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Original Research

HEALTH RISK ASSESSMENT OF INHALATION EXPOSURE TO SO2 AND NO2 AMONG TRADERS IN A TRADITIONAL MARKET

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ABSTRACT
Background: Air pollution is a global problem that is almost experienced by all countries. Causes of air pollution usually come from motor vehicles and industrial sources. One of places filled with transportations in community is a traditional market
Objective: This study aimed to asses the health risk of inhalation exposure to SO2 and NO2 on traders in the Siteba Market Padang City, Indonesia.
Methods: This was a descriptive quantitative research with Environmental Health Risk Analysis method (EHRA). The concentrations of SO2 and NO2 were measured at three different points in a total of 81 respondents who were randomly selected.
Results: Findings showed that the average of SO2 concentration was equal to 113 µg/m3, and the average NO2 concentration was 3 µg/m3. SO2 and NO2 exposure assessment on the traders were 0.005204 mg / kg / day and 0.00015604 mg / kg / day respectively. And the results of calculation of exposure risk characterization of SO2 and NO2 were at risk level (RQ) of <1.
Conclusion: It can be concluded that ambient air quality was safe although the complaints and discomforts among traders were still found. Therefore, further research to assess the other air quality parameters that affect the respiratory distress perceived by market traders is needed.

Keywords: risk analysis, SO2, NO2, trader

BACKGROUND

Humans in every second of their lives need air. They cannot maintain their lives for more than three minutes without air. The air is in the form of gas and is everywhere, so as a result, humans have never thought or cared about it. Free air or also known as ambient air, which is around humans can affect public health. Influence on health will appear if pollutants increase in such a way as to cause disease in humans, animals and plants. At such a level, the air is called contaminated. Air pollution can also be known from damage to human property (Slamet & Lingkungan, 2000). Air pollution is a global problem that is experienced by almost all countries (WHO, 2011). The cause of air pollution usually comes from motor vehicle and industrial sources (Gusti, 2017), which release CO, NO2, SO2, SO3, ozone, HC and dust particles. One activity that is quite dense visited by the community and transportation is a market. Through epidemiological studies, it can be

concluded that there is a relationship between air pollution and chronic obstructive pulmonary disease (Mukono, 2008). Air pollution also increases the risk for acute respiratory infections (WHO, 2016). Long-term exposure to ambient air pollution was a risk factor of a wide range of potential mental health disorders (Shin, Park, & Choi, 2018).

The causes of air pollution usually come from various sources, including vehicle exhaust, road dust, and windblown soil. Countries that are vulnerable to SO2 and NO2 emissions are developing countries with high levels of industrialization and dependence on the use of fossil fuels containing sulfur because of their low cost (Koplitz, Jacob, Sulprizio, Myllyvirta, & Reid, 2017). Vehicles and industries contribute to high SO2 emission loads due to fuel burning. The main cause of air pollution in India is due to plastic industry, food processing factories, and domestic waste burning (Maji, Dikshit, & Deshpande, 2016).

The incidence of chronic bronchitis in workers exposed to SO2 and NO2 gas is repeatedly higher at 3.5 / 1000 person-years compared to workers who are not exposed to SO2 and NO2 continuously IE 1.5 / 1000 person-years. This indicates a higher risk for workers who are exposed to gas continuously (Andersson, Murgia, Nilsson, Karlsson, & Torén, 2013). SO2 is considered a pollutant that is harmful to health, especially to the elderly and sufferers who experience chronic diseases of the cardiovascular respiratory system (Zakaria, 2009).

The density of human activities and motorized vehicles in the Siteba Market provides an opportunity for the risk of being exposed to the exhaust gas hazards of motorized vehicles, one of which is SO2 towards traders selling around the market. Based on our interviews conducted with 20 traders in the Siteba Market, it is indicated that traders felt shortness of breath, headache and nausea, especially on weekdays during the afternoon and evening. Therefore, this study aimed to assess the level of health risk exposure to SO2 and NO2 among traders in Siteba Market Padang City, Indonesia.

METHODS

Study design

This was a descriptive quantitative research using an environmental health risk assessment method (EHRA).

Sample

A total of 81 traders in the Siteba Market Padang, Indonesia were purposively selected as samples. The inclusion criteria were traders in the Siteba Market area, which consisted of street vendors and permanent traders who have been working for more than one year. Traders who were included in the inclusion criteria but not available during data collection were excluded from the study.

Instrument

Primary data were obtained by measuring the concentration of SO2 and NO2 directly around the Siteba Market at three measurement points. The data were collected using a special tool called impinge.

Data analysis

Data analysis was carried out in the Occupational Safety and Health Laboratory of the Province of West Sumatra. Potential inhalation dose/Intake and Risk Quotient (RQ) were calculated by mathematical equations (1) and (2).

$$I = \frac{C \times R \times t_e \times f_e \times D_t}{W_b \times t_{avg}} \quad (1)$$

$$RQ = \frac{I}{RfC} \quad (2)$$

The variables were used to calculate intake dose (I) and Risk Quotient (RQ) i.e. concentration of SO2 and NO2 (CO_2 = 0.133 mg/m^3 and NO_2 = 0.003 mg/m^3), breathing rate (R:0.83 m^3/jam), time of exposure (t_E:10 hours/day), frequency of exposure (f_E:331 days/year), duration of exposure (D_t:30 years for non-carcinogenic substances), average time period (duration of exposure x 365 days) and trader's weight.

Ethical consideration

This study has been approved by the Faculty of Public Health of Andalas University. The researchers assured that all participants have obtained appropriate informed consents.

RESULTS

Risk Identification

In this research, the source of SO2 was from the burning of fossil fuels due to the use of fuel from vehicles passing on the highway around the Siteba Market Padang. Source of Nitrogen Dioxide (NO2) comes from burning by vehicles, energy production and waste disposal. Exposure to human SO2 and NO2 at the study site can cause respiratory problems such as breathing difficulties, airway obstruction, throat irritation, inflammation and respiratory infections and destruction of lung areas that occur when humans breathe. SO2 and NO2 will easily dissolve in the water vapor that we breathe through the inhalation pathway causing irritation and airway obstruction. The population at risk of being exposed to SO2 and NO2 is a trader who sells at the market with a total of 81 respondents taken at each sampling point location.

Dose-Response Analysis

Dose response analysis was performed to determine the exposure pathway of a risk agent into the human body and to understand the health effects or changes that occur due to an increase in the concentration of risk agents that enter the body. The reference concentration (RfC) value is the result of experimental research from various sources, both carried out directly on human objects and extrapolation from experimental animals to humans. The RfC value used for the SO2 risk agent was 0.03 mg / kg / day obtained based on the provisions of EPA / NAAQS 1990, while the RfC value for NO2 established by IRIS from US-EPA was 0.02 mg / kg / day with the effect critical respiratory tract disorders (Kementerian Kesehatan, 2012). The reference concentration value or RfC was used as a comparison to the risk characterization with the intake value. The RfC value was also used to determine safe concentration, safe exposure time, frequency of safe exposure in risk management in this study by assuming the intake value equal to the dose response value so that the safe limit was obtained through the predetermined equation.

Concentration of SO2 and NO2

The results of measurements of SO2 and NO2 concentrations in Table 1 showed that the average of concentration of SO2 was 0.113 mg/m3 and concentration of NO2 was 0.003 mg/m3 that the value was less than Threshold Limit Value (TLV) recommended based on Government Regulation No. 41 of 1999, each of 0.9 mg/m3 for SO2 and 0.4 mg/m3 for NO2.

Table 1 The results of measurements of SO2 and NO2 concentrations

No	Measurement Point	Concentration (mg/m3)		TLV (mg/m3)	
		SO2	NO2	SO2	NO2
1.	Kodam Intersection	0.133	0.004	0.900	0.400
2.	Perumnas Intersection	0.117	0.003		
3.	Behind The Markets	0.089	0.003		
	Average	0.113	0.003		

It can be seen that the highest SO2 concentration in Kodam Intersection was 0.134 mg / m3 and the highest NO2 concentration was also at Kodam Intersection, which was 0.004 mg / m3. The average concentration of SO2 in the Siteba Market was 0.113 mg / m3, while the average concentration of NO2 was 0.003 mg / m3.

Intake of SO2 and NO2

Intakes of SO2 and NO2 were calculated in real time and lifetime. Real time exposure intakes were calculated using the actual average duration of exposure (Dt real), which was the duration of exposure based on the length of time individuals lived in the study area. Lifetime exposure intake used a 30-year

exposure duration for non-carcinogenic effects. In calculating the number of intakes, anthropometric values and activity patterns were used based on the mean or median values of each variable. Variable weight (Wb) and duration of exposure (Dt) used the mean value because it was normally distributed at 55.8 kg and 9.6 years. Whereas exposure time (tE) and frequency of exposure (fE) used median values because it was not normally distributed that was equal to 10.23 hours / day and 362 days / year. The inhalation rate used was 0.83 m3 / hour. The average duration used for non-carcinogenic effects were 365 x 30 years.

Table 2 Intake *Real time* and *Lifetime* SO_2 and NO_2 on Traders

No	Measurement Point	Intake Real time mg/kg/day		Intake Lifetime mg/kg/day	
		SO2	NO2	SO2	NO2
1	Kodam Intersection	0.0032	0.0001	0.0167	0.0005
2	Perumnas Intersection	0.0050	0.0001	0.0177	0.0005
3	Behind The Markets	0.0058	0.0002	0.0116	0.0004
	Average	0.0054	0.0002	0.0167	0.0005

Table 2 shows that the highest SO2 real time exposure intake at Behind The Markets was 0.0058 mg / kg / day and the average intake was 0.0054 mg / kg / day. While the highest intake of NO2 real time exposure at Behind The Markets was 0.0002 mg / kg / day with an average intake of 0.0002 mg / kg / day. The highest lifetime SO2 exposure utilization was at Perumnas Intersection which was 0.0177 mg / kg / day with an average intake of 0.0167 mg / kg / day. While lifetime NO2 exposure intake was the same as at Kodam Intersection and Perumnas Intersection which was equal to 0.0005 mg / kg / day, which was also the same value for average lifetime exposure intake.

Risk Quotient of SO2 and NO2

Table 3 shows that the risk level or Risk Quotient (RQ) SO2 and NO2 at all measurement points for real time exposure results were still below 1 (RQ <1).

Table 3 Risk Quotient

No	Measurement Point	RQ Realtime		RQ Lifetime	
		SO2	NO2	SO2	NO2
1	Kodam Intersection	0.123	0.005	0.642	0.025
2	Perumnas Intersection	0.191	0.007	0.679	0.027
3	Behind The Markets	0.222	0.009	0.447	0.018
	Average	0.206	0.008	0.643	0.025

DISCUSSION

The concentration of SO2 and NO2 obtained was still far below the quality standard value based on Government Regulation No. 41 of 1999 (Goverment of the Republic of Indonesia, 1999), each of 0.9 mg / m3 for SO2 and 0.4 mg / m3 for NO2. In line with Arista, Sunarsih, and Mutahar (2015), the concentrations of SO2 and NO2 obtained at Palembang Bus Terminal for NO2 showed the highest yield was 0.1503 mg / m3 with the average value of 0.046637 mg / m3 while for SO2 the highest yield was 0.3682 mg / m3 with the average value 0.2298 mg / m3. This was also in line with Syaputri (2013), which showed the highest SO2 concentration was 0.44749 mg / m3 and the highest NO2 concentration was 0.05781 mg / m3 not exceeding the threshold value. This result was also in line with the research conducted by (Mutiara, 2016) in Pasar Raya Padang obtained the highest SO2 concentration, which is 0.0231mg / m3 while the highest NO2 concentration is 0.00281 mg / m3 with also did not exceeded the threshold value.

SO2 and NO2 intakes for traders in Pasar Siteba Padang in the present study were higher than the intake values of street vendors in Jakarta with real time SO2 values of 0.0014 and NO2 real time 0.0014 and lifetime SO2 exposure of 0.0049 and NO2 lifetime that was 0.0052 (Wardani, 2012). This result was also higher than intake values of SO2 and NO2 of street vendor in Padang with 0.0011 and 0.0000 for real time exposure and 0.0026 and 0.0002 for lifetime exposure (Mutiara, 2016).

Risk characteristics are attempts to determine whether the exposed population is at risk for the risk agent that enters the body as expressed by RQ by combining the values obtained in the exposure analysis and response dose. The level of non-carcinogenic risk is obtained through the results of the division of daily intake with the value of dose-response or Reference Concentration (RfC). If RQ ≥ 1, SO2 and NO2 can cause health problems, but if RQ <1 then SO2 and NO2 cannot cause health problems (Rahman, 2007).

In this study, the realtime and the lifetime exposure levels of SO2 and NO2 at all measurement points were also still below 1 (RQ <1). It can be concluded that the risk level (RQ) of realtime exposure and lifetime of SO2 and NO2 were not risky or still safe for traders in the Siteba Market. This is in line with Wardani's research (2012) which obtained the value of RQ SO2 and NO2 <1 in Jakarta. It is also in line with Mutiara's research (2016) which states that exposure to inhaled SO2 and NO2 at street vendors in Padang is still safe.

Environmental health risk analysis is a predictive approach to see the potential of a risk agent in terms of creating risks that will disrupt health. Risk always exists and cannot be eliminated completely from an activity. The only thing that can be done regarding this risk is controlling every activity that is seen as a source of risk. This study succeeded in providing information about the risks borne by traders due to exposure to SO2 and NO2 so far able to predict for the next 30 years. Limitation of this study were that the ambient air data collection was not carried out in an aggregate manner so that the amount of exposure to SO2 and NO2 gas per individual could not be calculated, so the relationship or influence between ambient air quality and respiratory complaints of individuals or at risk populations was missing.

CONCLUSION

The level of health risk for realtime exposure and lifetime exposure to SO2 and NO2 for traders in Siteba Market Padang City does not pose a risk, meaning that they are still safe for the next 30 years. Risk management does not need to be done to control the impact of exposure to SO2 and NO2 on these traders. However, the Padang City government must always periodically monitor the concentration of pollutants and pollutants in the ambient air so as not to exceed the recommended safe limits.

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Declaration of Conflicting Interest
None declared.

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