (NO_x), Sulfur oxides (SO_x), Hydrocarbons (HC), Carbon monoxide (CO), and Photochemical oxidants (O_x) are among the pollutants inhaled from exhaust fumes car.[6,7]

Sulfur dioxide is a colorless gas with a strong odor that is easily soluble in water.[8] The health effects of this SO_2 molecule include irritation of the eyes, mucous membranes, skin, and respiratory tract. Even at low concentrations, inhaling SO_2 can cause chronic lung disorders as asthma and emphysema.[9] Essentially, the association between air pollution and the frequency of respiratory tract illnesses is very close. In a study conducted in Changsha, China, it was discovered that short-term exposure to SO_2 at low concentrations increased the daily risk of ischemic heart disease and increased the chance of death in women.[10] Apart from having an impact on respiratory disorders, environmental ecology studies have proven that PM_{10}, $PM_{2.5}$, and SO_2 can increase cardiovascular risk. This is based on atherosclerosis and an increase in blood pressure due to exposure to the surrounding environment.[11]

Based on data from the Samarinda City Environmental Service, the concentration of sulfur dioxide (SO_2) in 2022 will still be below the required ambient air quality level (150 $\mu g/Nm^3$). However, Central Bureau of Statistics in the city estimated that the East Kalimantan Province region will have a population gap in 2022. The district area which covered around 98.91% of the province is inhabited by 53.85% of the total population. Meanwhile, the other 45.99% of the population lives in urban areas which area is only 1.09%. This creates population density in urban areas, such as Samarinda City which is the city with the second highest population density in East Kalimantan Province, namely 1,160 people per km^2.[12] Due to increasing traffic in mobility modes and an ever-increasing population, there is a high potential for air pollution. People who live on the side of highways, have high intensity and mobility on highways, and work near highways such as street sweepers, are all at risk of experiencing health problems, especially air pollution, as a result.[12] Therefore, this study focuses on characterizing the risk of SO_2 in street sweepers in Samarinda City which can be used as an example of the risk of poor air quality in urban areas, on public health or certain communities, which is associated with the incidence of hypertension cases. This study also explain the characteristics of tropical rainforest areas that influence the air quality in Samarinda City.

MATERIAL AND METHODS

This research used a quantitative approach to environmental health risk assessment (EHRA), which includes hazard identification, dose-response assessment, exposure assessment, and risk characterization.[13,14] The EHRA approach will estimate the risk received by street sweepers as a result of SO_2 exposure on Samarinda City highways. This research was carried out at four highway points in Samarinda City, precisely located at the intersection of Lembuswana (Point 1), Jalan Juanda (Point 2), Jalan MT Haryono (Point 3), and Jalan Gadjah Mada (Point 4), Samarinda City, East Kalimantan. The distance between each point: Point 1 to Point 2 is 1 km, Point 2 to point 3 is 2.2 km, and point 3 to point 4 is 3.6 km. The air quality measurement point was chosen at the city center intersection because this location is an area with high levels of congestion, dense traffic activity, and

has great potential for air pollution, so it is representative for describing air quality conditions in urban areas. This research was carried out from August to November 2023.

Total sampling was used, yet the provision of the research inclusion criteria was determined. The subjects of this study were workers selected based on inclusion criteria who had worked as street sweepers for at least one year, as measured through interviews using a questionnaire sheet. Meanwhile, for the variable incidence of hypertension in street sweepers, real-time blood pressure was measured with a digital tensimeter. Blood pressure was measured during break times, following a 10-minute resting period to ensure physiological stabilization. It was measured twice (one repetition), ensuring that the respondent remained still and did not speak during the measurement.

The ambient air sampling locations chosen in sample selection was based on the following criteria: there were no compounds that produce SO_2, had has a dense vehicle intensity, and were is not blocked by buildings and trees. The SO_2 concentration measurement technique used an impinger with spectrophotometer analysis, which measured for 1 hour at each location point. The ambient air was measured in the morning (9 to10 am) and afternoon (1 to 2 pm). The collected data were then be substituted and analyzed to obtain intake values and risk levels (RQ) using the following equation[13,15,16]

$$Ink = \frac{C \times R \times tE \times fE \times Dt}{Wb \times tavg} \quad \text{.....(1)}$$

Information :
Ink: SO_2 Intake (mg/kg/day)
C: SO_2 concentration (mg/m^3)
R : Inhalation Rate (0.83 m^3/hour)
t_E: Time of Exposure (hours/day)
f_E: Frequency of Exposure (hours/year)
Dt: Duration of Exposure (real time, 30 years for lifetime years)
Wb: Body weight (kg)
tavg : Average time period (Dt x 365 days/year for non-carcinogenic substances) (days)

To determine the amount of risk (RQ) a formula equation is used, as follows: :

$$RQ = \frac{I_{nk}}{Rfc} \text{ ... ...} \quad (2)$$

Information :
RQ: Risk Quotient
Ink: SO_2 Intake (mg/kg/day)
Rfc: SO_2 reference concentration (mg/kg/day) (default : 2.6E-2 EPA/NAAQS 1990)

By calculating the risk quotient formula, the calculation results are obtained in the form of risk characteristics (RQ > 1 and RQ ≤ 1). If RQ > 1, it can be concluded that the SO_2 concentration in the ambient air of Samarinda City is at risk of causing health problems (non-carcinogenic), and vice versa. The chi-square test was used to show whether there is a difference in proportion between intake and hypertension variables (p-value). The OR (odds ratio) value is used to determine the degree or strength of the relationship between the variables studied.

RESULTS AND DISCUSSION

Sulfur Dioxide (SO_2) Concentration and Meteorological Factors

The measurement time is based on consideration of the operational work schedule of street sweepers. The description of the SO_2 concentration in the ambient air in the highway area of Samarinda City can be seen in Table 1 as follows:

Table 1 Description of SO_2 Concentration in Samarinda City

No.	Location	Time	Concentration		Air Quality Standard (µg/Nm^3)(2)
			µg/Nm^3	mg/m$^{3(1)}$	
1.	Point 1	Morning	7.22	0.007	150
		Afternoon	36.41	0.036	
2.	Point 2	Morning	9.03	0.009	
		Afternoon	26.17	0.026	

3.	Point 3	Morning	18.18	0.018
		Afternoon	15.93	0.016
4.	Point 4	Morning	18.67	0.019
		Afternoon	12.53	0.013

(1) SO_2 concentration is converted to mg/m^3 to calculate intake of SO_2
(2) Quality standards refer to Republic of Indonesia Government Regulation no. 22/ 2021 concerning Environmental Administration and Management.

Based on Table 1, the measured concentration of SO_2 at all sampling points remain below the environmental quality standards of 150 μg/Nm^3, as stipulated in Government Regulation No. 22/2021 concerning Environmental Management and Protection. Apart from measuring SO_2 concentration, meteorological factors were also measured, including temperature, humidity, and wind speed. Regional factors also influence SO_2 concentration levels, where East Kalimantan is included in the tropical rain forest. These conditions cause East Kalimantan to have relatively high air humidity, and rainfall, where the differences between seasons are not very visible. Apart from that, tropical rain forest has a humid climate or weather with high levels of evaporation[17] The distribution of SO_2 concentrations and meteorological factors can be seen in Table 2 as follows:

Table 2 Description of SO_2 Concentration and Meteorological Factors

Variable	Mean	Median	Min-Maks	SD	Kolmogorov-Smirnov
SO_2 Concentration (mg/m^3)	0.018	0.017	0.007 – 0.036	0.009	0.200
Meteorological Factors					
Temperature (^{0}C)	35.93	35.75	33.40 – 38.60	1.65	0.200
Humidity (%)	48.44	46.25	39.0 – 58.0	6.47	0.183
Wind Speed (m/s)	1.25	1.23	0.75 – 1,69	0.32	0.200

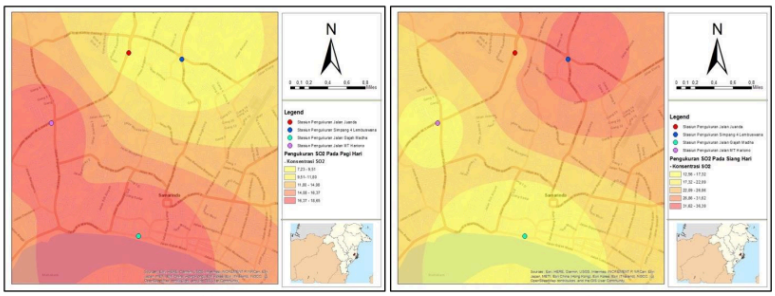
Based on Table 2, the average SO_2 concentration measurement results were 0.018 mg/m^3, with the lowest concentration being 0.007 mg/m^3 and the highest being 0.036 mg/m^3. The results of meteorological measurements showed that the average temperature was 35.93^{0}C, the average humidity was 48.44%, and the average wind speed was 1.25 m/s. SO_2 concentration can be influenced by humidity, wind speed, and temperature. The temperature factor can influence SO_2 concentrations much more effectively in the summer than in other seasons[18] Meteorological conditions (temperature, relative humidity, and wind speed) also influence the concentration of air pollutants in China[19] Additionally, analysis results in Erzurum, Turkey, show that higher TSP and SO_2 concentrations are strongly associated with cooler temperatures, lower wind speeds, higher pressure systems, lower precipitation, and higher relative humidity[20] However, there is research that shows a negative correlation between SO_2 concentration and meteorological factors consisting of temperature, rainfall, and wind speed[21]

Spatial analysis

In determining the distribution of SO_2 pollutant concentrations around the measuring station, interpolation analysis using the Inverse Distance Weighted (IDW) method was used. The SO_2 distribution pattern was detected based on the SO_2 concentration values from the four SO_2 measuring stations. With the help of the ArcGIS Map application, the SO_2 distribution pattern is displayed in Figure 1.

Figure 1(a) shows that the highest concentration of SO_2 pollutant in the morning is around the measuring station on Jalan Gadjah Mada and Jalan MT Haryono. Ambient air measurements in the morning (Central Indonesia Time, WITA) were conducted at the following times: Point-1 at 09:40, Point-2 at 11:10, Point-3 at 09:20, and Point-4 at 10:50. The SO_2 concentration value around the measuring station was 16.37 μg/Nm^3 to 18.65 μg/Nm^3. In contrast to the measuring stations on Jalan Gadjah Mada and Jalan MT Haryono, the SO_2 concentration values around the measuring stations on Jalan Juanda and the Lembuswana intersection in the morning were in the range of 7.23 – 9.51 μg/Nm^3. The value was quite low when compared to the delivery stations on Jalan Gadjah Mada and Jalan MT Haryono.

Figure 1 (b) shows that the highest concentrations of SO_2 pollutant during afternoon are around Jalan Juanda. measuring station and the Lembuswana intersection. Ambient air measurements in the afternoon (Central Indonesia Time, WITA) were conducted at the following times: Point-1 at 14:15, Point-2 at 13:00, Point-3 at 14:18, and Point-4 at 13:15. The SO_2 concentration around the Lembuswana intersection had a higher value compared to the other three measurement stations. The value was in the range of 31.62 μg/Nm^3 to 36.39 μg/Nm^3. Meanwhile, at the measurement station on Jalan MT Haryono, the concentration value was in the range of 22.09 – 26.66 μg/Nm^3.



(a) (b)

Figure 1. Distribution of Sulfur Dioxide Concentrations in Four Locations in Samarinda City: (**a**) morning measurements (**b**) afternoon measurements.

Apart from that, measurement stations on Jalan Gadjah Mada and Jalan MT Haryono during the afternoon were in the range of 12.56 – 17.32 μg/Nm^3. The distribution of pollutant concentrations is also influenced by traffic density, where the higher the level of traffic density, the higher the pollutant concentration. The measurement conditions in areas near rivers will also have an impact on the level of pollutant concentration which is influenced by wind speed[22] The difference in SO_2 concentration between morning and afternoon might be caused by the weather conditions at the time of measurement. Other studies have stated that there was no significant difference in SO_2 concentration compared to the measurement time as the SO_2 concentration was much higher in the morning[23] This also occurred in the study we conducted, where higher concentrations were detected at two time points in the morning.

Anthropometrics and Activity Patterns

Before estimating the street sweeper's exposure intake, anthropometric calculations in the form of body weight and activity patterns in the form of exposure time, exposure frequency, and exposure duration must be completed. Data related to anthropometry and activity patterns are factors that will influence the intake of street sweepers who work in areas that have a high potential for air pollution from modes of transportation. The anthropometric distribution and activity patterns of street sweepers can be seen in Table 3 as follows :

Table 3 Anthropometric Distribution and Activity Patterns of Street Sweepers in Samarinda City

Variable	Mean	Median	Modus	Min-Maks	SD	Kolmogorov-Smirnov
Anthropometric						
Body Weight	64.80	63.40	67.80	40.3 – 94.1	11.09	0.065
Activity Patterns						
Time of Exposure	5.52	5	5	3 – 7	0.89	< 0.001
Frequency of Exp.	363.03	365	365	317 – 365	8.25	< 0.001
Duration of Exp.	10.06	10	10	1.5 – 30	6.16	< 0.001

Based on Table 3, the average body weight of street sweepers in Samarinda City was 64.80 kg, the average time of exposure was 6 hours with an exposure frequency of 363 days/year, and the average duration of work as a street sweeper was 10 years. Body weight is a variable used in calculating pollutant intake values because body weight is a divisor in the ratio of exposure values. The greater the body weight of each individual, the smaller the intake value received. This condition will also affect the respiratory intake rate of each individual, where body weight will affect the vital capacity of the lungs, which is related to the elasticity of the chest cavity walls[24] The amount of exposure to particles or gases is influenced by various variables, including exposure time or working time. The longer the working time, the more gas is inhaled into the worker's body. The long-term impact that can occur is the greater potential risk of health problems occurring.[25]

Intake and Risk Characteristics

Intake of SO_2 for street sweepers who were respondents in this study was obtained based on SO_2 intake calculations based on a formula determined. Based on Table 4, it was found that 61 street sweeping workers in

Samarinda City had an average SO_2 intake of 0.0012 mg/kg/day with the lowest intake being 0.0003 mg/kg/day and the highest being 0.0029 mg/kg/day. Previous studies have shown that 74.5% of ceramic workers in Prered, Indonesia may experience respiratory disease symptoms when SO_2 intake exceeds 0.0126 mg/kg/day.[26] Meanwhile, in this study the average SO_2 intake was 0.0012 mg/kg/day, which is still low enough to cause health problems. However, further examination efforts are still needed to determine the specifics of the health problems experienced.

Table 4 Distribution of SO_2 Intake and risk characteristics of Street Sweepers in Samarinda City

Variabel	n	Mean	Median	Min-Maks	SD	Kolmogorov -Smirnov
Intake SO_2 (mg/kg/day)	61	0.0012	0.0011	0.0003 – 0.0029	0.00065	0.059
Risk Characteristics (RQ)	61	0.0524	0.0420	0.012-0.400	0.0517	<0.001

Based on Table 4, the results of calculating the level of risk characteristics in street sweepers with an average of 0.0524 (RQ<1) and categorized as this condition illustrate that all street sweeping workers who were respondents are included in the group not at risk or safe from Sulfur dioxide (SO_2) exposure. Although the level of SO_2 risk characteristics of road sweepers is still considerable safe, the RQ lifespan varies from 5 to 30 years and requires further calculations. In that period, the risk of SO_2 exposure of road sweepers increases and can lead to health problems.

Relationship Between Intake of SO_2 and Hypertention Among Street Sweepers

Table 5 shows an analysis of the relationship between SO_2 intake and the incidence of hypertension in street sweeper workers, taking anthropometric characteristics (body weight) and activity patterns (length of exposure, frequency of exposure, and duration of exposure) into considered. The results of the analysis of the relationship between SO_2 intake and the incidence of hypertension. It was found that 18 (69.2%) street sweeping workers with SO_2 intake >0.0012 mg/kg/day experienced hypertension. Meanwhile, there were 25 (71.4%) workers with an SO_2 intake of ≤0.0012 mg/kg/day who experienced hypertension. The results of the chi-square test obtained a value of p = 1.000, so it can be concluded that there was no difference in the proportion of hypertension incidents with SO_2 intake. The results of the analysis obtained a value of OR = 1.111 (OR > 1), which means that workers with SO_2 intake >0.0012 mg/kg/day have a chance of developing hypertension 1.111 times greater than street sweeper workers with an intake of ≤0.0012 mg/kg/day.

Table 5. Distribution of Street Sweepers According to SO_2 Intake and Hypertension Incidence

SO_2 Intake (mg/kg/day)	Hypertension Incidence				Total		OR (95%CI)	p-value
	No		Yes					
	n	%	n	%	n	%		
>0.0012	8	30.8	18	69.2	26	100.0	1.111 (0.4-3.37)	1.000
≤0.0012	10	28.6	25	71.4	35	100.0		
Total	18	29.5	43	70.5	61	100.0		

Based on the analysis of the relationship between SO_2 intake and the incidence of hypertension, it was found that there was no relationship between SO_2 pollutant and the incidence of hypertension in street sweeper workers in Samarinda City. This is in line with an ecological study conducted in East Java, which stated that there was no relationship between SO_2 and NO_2 on the number of hypertension cases in short-term exposure[27] Meanwhile, a cohort study stated that an increase in SO_2 concentration of 10 $\mu g/m^3$ was associated with a 76% higher risk of hypertension (hazard ratio: 1.76; 95% CI: 1.163 -1.189)[28] The high incidence of hypertension in workers is possibly due to other factors. Previous research shows that there was a relationship between the incidence of hypertension and smoking habits in terms of smoking age, duration of smoking and type of cigarette[29] Apart from that, excessive intake of saturated fatty acids and trans fatty acids as well as high consumption of salt and sugar can trigger hypertension[30]

CONCLUSION

The research concluded that the concentration of Sulfur dioxide (SO_2) is still below the ambient air quality standard (<150 $\mu g/m^3$) in the ambient air of Samarinda City, East Kalimantan. The average exposure time for workers is 5 hours/day; The frequency of exposure is 365 days and the duration of exposure is 10 years.

Meanwhile, the average body weight of a street sweeper is 64.8 kg. Meanwhile, the average SO_2 intake of street sweepers in Samarinda City is 0.0012 mg/kg/day with an average of 0.0524 (RQ≤1). So it can be concluded that street sweepers are still in a safe condition (not at risk) from exposure to SO_2 in Samarinda City. Apart from that, this study stated that there was no relationship between the incidence of hypertension in street sweepers and sulfur dioxide intake. However, higher intake levels have the potential to cause hypertension.

REFERENCES

1. Li S, Xing J, Yang L, Zhang F. Transportation and the Environment in Developing Countries. Annu Rev Resour Econ 2020:389–409. https://doi.org/10.1146/annurev-resource-103119.
2. Munsif R, Zubair M, Aziz A, Zafar M. Industrial Air Emission Pollution: Potential Sources and Sustainable Mitigation, 2021. https://doi.org/10.5772/intechopen.93104.
3. Singh Sarla G. Air pollution: Health effects. Revista Medicina Legal De Costa Rica 2020;37:33–8. Available at: https://www.scielo.sa.cr/pdf/mlcr/v37n1/2215-5287-mlcr-37-01-33.pdf
4. Colvile RN, Warren RF, Mindell J, Hutchinson E. The Transport Sector as a Source of Air Pollution. Atmospheric Environment, 35 (9) Pp 1537-1565 ISSN 13522310 2001;35. https://doi.org/10.1016/S1352-2310(00)00551-3.
5. Suryani AS. Polusi Udara di Wilayah Perkotaan Indonesia. Jakarta: 2022.
6. Ismiyati, Marlita D, Saidah D. Pencemaran Udara Akibat Emisi Gas Buang Kendaraan Bermotor. Jurnal Manajemen Transportasi & Logistik (JMTransLog) 2014;01:241–8. http://dx.doi.org/10.54324/j.mtl.v1i3.23
7. WHO. Ambient (Outdoor) Air Pollution 2024. Available at: https://www.who.int/news-room/fact-sheets/detail/ambient-(outdoor)-air-quality-and-health
8. Agency for Toxic Substances and Disease Registry (ATSDR). ToxFAQs : Sulfur Dioxide. Atlanta, Georgia: 1999. Available at: https://www.atsdr.cdc.gov/toxfaqs/tfacts116.pdf
9. Agency for Toxic Substances and Disease Registry (ATSDR). Sulfur Dioxide (SO2). CAS 7446-0. Atlanta, Georgia: U.S. Department of Health and Human Services; 2014.
10. Xu Z, Xiong L, Jin D, Tan J. Association between short-term exposure to sulfur dioxide and carbon monoxide and ischemic heart disease and non-accidental death in Changsha city, China. PLoS One 2021;16. https://doi.org/10.1371/journal.pone.0251108.
11. Kowalska M, Krzych Ł. The impact of particulate matter and sulphur dioxide on blood pressure — current knowledge. Nadciśnienie Tętnicze 2007;11:435–42. Available at: https://journals.viamedica.pl/arterial_hypertension/article/view/12469
12. Kurnia Izzati C, Noerjoedianto D, Astuti Siregar Program Studi Ilmu Kesehatan Masyarakat Universitas Jambi S. Analisis Risiko Kesehatan Lingkungan Paparan Nitrogen Dioksida (NO2) Pada Penyapu Jalan di Kota Jambi Tahun 2021. vol. 5. 2021. https://doi.org/10.22437/jkmj.v5i2.14032
13. Louvar JF, Louvar BD. Health and environmental risk analysis : fundamentals with applications. Prentice Hall; 1998.
14. APHC. Environmental Human Health Risk Assessment Toxicity Values. 2020.
15. US EPA. Risk Assessment Guidance for Superfund Volume I Human Health Evaluation Manual (Part A). 1989.
16. Direktorat Jenderal PP dan PL Kementerian Kesehatan. Pedoman Analisis Risiko Kesehatan Lingkungan (ARKL). Jakarta: 2012.

17. Lambang O, Herliani S, Haryanto SZ. Literasi Hutan Tropis Lembab Dan Lingkungannya. 2019.

18. Jayamurugan R, Kumaravel B, Palanivelraja S, Chockalingam MP. Influence of Temperature, Relative Humidity and Seasonal Variability on Ambient Air Quality in a Coastal Urban Area. International Journal of Atmospheric Sciences 2013;2013:1–7. https://doi.org/10.1155/2013/264046.

19. Liu Y, Zhou Y, Lu J. Exploring the relationship between air pollution and meteorological conditions in China under environmental governance. Sci Rep 2020;10. https://doi.org/10.1038/s41598-020-71338-7.

20. Turalioğlu ST. An assessment on variation of sulphur dioxide and particulate matter in Erzurum (Turkey). Environ Monit Assess 2005 May;104(1-3):119-30 2005;104:1–3. https://doi.org/10.1007/s10661-005-1607-7.

21. Wang Q, Li X. Correlation Analysis between Meteorological Factors and Pollutants Based on Copula Theory. J Phys Conf Ser, vol. 2168, IOP Publishing Ltd; 2022. https://doi.org/10.1088/1742-6596/2168/1/012028.

22. Jereb B, Gajšek B, Šipek G, Kovše Š, Obrecht M. Traffic density-related black carbon distribution: Impact of wind in a basin town. Int J Environ Res Public Health 2021;18. https://doi.org/10.3390/ijerph18126490.

23. Adeyanju AA, Manohar K. Effects of Vehicular Emission on Environmental Pollution in Lagos. Sci-Afric Journal of Scientific Issues, Research and Essays 2017;5:34–51.

24. Ihsan IM, Oktivia R, Anjani R, Zahroh NF. Health risk assessment of PM2.5and PM10in KST BJ Habibie, South Tangerang, Indonesia. IOP Conf Ser Earth Environ Sci, vol. 1201, Institute of Physics; 2023. https://doi.org/10.1088/1755-1315/1201/1/012033.

25. Nurhisanah S, Hasyim H. Environmental health risk assessment of sulfur dioxide (SO2) at workers around in combined cycle power plant (CCPP). Heliyon 2022;8. https://doi.org/10.1016/j.heliyon.2022.e09388.

26. Ayudhia Rachmawati, Haryoto Kusnoputranto, Bambang Wispriyono. Intake of Sulfur Dioxide (SO2) Exposure to the Symptoms of Respiratory Impairment in Ceramics Industry Plered, Indonesia. Indian J Public Health Res Dev 2020;11:1863–8. https://doi.org/10.37506/ijphrd.v11i3.2191.

27. Firdausi SA, Azizah R, Jalaludin J, Zakaria ZA. Association of short-term exposure to sulphur dioxide and nitrogen dioxide with number of hypertensions in East Java, Indonesia. IOP Conf Ser Earth Environ Sci, vol. 1013, Institute of Physics; 2022. https://doi.org/10.1088/1755-1315/1013/1/012009.

28. Yan M, Li C, Zhang L, Chen X, Yang X, Shan A, et al. Association between long-term exposure to Sulfur dioxide pollution and hypertension incidence in northern China: a 12-year cohort study. Environmental Science and Pollution Research 2020;27. https://doi.org/10.1007/s11356-020-08572-z.

29. Farid M, Lusno D, Haksama S, Wulandari A, Sriram S, Shedysni SN, et al. Association between smoking and hypertension as a disease burden in Sidoarjo: a case-control study. International Journal of Applied Biology 2020; 4(2).

30. WHO. Diet, nutrition and hypertension. Geneva: 2013.

The Risk of Sulfur Dioxide Exposure to The Incidence of Hypertension on Street Sweepers In Samarinda City (Tropical Rain-Forest Area)

ORIGINALITY REPORT

22%	17%	12%	8%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	repository.poltekeskupang.ac.id Internet Source	3%
2	Submitted to Universitas Diponegoro Student Paper	2%
3	I M Ihsan, R Oktivia, R Anjani, N F Zahroh. " Health risk assessment of PM and PM in KST BJ Habibie, South Tangerang, Indonesia ", IOP Conference Series: Earth and Environmental Science, 2023 Publication	2%
4	www.researchgate.net Internet Source	1%
5	www.mdpi.com Internet Source	1%
6	pmc.ncbi.nlm.nih.gov Internet Source	1%
7	fikes.uima.ac.id Internet Source	1%
8	Azwaldi Azwaldi, Ismar Agustin. "The Determinant Factors of Nurse Compliance in the Use of Personal Protective Equipment (PPE)", JOSING: Journal of Nursing and Health, 2022 Publication	1%

9	Shofi Nurhisanah, Hamzah Hasyim. "Environmental health risk assessment of sulfur dioxide (SO2) at workers around in combined cycle power plant (CCPP)", Heliyon, 2022 Publication	1 %
10	journal.unpak.ac.id Internet Source	1 %
11	Submitted to UIN Sunan Ampel Surabaya Student Paper	1 %
12	repository.unipa.ac.id Internet Source	1 %
13	sjii.indexedresearch.org Internet Source	1 %
14	docplayer.info Internet Source	1 %
15	medicopublication.com Internet Source	1 %
16	repo-dosen.ulm.ac.id Internet Source	<1 %
17	Submitted to Universitas Negeri Surabaya Student Paper	<1 %
18	psasir.upm.edu.my Internet Source	<1 %
19	journal.fkm.ui.ac.id Internet Source	<1 %
20	Submitted to Republic Polytechnic Student Paper	<1 %
21	Submitted to Universitas Respati Indonesia Student Paper	<1 %

22	Qonita Rizqina Firdaus, Dini Arista Putri, Elvi Sunarsih, Rafika Oktivaningrum. "Impact of Risks Due to Exposure to Hydrogen Sulfide (H2S) on Communities Around the Medang Prabumulih River TPA", JURNAL KESEHATAN LINGKUNGAN: Jurnal dan Aplikasi Teknik Kesehatan Lingkungan, 2023 Publication	<1 %
23	scholar.unair.ac.id Internet Source	<1 %
24	ejurnal.ung.ac.id Internet Source	<1 %
25	link.springer.com Internet Source	<1 %
26	Nazahah Hunafa, Rachmaniyah Rachmaniyah, Rusmiati Rusmiati, Khambali Khambali. "Environmental Health Risk Assessment of Carbon Monoxide Exposure for Security Guards and Ticketing Officers at Safe N Lock Sidoarjo", International Journal of Advanced Health Science and Technology, 2025 Publication	<1 %
27	Submitted to Universitas Indonesia Student Paper	<1 %
28	Musfirah Musfirah, Ahmad Faizal Rangkuti, Isana Arum Primasari, Ichtiarini Nurullita Santri et al. "Environmental Health Risk Analysis of Sulfur Dioxide (SO2) Inhalation Exposure in Ambient Air Among the Tirtonirmolo Community, Bantul.", JURNAL KESEHATAN LINGKUNGAN, 2024 Publication	<1 %
29	assets-eu.researchsquare.com Internet Source	<1 %

30	journals.plos.org Internet Source	<1 %
31	oamjms.eu Internet Source	<1 %
32	www.blhkotabengkulu.web.id Internet Source	<1 %
33	www.frontiersin.org Internet Source	<1 %
34	Balqis Ufairah Rioza, Yudhie Tanta, Eka Febri Zulissetiana. "THE RELATIONSHIP BETWEEN AIR POLLUTION AND CORONARY ARTERY DISEASE: A SYSTEMATIC REVIEW", Jurnal Kedokteran dan Kesehatan : Publikasi Ilmiah Fakultas Kedokteran Universitas Sriwijaya, 2024 Publication	<1 %
35	Jakub Federla, Jana Korytárová. "Including Carbon Dioxide and Sulphur Dioxide Production in the Lifetime Costs of Buildings", Procedia Computer Science, 2024 Publication	<1 %
36	Reni Suhelmi, Hansen Hansen, Ramadhani Putri Nurislam. "Health Risks of Exposure to Cadmium in Tila Fish in The Community of Kerta Buana Village, Kutai Kartanegara District", JURNAL KESEHATAN LINGKUNGAN: Jurnal dan Aplikasi Teknik Kesehatan Lingkungan, 2023 Publication	<1 %
37	Xuerui Bai, Hongying Qu, Zebing Ye, Ruoting Wang, Guanhao He, Zhongguo Huang, Zhiying Jiang, Changfa Zhang, Shuai Li, Guowei Li. "Relationship between short-term exposure to sulfur dioxide and emergency ambulance	<1 %

dispatches due to cardiovascular disease",
Environmental Epidemiology, 2024
Publication

38	ebin.pub Internet Source	<1 %
39	journal.stikesmahardika.ac.id Internet Source	<1 %
40	minio.umkt.ac.id Internet Source	<1 %
41	repositori.uin-alauddin.ac.id Internet Source	<1 %
42	repository.radenintan.ac.id Internet Source	<1 %
43	www.saudijournals.com Internet Source	<1 %

Exclude quotes	On	Exclude matches	Off
Exclude bibliography	On		

The Risk of Sulfur Dioxide Exposure to The Incidence of Hypertension on Street Sweepers In Samarinda City (Tropical Rain-Forest Area)

GRADEMARK REPORT

FINAL GRADE

/0

GENERAL COMMENTS

PAGE 1

PAGE 2

PAGE 3

PAGE 4

PAGE 5

PAGE 6

PAGE 7

PAGE 8