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ENVIRONMENTAL HEALTH RISK ANALYSIS OF CARBON MONOXIDE GAS EXPOSURE AMONG TRADERS OF GIWANGAN TERMINAL, YOGYAKARTA

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Abstract

Introduction: *The characteristics of CO gas are that it has no color, odor, and taste resulting from incomplete combustion, which accounts for 70% of motorized vehicle-related air pollution. Terminal traders are among those who are vulnerable to pollution caused by motorized vehicles. The study's goal was to determine the environmental health risk analysis of CO gas exposure to traders at Yogyakarta's Giwangan Terminal.* ***Methods:*** *This study was quantitative using a cross-sectional design study with the Environmental Health Risk Analysis (EHRA) approach. This study used purposive sampling technique. The population was traders, with a sample of 51 respondents. The research instrument is a questionnaire. The Chi-square test was used to measure the bivariate analysis data.* ***Results and Discussion:*** *The average concentration of CO gas was 0.9523 mg/m³, exposure duration was 12.1 hours/day, exposure frequency was 339.94 days/year, exposure duration was 11.96 years, and inhalation rate was 4.1 m³/o'clock. The highest abnormal blood pressure was 40 respondents. Real-time intake min. 0.0184 mg/kg/day, max. 3.0919 mg/kg/day (arrival), real-time intake min. 0.0190 mg/kg/day, max. 3.2021 mg/kg/day (departure). A total of 43 traders had a risk quotient (RQ) > 1.* ***Conclusion:*** *There was a relationship between the intake and the RQ of CO gas exposure but no relationship between blood pressure and the RQ due to CO gas exposure to traders at the Giwangan Terminal, Yogyakarta.*

INTRODUCTION

Air pollution is one aspect of the environment that is very risky for health. Reducing air pollution levels in each country can have an impact on reducing the burden of stroke, heart disease, lung cancer, and chronic and acute respiratory diseases. Good policies and investments in supporting environmentally friendly transportation models, energy efficient homes, power generation, industry, and good municipal waste management will reduce the number of major sources of outdoor air pollution (1). One of the air pollutants is carbon monoxide (CO) gas which is defined as a gas with the characteristics of no color, no odor, and no taste that comes from incomplete combustion (2). Based on Regulation of Government of Republic Indonesia No. 22 of 2021 concerning the Implementation of environmental protection and management, it is known that the national air quality standard for CO gas is 10,000 µg/m³ per 1 hour (3).

The flow of exposure to CO gas is when this gas is inhaled into the human lungs it will affect the blood circulation system. This will interfere with oxygen entering the body and the toxic nature of the gas can be metabolized in the blood. Thus, the blood more easily binds to CO gas which affects the function of the blood in supplying oxygen (4). CO gas has a binding capacity of Hb 210x greater than the binding capacity of O_2 with Hb which causes disturbances in the Hb function (4). The higher concentration of CO gas in the air can affect blood COHb and cause human health effects (5). Thus, the supply of O_2 into the body's cells decreases and results in constriction of blood vessels which has an effect on increasing blood pressure (6).

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Blood pressure is the pressure that comes from arterial blood flow which has an important function in the blood circulation system which aims to encourage blood that supplies a lot of O_2 to be distributed to body organs (7). The more COHb content can lead to high blood pressure. As, there is a significant decrease in diastolic blood pressure from a number of studies on the relationship between CO gas and blood pressure. The results of the study stated that blood pressure increases accompanied by an increase in the concentration of CO gas. The presence of vasodilation of CO gas and the results of animal studies support the finding that exposure to CO gas can cause a decrease in blood pressure (8).

The magnitude of the health risk due to exposure to CO gas can be analyzed using the Environmental Health Risk Analysis (EHRA) method. EHRA has the aim of knowing the estimated risk of exposure to CO gas seen from the RQ value. As research showed that the results of the EHRA test at 10 research points showed an average of each variable, namely the length of exposure 7.4 hours/day, frequency of exposure 349.72 days/year, duration of exposure 18 years, the average realtime intake value of 2.94 mg/kg/day, and an average lifetime intake of 4.76 mg/kg/day. The results of RQ > 1 as many as 5 people (8.6%) were at risk of being exposed to CO gas, and RQ < 1 as many as 53 people (91.4%) (9).

Unsafe RQ results (RQ>1) will be carried out risk management. Risk management of CO gas can be pursued by reducing working hours per day, decreasing frequency per 1 year, and reducing length of stay in exposed locations. This is adjusted to the effectiveness of the local location (10). One of the locations that are prone to causing air pollution is the bus terminal because of the many human activities in it. Giwangan Terminal is a type A terminal that serves as a place to get on and off bus passengers from big cities such as Sumatra, Java, Bali, and Nusa Tenggara which is the largest in Yogyakarta (11).

Giwangan Terminal is still operating with a high level of bus passenger mobility. During 2017-2020, the number of buses operating was 3,465,554 buses. Buses departing from the terminal are 1,730,858 buses and incoming buses are 1,734,969 buses. These buses include inter-city transportation between provinces, inter-city transportation within the province, and Urban buses. The highest mobility is in the form of inter-city transportation between provinces buses with a total of 1,923,267 buses (12). The increasing number of vehicles is directly proportional to high concentration of carbon monoxide gas will impact on increasing air pollutants (13).

The number of inter-city transportation between provinces bus passengers has decreased due to the covid-19 pandemic at the Giwangan Terminal, there was an increase in passengers again reaching 60% in the June 2020 period (14). The results of the concentration of CO gas at the arrival and departure of buses obtained an average of 5.8045 ppm and 4.9572 ppm, respectively. This means that there is a significant difference even though it is still below the NAV (15). The number of vehicles at the terminal can put people at risk of being exposed to CO gas. The content of this CO gas was analyzed in order to estimate the magnitude of the risks and effects on human health due to the mobility of the operating bus (13).

Based on observations in February-March 2021, there are three traders who have been trading for 17 years at the Yogyakarta Giwangan Terminal. The trader who trades every day for 8 hours / day and mentions the health complaints experienced, namely high blood pressure. The quantity of inter-city transportation between provinces buses operating is still high, around 800-900 per day, according to the daily data reports of incoming and outgoing buses by the Giwangan Terminal Management Unit. Traders at the Giwangan Terminal Yogyakarta are a population group that has the potential to be exposed to CO gas because they carry out trading activities in the terminal area for a long time. Therefore, researchers are interested in conducting research on EHRA of CO Exposure to Traders at Giwangan Terminal in Yogyakarta with the aim of identifying the dangerous concentration of CO gas, knowing the description of blood pressure values in traders, and knowing the relationship between CO gas concentration and RQ value.

METHODS

This study employed a descriptive quantitative, cross-sectional research design. The Environmental Health Risk Analysis approach was used in the study. The study population was 92 traders. However, only 51 people were successfully located in the Giwangan Terminal while in the field. This was due to the fact that many traders had not been actively trading during the pandemic period. Purposive sampling as sampling technique, which was carried out in October 2021 using a questionnaire instrument. This study was approved by Ethical Committee of Universitas Islam Indonesia Number 19/Ka.Kom.Et/70/KE/IX/2021.

Smart Sensor Carbon Monoxide Meter AS8700A, Digital Sphygmomanometer for tension meters, weight scales, cameras/mobile phones, and stationery are among the measuring devices used. Data collection using the method directly so that the results of the CO gas concentration can be seen and stored without the need for a laboratory analysis. The tool incorrectly referred to the SNI 19-7119.6: 2005 guidelines for determining the location of sampling for ambient air quality monitoring tests. Researchers and laboratories from the Environmental Laboratory and Occupational Health and Safety (OHS) PT. Green Lab Indo Global Yogyakarta conducted the measurements.

Measurement of CO gas samples is carried out for 1 day with the period of time to get the results of the analysis of the sampling for 2 weeks after sampling. Measurement time for three (3) repetition times included in the morning (08.00-09.00 WIB), mid-day (12.00-13.00 WIB), and afternoon (16.00-17.00 WIB) at the point of departure and bus arrival point. Then, interviews, weighing, observation, and documentation were carried out. The data analysis used was univariate and bivariate analysis. Univariate analysis to measure the characteristics respondents as well as environmental health risk analysis variables consisting of hazard identification, dose-response analysis, exposure analysis, and risk characterization.

Equations 1 and 2 show the equation for calculating the noncarcinogenic risk of inhalation routes (10),(38),(48).

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

Description:

I_{nk} : Non-carcinogenic intake, mg/kg/hari
C : Risk agent level, mg/M³ for air medium
R : Intake rate or consumption, m³/jam for inhalation
t_E : Exposure time
f_E : Exposure frequency
D_t : Exposure duration, years (*real time* or projection, 30 years for residential default values)
W_b : Body weight, kg
t_{avg} : Average time period (30 years x 365 days/year for non-carcinogenic substances)

Calculating the level of risk for non-carcinogenic effects and calculating the level of risk for carcinogenic effects are both part of risk characterization. The formula for calculating risk characterization is as follows.

$$RQ = \frac{\mathrm{Ink}}{RfD \ atau \ RfC} \quad (2)$$

Description :

RQ : Risk Quotient
RfC : Reference of Concentration for CO exposures is 0.02 mg/kg/day , its deriving formula for Asian population (10).

The Risk Quotient (RQ) expresses the risk characteristics. Chronic CO risks are not safe for the community if RQ > 1. Then, bivariate analysis using Chi-Square test to measure relationship intake and blood pressure classification with RQ levels of CO gas exposure among traders in Giwangan Terminal.

RESULTS

Respondents Characteristics

Respondents in this study were 51 traders, namely 41 female traders (80.4%), the oldest trader is 85 years old, but the highest proportion of age among traders is in the age range of 51-60 years (33.3%). Traders' weight is dominated by between 61-70 kg (35.3%) with an average of 63.9 kg. The majority of traders in the terminal have a history of blood pressure as many as 30 respondents (58.8%). Traders in the terminal are dominated by abnormal blood pressure of 40 respondents (78.4%) with an average systolic blood pressure of 136.7 mmHg and diastolic blood pressure of 83.9 mmHg.

Environmental Health Risk Analysis

Hazard identification for this study explained through the average concentration of ambient air CO gas at Giwangan Terminal is 952.2 g/Nm³ or 0.9523 mg/m³. This concentration does not exceed the national NAV according to the Indonesian Government Regulation No. 41 of 1999 which is 30,000 g/Nm³. Dose-response analysis performed from the highest inhalation rate for traders is between 8.1-8.9 m³/hour and the lowest inhalation rate is between 1.3-2.0 m³/hour. Traders' exposure time in the terminal is the highest at 24 hours/day and the lowest at 8 hours/day. Traders in the terminal have the longest exposure frequency of 365 days/year and the fastest exposure frequency of 269 days/year. The highest duration of exposure to CO was traders between the ages of 16-17 years is 23 people (45.1%) and the lowest duration was between the ages of 1-5 years is 12 people (23.5%).

Tabel 1. Frequency of Blood Pressure Characteristics and Classification of Traders at Giwangan Terminal Yogyakarta in 2021

Variables	Total (n=51)	
Characteristics of Traders	f	%
Gender		
Man	10	19.6
Woman	41	80.4
Age (Years)		
17-30	7	13.7
31-40	9	17.6
41-50	11	21.7
51-60	17	33.3
61-70	5	9.8
71-85	2	3.9

Variables	Total (n=51)	
Characteristics of Traders	**f**	**%**
Body Weight (kg)		
34-40	2	3.9
41-50	5	9.8
51-60	13	25.5
61-70	18	35.3
71-80	7	13.8
81-90	4	7.8
91-96	2	3.9
Blood Pressure History		
Yes	30	58.8
No	21	41.2
Blood Pressure Classification		
Normal	11	21.6
Abnormal	40	78.4

The minimum realtime intake value is 0.0184 mg/kg/day at the bus arrival and the maximum intake value is 3.2021 mg/kg/day at the bus departure. Meanwhile, the minimum intake lifespan is 0.5528 mg/kg/day at bus arrivals and a maximum of 5.6508 mg/kg/day at bus departures. The risk characteristics of traders at Giwangan Terminal show that the number of traders at risk of RQ > 1 in realtime is 43 traders and a lifetime is 51 traders. Meanwhile, RQ < 1 that is not at risk in realtime are 8 traders. Risk management that can be implemented at Giwangan Terminal Yogyakarta is reducing exposure time and reducing exposure frequency to traders.

Bivariate Analysis of Risk Factor (Intake and Blood Pressure) with Risk Quotient

The relationship between Intake (Ink) and Risk Quotient (RQ) at traders the Giwangan Terminal shows that the highest intake value is intake > 10 years with RQ>1 of 29 respondents (56.9%) compared to intake of >10 years with RQ ≤ 1 of 4 respondents (7.8%). The Risk Prevalence (RP) value obtained shows that intakes are 0.017 times more at risk of being exposed to CO gas with p value = 0.000 (<0.05) which means that there is a relationship between intake and RQ due to CO gas exposure to traders at Giwangan Terminal Yogyakarta.

The relationship between blood pressure and Risk Quotient (RQ) at Giwangan Terminal traders shows that the highest blood pressure value is abnormal blood pressure with RQ >1 as many as 27 respondents (52.9%), while the lowest blood pressure classification is normal blood pressure with RQ > 1 as many as 4 respondents (7.8 %). The Risk Prevalence (RP) value is 0.275, which means that traders who have blood pressure are 0.275 times more at risk due to exposure to CO gas. The p value = 0.085 (> 0.05), so it is stated that H_0 is accepted, which means that there is no relationship between blood pressure and the Risk Quotient (RQ) due to CO gas exposure to traders at the Giwangan Terminal Yogyakarta.

Tabel 2. Environmental Health Risk Analysis of CO Gas Exposure to Traders at the Yogyakarta Giwangan Terminal in 2021

Variables	Results	
Hazard Identification of Ambient Air Concentration of CO Gas	**Mean**	0.9523 mg/m³
Dose-Response Analysis	**f**	**%**
Inhalation Rate		
1.3-2.0	6	11.9
2.1-3.0	10	19.6
3.1-4.0	12	23.5
4.1-5.0	10	19.6
5.1-6.0	9	17.7
6.1-7.0	1	1.9
7.1-8.0	1	1.9
8.1-8.9	2	3.9
Exposure Analysis		
Exposure Time		
8	14	27.5
9	3	5.9
10	5	9.8
11	9	17.6
12	9	17.6
14	1	2
15	1	2
17	2	3.9
18	1	2
19	1	2
24	5	37.3
Exposure Frequency		
269	3	5.9
305	1	2
317	14	27.5
329	1	2
341	7	13.7
353	4	7.8
361	1	2
363	1	2
365	19	
Exposure Duration		
1-5	12	23.5
6-10	9	17.7
11-15	7	13.7
16-17	23	45.1
Respondent's Intake (mg/kg/day)	**Realtime**	**Lifespan**
Min	0.00283	0.05568
Max	0.21938	0.38714
Rizk Characterization	**RQ > 1**	**RQ < 1**
Realtime	43	8
Lifespan	51	0
Risk Management	**Subtraction tE** **Subtraction fE**	

Tabel 3. The Relationship Between the Intake Value (Ink) and The Risk Quotient (RQ) Value Due to CO Gas Exposure to Traders at The Giwangan Terminal Yogyakarta in 2021

Intake Classification	Risk Quotion (RQ)				Total		RP (CI)	p-value
	RQ > 1		RQ ≤ 1					
	n	%	n	%	n	%		
Intake > 10 Years	29	56.9	4	7.8	33	64.7	0.017 (0.003-0.105)	0.000
Intake ≤ 10 Years	2	3.9	16	31.4	18	35.3		
Total	31	60.8	20	39.2	51	100.0		

Tabel 4. Relationship Between Blood Pressure and Risk Quotient (RQ) of CO Gas Exposure to Traders at Giwangan Terminal Yogyakarta in 2021

Blood Pressure Classification	Risk Quotient (RQ)				Total		RP (CI)	p-value
	RQ > 1		RQ ≤ 1					
	n	%	n	%	n	%		
Abnormal	27	52.9	13	25.5	40	78.4	0.275 (0.068-1.111)	0.085
Normal	4	7.8	7	13.7	11	21.6		
Total	31	60.8	20	39.2	51	100.0		

DISCUSSION

Majority traders were female in this study, its in line with research conducted in the Terminal Area of Pakusari district which stated that the percentage of female traders (55.6%) was higher than that of male traders (44.4%) (16). Factors encouraging women traders to meet the needs of their lives and their families. Capital, location, time to travel, unyielding spirit, and a supportive environment. In addition, consideration of motivation for high morale (16). This study is in line with research conducted on traders on Semarang, showing that the average age of traders is 43 years old. This weight exceeds the US-EPA standard value for Indonesian adults. lower body weight can lead to larger internal doses (17). The youngest respondent is 22 years old and the oldest is 63 years old. The existence of a slight age difference indicates that on average those who are still working in the Terminal are of productive age (30-50 years). Body weight in this study consistent with study which conducted on traders has an average body weight of 62.48 kg at the Kampung Rambutan Terminal (18).

This result is inversely proportional with other study reported that the highest proportion of respondents did not have a history of blood pressure of 47 respondents (67.1%) (19). History of blood pressure in the elderly can affect the condition of blood pressure in the next generation. History of blood pressure will have no effect if there are no supporting factors such as conditions and environment. The higher the blood pressure over a long period, the more severe the complications that can occur (20). Findings study about abnormal blood pressure consistent with similar studies that effect of CO gas on blood pressure, 63.3% of respondents had higher blood pressure (6). Changes in blood pressure values due to the concentration of CO gas exposure under study, it was found that blood pressure decreased according to the increase in CO gas concentration. In particular, diastolic blood pressure decreased significantly. Other studies say that there is a relationship between CO gas and blood pressure and blood pressure increases due to an increase in the concentration of the gas. However, several studies also mention a decrease in blood pressure with increasing concentrations of CO gas exposure (8).

CO gas concentration does not exceed the national air quality according to the Indonesian Government Regulation. However, the concentration of CO gas analyzed still poses a dangerous risk in the long term impact for traders, one of the impacts studied is health problems due to gas exposure which can affect the blood pressure levels of traders. This is in accordance with research conducted in the city of Malang which states that CO gas has an influence on blood pressure, it is known that under 63.3% of respondents have high blood pressure (6). The risk of CO gas poisoned by inhalation pathway was relatively high concentrations and its impact to death cases (21). Other studies reported that the varying CO concentrations in the ambient air are caused by a various factors such as temperature, humidity, wind speed, and air pressure (22).

Inhalation rate of traders for this study does axceed international standard. According to the US-EPA, the default inhalation rate is 0.83 m^3/h. The rate of inhalation has an influence on the results of the intake value of exposure to risky agents received by the respondent (23). Exposure dose is a factor that determines the impact and severity of health risks on exposure to CO gas which causes mild cardiovascular and neurological behavior at low levels to unconsciousness, even death after exposure for a long time or after acute exposure to high levels of CO gas. The RFC in this study was 0.02 mg/kg/day according to the results of the formula calculation. According to the basic principle of pharmacology which states that the dose of a compound can determine the compound can potentially act as a therapy or poison (24). The impact of short-term exposure to CO gas is still well tolerated in normal humans (25). Over a long period of time CO gas can result in neurologic injury that will develop for example, ataxia, dementia, concentration deficits, or abnormal behavior (26). Tissue hypoxia is the main toxic effect of acute CO poisoning caused by the formation of COHb. Tissue hypoxia due to CO gas has the potential for vascular permeability and results in increased accumulation of interstitial fluid with decreased circulating blood volume (hemoconcentration) affecting multiple organs (21).

Exposure time of traders in the terminal was higher than workload standard. Traders in the terminal are informal workers who are not bound by agency regulations for long working days. Thus, many activities are carried out in shops where they are traded (27). The longer the trader works in an environment containing CO pollutant gas, the greater the value of inhalation of the gas into the body (28). The traders get higher exposure frequency than previous study which showed that the frequency of exposure to traders was 350 days/year (29). The results of the analysis in the field show that there are traders who trade for 5 days/week, 6 days/week, and work full time in 1 week. There are differences in the intensity of working time per day due to flexibility and some are in accordance with the provisions of the work. Traders are dominated by many activities in the terminal. This will greatly affect the risk of exposure to CO gas. This is supported by the results of research conducted on traders in the city of Semarang which stated that the duration of exposure to dominant traders of more than 10 years (30).

The intake value will affect the trader's RQ value. Differences in exposure patterns on the level and time of exposure per year will affect the intake received by traders (31). This was adjusted for daily duration of exposure, frequency of exposure, and duration of exposure compared with body weight (32). These result is in line with research conducted on traders in the Projo Ambarawa Market, which states that the intake value for 58 traders was found to have an average real-time intake of 2.94 mg/kg/day, a maximum value of 9.19, and a minimum value of 0.03. mg/kg/day. While the lifetime intake results obtained an average of 4.76 mg/kg/day, a maximum value of 17.50 mgkg/day, and a minimum value of 0.46 mg/kg/day (9). The intake lifetime value is higher than the realtime intake. This is because the duration of exposure is greater than the lifetime of 30 years. The calculation with the two methods above has a goal if the current condition (realtime) results divided by intake and reference dose < 1, it requires a projection test for prolonged exposure in the future. Therefore, the lifespan calculation was analyzed to see the projected duration of the carcinogenic impact in the next 30 years (33).

The risk characterization is in line with research conducted in the city of Surabaya which states that all respondents get an RQ value > 1, so all respondents are at risk of being exposed to CO gas (34). Research in the city of Medan that has been conducted shows that ambient air quality is influenced by traffic volume, which is dominated by freight transport, while passenger transport only has a small effect. Even so, it can also have a big impact if traffic conditions are very heavy. The magnitude of the effect of traffic performance on ambient air quality is 28.07%, this result is quite large for one parameter of air pollutant in urban areas. While the rest is influenced by other factors. (35).The number of vehicles entering the terminal is one of the risk factors for exposure to CO gas. The highest number of motorized vehicles is associated with environmental problem of CO gas exposure (36). Highest levels of some air pollutant gases caused by fuel type combustion and bus idling (37). The primary toxicity effect of carbon monoxide exposure was indeed a respiratory disease in both the short and long term (38).

Risk management related to results study can be done through creating green open space (RTH) at the research site. Green space can be implemented by planting trees or plants capable of absorbing CO gas such as Sansevieria trifasciata or Green Tiger's tongue-in-law. As the results of the study stated that the average level of CO gas before being given the *Sansevieria trifasciata* "Green Tiger" plant was 64.27 ppm to an average of 42.06 ppm after being given the plant. The p-value = 0.01 ($p<0.05$) means that the gas content decreased significantly after being given the Sansevieria trifasciata "Green Tiger" plant (39). Other risk management is minimaze inhalation pathway using Personal Protective Equipment (PPE) from CO gas exposed (38,40). Previous research has found that respondents who wear masks as PPE have lower average COHb levels than those who do not (41).

There is a relationship between intake and RQ due to CO gas exposure to traders at Giwangan Terminal Yogyakarta. The duration of exposure involves determining the high and low levels of intake received by traders. The amount of intake is related to how long the trader has been at the research site. The longer the trader is present, the higher the intake and risk received (42). Intake is defined as the conversion value obtained from the level of CO to CO inhaled into the body and is useful for estimating CO intake in traders (43).

The duration of exposure is directly proportional to the amount consumed; the longer the respondent remains in the location, the greater the health risk (31). In people with a history of heart disease, low CO concentrations can cause fatigue and chest pain. It can cause visual disturbances and decreased brain function at moderate concentrations. It causes impaired visual coordination, headaches, dizziness, confusion, nausea, and can also cause flu-like symptoms at higher concentrations (44). Blood pressure disorders are one of the health risks of CO gas consumption. This is caused by an increase in pulmonary artery pressure and resistance, which leads to right ventricular failure (45).

There is no relationship between blood pressure and the Risk Quotient (RQ) due to CO gas exposure to traders at the Giwangan Terminal Yogyakarta in 2021. The results of this study are in accordance with the results of research conducted in the city of Medan which states that there is no significant relationship between exposure to CO gas (intake) and blood pressure with p = 0.067, p = 0.063 (19). In addition, the results of another study stated that the results of measuring blood pressure in people exposed to CO gas showed an increase in CO gas levels resulting in a decrease in systolic blood pressure and diastolic blood pressure (8).

The findings of this study are consistent with other study (19), which found no significant relationship between carbon monoxide gas intake and blood pressure (p = 0.067, p = 0.063). The results of blood pressure measurements after CO gas exposure revealed that increasing CO concentrations tended to decrease both systolic and diastolic blood pressure (8). Blood pressure can be used to help diagnose and predict the severity of poisoning (46). Several studies have found that the best blood pressure range for adults and the elderly may be influenced by previous blood pressure characteristics (47). As a direct consequence, while there is no significant relationship between blood pressure and the level of risk associated with CO gas exposure, it is still prudent to be aware of the long-term effects associated with human blood pressure disorders.

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CONCLUSION

We can concluded that there was a relationship between the intake and the RQ exposure of CO gas among traders at Giwangan Terminal Yogyakarta. Contrary with prevoius result, there was no relationship between blood pressure classification and RQ exposure of CO gas among traders at Giwangan Terminal Yogyakarta. Reduced exposure time (tE) and exposure frequency (fE) are both risk management strategies for CO gas exposure.

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