International Journal of Sciences: Basic and Applied Research (IJSBAR)

ISSN 2307-4531
(Print & Online)

http://gssrr.org/index.php?journal=JournalOfBasicAndApplied

The Risk Assessment Due to the Exposure of Co and No$_2$ in the Traders in Malengkeri Terminal Area, Makassar City

Deddy Alif Utama[a], Anwar Daud[b], Masni[c]

[a]Program Studi Kesehatan Masyarakat Universitas Hasanuddin
[b,c]Konsentrasi Kesehatan Lingkungan Fakultas Kesehatan Masyarakat Universitas Hasanuddin
Email: deddyalif29@gmail.com

Abstract

Transportation is a major source of air pollution that produce almost 70% of emissions in the world where 60-65% of that emissions, consisted of carbon monoxide (CO) and nitrogen dioxide (NO_2). This research aimed to determine the health risk as the resulted of the exposure to CO and NO_2 in traders in Malengkeri Terminal area, Makassar City. The research used the observational design with the environmental health risk assessment approach. The 48 environmental samples and 58 human samples were chosen using the purposive samplinh technique. And then, the data were analyzed using the Environmental Health Risk Analysis (EHRA) and processed using Microsoft Excel 2007 and IBM SPSS version 20.00. The research results revealed that the mean concentration of CO gas in Malengkeri Terminal area at the beginning of the week was 312.59 mg/Nm^3, while at the end of the week was 449.06 mg/Nm^3. The mean concentration of NO_2 at the beginning of the week was 16.49 mg/Nm^3, while at the end of the week was 7.22 mg/Nm^3. The mean RQ of CO at the beginning of the week was 0.11883, while at the end of the week was 0.15363. The mean RQ of NO_2 at the beginning of the week was 0.03424, while at the end of the week was 0.01683. The mean cumulative RQ at the beginning of the week was 0.15307, while at the end of the week was 0.17046.

---

* Corresponding author.
E-mail address: author@institute.xxx .

Both CO and NO_2 pollutant concentration had not exceeded the threshold limit value. Both the RQ and cumulative RQ had not indicated any non-carcinogenic health risk (≤ 1). Nevertheless, the result of the analysis revealed the data that the highest RQ value and the highest RQ cumulative value of the exposure to CO at the end of the week had exceeded the maximum risk value.

***Keywords**:* environmental health risk assessment, carbon monoxide, nitrogen dioxide, traders, terminal.

1. Introduction

Transport is a major source of air pollution in the world that accounts for nearly 70% of NOx emissions, 52% and 23% of VOC emissions of particulates and will increase each year as the number of vehicles continues to increase [1]. Other studies mention that the decline in air quality urban areas suspected of high consumption of fuel for the transport sector, about 53% [2]. Nearly 60% of pollutants produced in the world is composed of carbon monoxide (CO) and of the various activities that produce CO, transport activity is the largest contributor to emissions of CO which is followed by industrial activity [3]. In addition to CO gas, nitrogen dioxide (NO2) is also one of the pollutants contained in the air and most widely produced by motor vehicles [4]. Based on data collected by [5], the transportation sector accounts for 65 to 75% of the total NO2 gas emissions from the transport sector.

Research conducted by the Environment Agency of Yogyakarta in 2010 at the Bus Terminal, the concentration of carbon monoxide in the air that is equal to 67 799 g / m3. This means it has exceeded the quality standards that have been established under PP 41/1999 on Air Pollution Control [6]. Another study conducted in the area of Makassar Terminal Malengkeri get the fact that the value of the Air Pollution Standard Index (ISPU) for the pollutants carbon monoxide on weekdays and days off in a row is 152.25 ug / m3 and 178.35 ug / m3, so already classified in the category of unhealthy [7].

Although it serves as the main terminal in the south of the city of Makassar, the opposite is actually found in terminal condition Malengkeri Makassar. Conditions of facilities that are not feasible and not according to the standard, the circulation of pedestrians and vehicles are mixed resulting in a very dense terminal condition. The number of vehicles in operation in 2013 is ± 3,516 vehicles / day with a ratio of 29% the percentage of public transport and 71% of private vehicles [8]. In 2014 rose to ± 4,046 vehicles / day with almost the same percentage is 33% public transport and 67% of private vehicles (PD Makassar Terminal [9]. This of course can lead to increasing levels of air pollution, especially gas CO and NO2. As a result of the high concentration of CO in the terminal area, there is a group of workers who have a high risk of exposure to the hazardous substance. Among those who have relatively fixed activity or sedentary such as for example the merchants. This study aimed to analyze the magnitude of health risks in the area of Terminal Malengekri traders due to exposure to CO and NO2.

2. Materials and Methods

2.1 Research Methods

This study uses an observational study design with Environmental Health Risk Analysis approach to calculate the amount of risk to health from inhaling air containing CO and NO2.

2.2 Location Research

This research was conducted in the area of Makassar Terminal Malengkeri for 3 months from April through June 2015.

2.3 Population and Sample

The human population in this study were all traders (selling goods and / or services) that work in the area of Makassar Terminal Malengkeri totaling 110 merchants and neighborhood population in this study is the ambient air inside the terminal area Malengkeri Makassar. Sample (respondents) in this study were mostly merchants, amounting to 58 people and are determined based on the criteria of the study sample. The criteria include: has worked as a trader in kawasaan Terminal Malengkeri for at least 1 year, during the study were in the location of the research and willing to be a sample of this research. While air samples taken at eight points at the beginning of the week and weekend. The measurement point is determined by purposive sampling based on the density of the number of vehicles potentially lead to CO and NO2 pollution criteria include: sampling points within 1-5 meters from the source of pollutants with a height of 1.5 to 3 meters and measurements performed at locations less trees.

2.4 Data Collection

Air samples taken directly in the area of Terminal Malengkeri Makassar with the assistance of BTKL-PP Makassar in 8 predetermined point. Air sampling was conducted twice a week at the beginning of the week and at weekends. Primary data obtained from the content of CO and NO2 measurements in ambient air then examined in a laboratory, respondents intake indicator data obtained using a questionnaire and the data obtained using the respondents' weight weight scales. Secondary data such as air quality monitoring data from the Regional Environmental Agency (BLHD) Makassar and the Ministry of Environment (MOE) as well as data about the South Sulawesi city of Makassar Terminal Malengkeri of Makassar Terminal Metro PD.

2.5 Data Analysis

Analysis of data using the approach of Environmental Health Risk Analysis (ARKL) which includes the identification of hazards (hazard potential identification), analysis of exposure (exposure assessment), the analysis of dose response (dose-response analysis), the characteristics of the risk (risk characterization), and risk management. The data is processed using Microsoft Excel 2007 and IBM SPSS version 20.00. Presentation of data in tabular form accompanied by narration.

3. Research Results

The results showed that the average concentration of CO and NO2 in the area of Terminal Malengkeri not exceed the threshold while the air quality standard for CO and NO2 exposure largely not pose a health risk to the merchants in the area of Terminal Malengkeri Makassar.

CO and NO2 concentrations in the area of Makassar Terminal Malengkeri Table 1 shows the concentrations of CO and NO2 levels at two sampling time is at the beginning of the week and weekend. Because all the data were not normally distributed, then the median value taken as the average value.

Table 1: Consentration of CO and NO_2 at Malengkeri Terminal Area, Makassar City 2015

Statistics	Consentration (μg/Nm^3)			
	CO		NO_2	
	Beginning of week	End of week	Beginning of week	End of week
Min	244,17	239,50	7,54	4,45
Max	522,21	844,96	20,24	15,08
Mean	343,84	504,96	14,54	7,90
Median	312,59	449,06	16,49	7,22
SD	104,98	248,03	4,47	3,22
Varian	11022,39	61520,47	19,93	10,42

The average concentration levels of pollutants CO at the beginning of the week was 312.59 mg / Nm3 or 0.31259 mg / m3 while at the weekend was 449.06 mg / Nm3 or 0.44906 mg / m3. The average concentration levels of pollutants NO2 at the beginning of the week was 16.49 ug / Nm3 or 0.01649 mg / m3 while at the weekend was 7.22 ug / Nm3 or 0.0722 mg / m3.

3.1 Karakeristik risk (RQ) as a result of exposure Traders CO and NO2

Table 2 shows the level of risk due to exposure to merchant CO and NO2 at two sampling time is at the beginning of the week and weekend. At the beginning of the week, the highest CO RQ is at 0.49233 and the average RQ is 0.11883. At weekends, the highest CO RQ amounted to 1.03904 and the average RQ is 0.15363. While at the beginning of the week, RQ highest NO2 is at 0.15760 and the average RQ is 0.03424. At weekends, RQ highest NO2 is at 0.07295 and the average RQ is 0.01683.

Table 2 shows the level of risk due to exposure to merchant CO and NO2 at two sampling time is at the beginning of the week and weekend. At the beginning of the week, the highest CO RQ is at 0.49233 and the average RQ is 0.11883. At weekends, the highest CO RQ amounted to 1.03904 and the average RQ is 0.15363.

While at the beginning of the week, RQ highest NO2 is at 0.15760 and the average RQ is 0.03424. At weekends, RQ highest NO2 is at 0.07295 and the average RQ is 0.01683.

Table 2: Distribution of *RQ* due to CO dan NO_2 exposure among Seller Malengkeri Terminal Area, Makassar City 2015

Statistics	***RQ* CO**		***RQ* NO_2**	
	Beginning of week	**End of week**	**Beginning of week**	**End of week**
Min	0,00555	0,01445	0,00278	0,00135
Max	0,49233	1,03904	0,15760	0,07295
Mean	0,11883	0,15363	0,03424	0,01683
Median	0,08546	0,08956	0,02432	0,01322
SD	0,11518	0,19785	0,03285	0,01472
Varian	0,013	0,039	0,001	0,000

3.2 Cumulative Risk Magnitude (RQ cumulative) due to exposure Traders CO and NO2

Tabel 3: Distribusi *RQ Cumulative due to* exposure of CO and NO_2 among sellers Malengkeri Terminal Area, Makassar City 2015

Statistik	***RQ Cumulative***	
	Beginning of week	**End of week**
Min	0,00833	0,01702
Max	0,62194	1,11198
Mean	0,15307	0,17046
Median	0,11394	0,10011
SD	0,14729	0,21175
Varian	0,022	0,045

Table 3 shows the magnitude of the cumulative risk / RQ cumulative traders due to exposure to CO and NO2 at two sampling time is at the beginning of the week and weekend. At the beginning of the week, the highest RQcum RQcum is 0.62194 and the average was 0.15307 whereas at the beginning of the week, the highest RQcum RQcum is 1.11198 and the average is 0.17046.

4. Discussion

Results of the analysis shows that the average concentration of CO at the time the weekend is much higher than at the beginning of the week. This is consistent with findings that air pollution during weekends and evenings to rise relatively higher than during weekdays. On weekends, people mostly go out to rest and leisure. When the holidays, most of them use motorized vehicles. However this is not absolutely valid on certain types of pollutants [10.11].

In contrast to this, the concentration of pollutant NO2 has decreased during the weekend. Research reveals that NO and NO2 gas more detected in areas with high levels of congestion. This high congestion occurs mostly at the beginning of the week when everyone will start activities respectively [12,13]. There are several factors that influence the concentration of vehicle emissions apart from the number of vehicles. These factors include: the condition of the vehicle engine, vehicle type, technological and environmental factors such as temperature, humidity and wind speed [14]. Based on research conducted by [15], pollutants such as NO2 is more common in the type of vehicles such as cars compared to the motor.

In addition, based on the reaction formation, NO2 from NO and O2 occur in relatively small quantities, although the presence of excess air. This is in contrast to the reaction of CO and CO2 formation of O2, where the excess air will quickly lead to the formation of CO2. NO2 formation is slow, due to the speed of the reaction is strongly influenced by temperature, concentration of NO and O3 concentrations. At temperatures 1100¬oC amount of NO2 formed is usually less than 0.5% of total NOx. The high temperature is likely to help NO2 to berfotolisis so back to form NOx gas [16,17].

In addition, the concentration of CO is also much higher when compared to the concentration of NO2. This is due to CO gas as a result of incomplete combustion of various types of fuel is one of the main pollutants resulting from motor vehicle while NO2 is the result of combustion byproducts are formed from the reaction of NOx gases in the air [16]. Under Regulation 41 of 1999, in which the CO quality standard is 30,000 mg / Nm3 for 1 hour and 24,000 mg / Nm3 for 24 hours while NO2 has a threshold of 400 mg / Nm3 for 1 hour and 150 mg / Nm3 for 24 hours. It can be concluded that both CO and NO2 has not exceeded the threshold quality standards.

The concentration of pollutants in the air is influenced by meteorological factors such as temperature, humidity, air pressure and wind speed and direction. Air temperature effect caused by some chemical reactions of pollutants that would take place more rapidly at elevated temperatures. Humidity is closely associated with the deposition of various types of pollutants. Pollutants in the air will always move from areas of high pressure to areas of low pressure and displacement process is highly dependent on wind direction and speed [18-21].

Determination of the risk in this study conducted through the calculation by comparing the intake (intake) with a reference concentration (RFC). RQ calculation results can indicate the level of health risk merchants from inhaling air containing CO and NO2. If RQ ≤ 1 shows the exposure is still below normal limits and respondents who inhale it still within safe limits from a health risk by CO and NO2 throughout his life. Whereas, if the RQ> 1 indicate exposure is above normal limits and respondents who inhale it has health risks by CO and NO2 throughout his life.

The analysis showed that the average value of RQ due to exposure to CO and NO2 good at the beginning of the week and the weekend has not shown the existence of a health risk due to the overall value of the RQ is below the threshold of health risk or RQ ≤ 1. However, the results of the analysis Data obtained that the highest RQ score CO exposure during the weekends is 1.03904. These results indicate that the RQ value has exceeded the threshold of health risk or RQ> 1. It can be concluded that the health risks still need to be controlled so that RQ numerical value does not exceed 1.

Broadly speaking, the average cumulative RQ either at the beginning of the week and the weekend also not shown any health risk due to the cumulative overall RQ values are below the threshold of health risk or RQ ≤ 1. However, from the results of the analysis of the data obtained that The highest RQcum CO exposure value during the weekend is 1.11198. These results indicate that the RQ value has exceeded the threshold of health risk or RQ> 1. It can be concluded that the health risks still need to be controlled so that RQ numerical value does not exceed 1.

The study says that if in an Exposure contained many chemicals, the amount of risk (RQ) of these substances can be accumulated with some reservations. The most important requirement is that pollutants can cause similar effects and harm health. In addition, these substances also have to have the same target organ [22]. Pollutants CO and NO2 in this case have a relationship because both of these pollutants can affect the respiratory system [23-25] and the cardiovascular system [26]. Several other theories related outcomes of exposure to CO and NO2 have been raised by Mukono (2008) and the results of research conducted by several researchers such as [26], and [27], where the outcome is caused by exposure to CO one is an acute vertigo and cardiovascular diseases such as heart failure, while for NO2 outcome happens one of them was about asthma and respiratory diseases.

It is known that there is a positive correlation between intake, the concentration of pollutants and environmental factors (location of residence, environmental conditions, the number of vehicles and meteorological conditions). Several studies have shown that the closer location to stay / reside someone with a source of pollutants, the higher the concentration of pollutants in the area [28, 29]. Research conducted by (2012), to get the result that every highway that is not planted Angsana Angsana tree or have a number of very little, correlated with higher concentrations of CO and NO2 in the region. [30], in his research also explained that there was a significant relationship between the number of vehicles, the concentration of NO2 in the air surrounding the disease and the incidence of respiratory tract. Temperature, humidity and wind speed as previously described also has a positive correlation to the concentration of pollutants in the air that influence the intake of a person.

In addition to environmental factors, weight and rate of inhalation is also a very important anthropometric variables in calculating risk-agent big the actual dose received by an individual. The greater the weight, the smaller the internal dose to be received [31]. Similarly with age, as previously described age affects the body's resistance to exposure to toxic substances / chemicals. The higher the age, the body's resistance will decrease [28].

5. Conclusions and Suggestions

The average concentration of CO gas at the beginning of the week in the area of Terminal Malengkeri Makassar is 312.59 mg / Nm3 whereas during the weekend was 449.06 mg / Nm3. The average concentration of NO2 at the beginning of the week 16.49 mg / Nm3 and at weekends is 7.22 mg / Nm3. Each of these pollutant concentrations of both CO and NO2 has not exceeded the threshold when compared to PP No.41 Year 1999. The magnitude of the health risk (RQ and RQ cumulative) due to exposure to CO and NO2 has not shown the existence of non-carcinogenic health risk (RQ $\leq$ 1) on all respondents. Nevertheless, the results of the analysis of the data obtained that the value of RQ and the highest RQcum CO exposure during the weekends is> 1. It can be concluded that the health risks still need to be controlled. The best risk management options that can be taken are to decrease the concentration of exposure is safe to replace the intake value that is equal to the value of the RFC and the use of breathing masks.

Acknowledgment

Infinite writer to convey to parents the author above all the effort, effort and prayer that this study he completed on time. Thanks are extended to Prof. author Dr. Anwar David, SKM., Kes as a mentor I and Dr. Masni, Apt., MSPH II as a mentor, who has been willing to take the time and thoughts in helping resolve the authors of this study. The author also to thank the Director of Makassar Terminal Metro PD along with the staff who has to carve huge merit in assisting authors during the study period.

References

[1] Department of Environment & Conservation. (2005). *Clean Car for NSW*, ISBN 1 74137 107 4.

[2] Lvovsky K.G. *et al*. (2000). *Environmental Cost of Fossil Fuels*. Pollution Management Series. The World Bank Environment Department.

[3] Utomo B. J. W. (2012). *Mengurangi Emisi* CO_2 *dan CO untuk Menuju Ruang Kehidupan Kota yang Nyaman dan Berkelanjutan di Kawasan Kota Malang*. Spectra. 10 (20): 1–10.

[4] Sastrawijaya A.T. 2009. *Pencemaran Lingkungan*. Rineka cipta: Jakarta

[5] Mandra dkk. (2013). *Model Dinamik Pengendalian Emisi CO dan* NO_2 *Kendaraan Bermotor di Kota Makassar*. Prosiding Seminar Nasional HPTI I.

[6] Kusumaningtiar D.A. (2014). *Analisis Kontribusi Kadar COHb dalam Darah terhadap Kapasitas Fungsi*

Paru pada Pekerja Jasa Terminal Angkut di Terminal Giwangan Kota Yogyakarta (Tesis). Yogyakarta: Universitas Gajah Mada.

[7] Inayah Y.N. (2015). *Analisis Tingkat Pencemaran Udara pada Kawasan Terminal Malengkeri di Kota Makassar*. Jurnal T.A. Program Studi Teknik Lingkungan Jurusan Sipil Fakultas Teknik Universitas Hasanuddin.

[8] Hadiance A.R. (2013). *Evaluasi dan Pengembangan Terminal Penumpang Tipe B (Studi Kasus: Terminal Malengkeri Kota Makassar)*. Tesis. Yogyakarta: Universitas Gajah Mada.

[9] P.D Terminal Makassar Metro. (2013). *Laporan Jumlah Kendaraan yang Berangkat dan Tiba di Terminal Unit Malengkeri Tahun 2013. Laporan tidak diterbitkan.*

[11] Davis L.W. (2007). *The Effect of Driving Restrictions on Air Quality in Mexico City*. Department of Economics. University of Michigan.

[10] Shang *et al*. (2014). *Inferring Gas Consumption and Pollution Emissions of Vehicles throughout a City*. KDD 2014: 1027-1036.

[12] Song *et al.* (2011). *Relationships among the Springtime Ground–Level NO_X,O3 and NO_3 in the Vicinity of Highways in the US East Coast*. Atmospheric Pollution Research. 2: 374-383

[13] Zhang K. *et al*. (2013). *Air Pollution and Health Risks due to Vehicle Traffic*. Science of the Total Environment. 450–451: 307–316.

[14] Zhang, K. 2010. *Exposures and Health Risks due to Traffic Congestion*. Dissertation. Environmental Health Sciences. The University of Michigan. [online]. http://deepblue.lib.umich.edu/bitstream/handle/2027.42/77813/zhangkai_1.pdf?sequence=1. Diakses 6 Februari 2015.

[15] Hodijah dkk. 2014. *Estimasi Beban Pencemar dari Emisi Kendaraan Bermotor di Ruas Jalan Kota Pekanbaru*. Dinamika Lingkungan Indonesia. 1(2):71-79.

[16] Fardiaz S. (1992). *Polusi Air dan Udara*. Yogyakarta: Kanisius.

[17] Kurtenbach *et al*. 2012. *Primary NO_2 Emissions and Their Impact on Air Quality in Traffic Environments in Germany*. Environmental Sciences Europe. 24:21.

[18] Mapoma *et al*. (2014). *Air Quality Assessment of Carbon monoxide, Nitrogen dioxide and Sulfur dioxide Levels in Blantyre, Malawi: A Statistical Approach to A Stationary Environmental Monitoring Station*. African Journal of Environmental Science and Technology. 8(6): 330-343.

[19] Saini *et al*. (2014). *Ozone Distributions and Urban Air Quality during Summer in Agra – A World Heritage*

Site. Atmospheric Pollution Research. 5: 796-804.

[20] Okoroafor U. (2014). *Influence of Meteorological Factors on Vehicular Emissions during Wet Season in South-South Nigeria*. Archives of Applied Science Research. 6 (4): 162-164.

[21] Habeebullah *et al*. (2014). *The Interaction between Air Quality and Meteorological Factors in an Arid Environment of Makkah, Saudi Arabia*. International Journal of Environmental Science and Development. 6 (8): 576-580.

[22] Goyal R. (2007). *Garfield County Air Toxics Inhalation: Screening Level Human Health Risk Assessment: Inhalation Of Volatile Organic Compounds Measured In Rural, Urban, and Oil &Gas Areas In Air Monitoring Study*. Colorado: Colorado Department of Public Health and Environment (CDPHE).

[23] He Q. *et al.* (2010). *Effects of Ambient Air Pollution on Lung Function Growth in Chinese Schoolchildren*. Respiratory Medicine. 104: 1512-1520.

[24] Morales *et al*. (2014). *Intrauterine and Early Postnatal Exposure to Outdoor Air Pollution and Lung Function at Preschool Age*. Thorax. 10: 1–10.

[25] Cheong *et al*. (2012). *Vertical Distribution of* NO_2 *in an Urban Area: Exposure Risk Assessment in Children*. J Civil Environ Eng. 2:4

[26] Atkinson *et al*. (2013). *Long-Term Exposure to Outdoor Air Pollution and Incidence of Cardiovascular Diseases*. Epidemiology. 24: 44–53

[27] Pope *et al*. (2014). *Associations of Respiratory Symptoms and Lung Function with Measured Carbon Monoxide Concentrations among Nonsmoking Women Exposed to Household Air Pollution:The Respire Trial, Guatemala*. Environ Health Perspect. 1289

[28] Meo *et al*. (2013). *Effect of Duration of Exposure to Cement Dust on Respiratory Function of Non-Smoking Cement Mill Workers*. Int. J. Environ. Res. Public Health. 10: 390-398

[29] Parra J & George L. (2005). *Performance and application of an inexpensive method for measurement of nitrogen dioxide*. Portland State University. 1 (1): 278-286

[30] Nielsen *et al.* (2010). *Lung Cancer Incidence and Long-Term Exposure to Air Pollution from Traffic*. Environ Health Perspect. 119: 860–865

[31] Nukman A. dkk. (2005). *Analisis dan Manajemen Risiko Kesehatan Pencemaran Udara*: *Studi Kasus di Sembilan Kota Besar Padat Transportasi*. Jurnal Ekologi Kesehatan. 4 (2): 270-289