International Journal of Applied Engineering Research ISSN 0973-4562 Volume 12, Number 20 (2017) pp. 9434-9437

Comparison of Risk Level of Exposure to PM10 on Students at Vegetated and Non Vegetated Elementary School in Padang City

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Abstract

The problem of air pollution is a global problem faced almost in all countries. PM10 (Particulate Matter) as air pollutant, which is believed by environmental experts and public health as triggering respiratory infections. This study aims to analyze the environmental health risks to PM10 exposure and compare these risks between students at vegetated and non-vegetated elementary school in Padang City, Indonesia. Then explore risk management and risk communication that can be done so that the risks can be minimized. This is observational analytic research with Environmental Health Risk Assessment method (EHRA). The research location is in SDN (State Elementary School) Percobaan for vegetated school and SDN 17 Gunung Pangilun for non vegetated school. The RQ (Risk Quotient) value represents the potential risk of PM10 exposure. The results of this study showed the highest intake of 0.001 mg/kg/day at the gate of non vegetated school and the lowest intake of 0.00041 mg/kg/day located in the square of vegetated school. The RQ score is less than 1 in all sampling locations, meaning exposure is still safe or no risk to elementary school students either students at vegetated school and students at non-vegetated school. Risk management is done by making vegetated in non-vegetated elementary school so that it can absorb air pollution especially PM10, limiting the age of motor vehicles, regular emissions testing, and the use of environmentally friendly fuels such as gas fuel. Risk communication is done to the school, local government such as Environmental Office of Padang City, Padang City Education Office, and Padang City Health Office, as well as those responsible to reduce the impact of PM10 exposure.

Keyword: EHRA, PM10, Elementary School Student

INTRODUCTION

Humans every second during his lifetime will require air. On average, humans can not sustain life without air for more than three minutes. The air is gas and everywhere, so humans never think about it or pay attention to it. Free air or also known as ambient air, which is around humans can affect public health (Soemirat 2015).

The problem of air pollution is a global problem that almost all countries experience. Air pollution can occur outside the room or indoors. Air pollution takes place outside the room due to outdoor air pollutants from motor vehicle combustion such as cars, motorcycles, trucks, and buses as well as from stationary sources such as industry, building processes, road activities and traces of land over highways (WHO 2011).

In the case of air pollution, both outside and indoor (indoor and outdoor pollution), dust is often used as one of the pollution indicators used to indicate the level of environmental hazard. Dust particles will be in the air in a relatively long time in a state of floating in the air, then enter into the human body through the breathing. In addition too harmful to health, it can also interfere with the invisibility of the eye and can perform various chemical reactions so that the composition of airborne dust becomes very complicated particles because it is a mixture of various materials with relatively different sizes and shapes (Pudjiastuti 2001).

Particulate Matter (PM) or floating dust particles which are very complex mixtures of various organic and inorganic compounds such as sulfate, nitrate, ammonia, sodium chloride, carbon, mineral dust, and water. These air particles are in solid form diameter less than 10 um which is usually called PM10 and less than 2.5 um inside the house (PM2.5). This particle is believed by environmental experts and public health as a trigger for respiratory infections, because the solid particles PM10 and PM2.5 can settle on the respiratory tract in bronchi and alveoli (WHO 2011).

The effects of PM10 exposure to health have been experienced by many rural and urban communities in both developing and developed countries. Chronic exposure of PM10 plays a role in increasing the risk of cardiovascular disease as well as respiratory diseases including lung cancer (WHO 2011). Research in Depok showed that the measurement of PM10 concentration in vegetated area was lower than non vegetated area which showed that vegetated had a significant role to decrease PM10 concentration in ambient air. The existence of this vegetated has indeed been proven by several studies to reduce the concentration of PM10 (Suhananto 2013).

Large-sized particulates can be retained in the upper respiratory tract, whereas small particulates can reach the lungs, after which the contaminants absorbed by the circulatory system and spread throughout the body. The health effects that can be found are acute respiratory infections, including asthma, bronchitis, and other respiratory disorders. It is estimated that the impact of air pollution in Jakarta associated with premature mortality, hospital care, reduced effective working days, and acute respiratory infections in 1998 worth 1.8 trillion rupiah and increase to 4.3 trillion rupiah in 2015 (Sumantri 2013).

Based on air quality monitoring data in West Sumatra, the concentration of PM10 at some point in Padang City has passed the environmental quality standard based on Government Regulation No. 41 of 1999 on Pollution Control (KNLH 1999). In this rule the PM10 quality standard is 150 µg / Nm3. Based on the background, researchers are interested in conducting a study comparing the risk level of PM10 exposure to elementary school students of vegetated and non-vegetated in Padang City. This study is important because the effects of PM10 exposure can lead to decreased lung function in children. The results of this study are not only useful in risk control, but also can be used as a scientific framework in decision making and policy in addressing health and environmental issues.

This study aims to analyze the level of environmental health risk through comparison of risk level of environmental health of PM10 exposure on elementary school students with vegetatation and non vegetated in Padang City and risk management that can be done so that risk can be minimized.

RESEARCH METHOD

This study was an observational analytic study using the method of Environmental Health Risk Assessment (EHRA) or prediction design. Risk Analysis Paradigm used to assess and predict which would occur due to exposure to hazardous substances. In this case PM10 comes from the burning of motor vehicles such as cars, motorcycles, trucks, and buses as well as on-road activities, as well as trails of land on the highway.

In the calculation of estimates or estimates of risk in this analysis used a single point estimation, meaning that all data taken must have one value. This research will be carried out in Padang City in 2017. The place of study is at SDN Percobaan which is located at Jl. Ujung Gurun No.56 for vegetated school and SDN 17 Gunung Pangilun in Gunung Pangilun sub-village for non-vegetated school.

The collection of data and information in the field include PM10 in the air at SDN Percobaan for vegetated area and SDN 17 Gunung Pangilun for not vegetated area. This data is taken using an air measuring instrument that is Environmental Particulate Water Monitor (EPAM) 5000. Analysis method is direct reading. Air measurements were carried out for 30 minutes each at 4 sample points for 1 day.

Anthropometric data were taken with direct weighing on the respondents using the scales, while the pattern of activities that were asked, among others, long school day and year. Data collection of anthropometry and activity pattern using research questionnaire of Environmental Health Risk Assessment with population at risk of 5th graders and 6th graders.

To determine the level of health risk in elementary school students then do the calculation of RQ (Risk Quotient). RQ represents the potential risk of PM10 exposure. The value of RQ ≤ 1 indicates PM10 indication of the absence of a possible risk of adverse effects. While RQ > 1 shows the PM10 indication of the possibility of risk of adverse effects and need to be controlled.

RESULT AND ANALISYS

Concentration of PM10

The PM10 concentration is measured at four points for 30 minutes at each sample point via direct measurements using the Environmental Particulate Air Monitor (EPAM) 5000. The measurements of the tool are converted into 24 hours. During the measurement of PM10 concentration is also done the calculation of the average volume of vehicles passing through the road at the sample point. The result of measurement of PM10 concentration and calculation of vehicle volume average can be seen in table 1 below.

Table 1: Concentration of PM10

No	Category of School	Location	PM_{10} Concentration (µm/Nm^3)
1	Vegetated	Gate of SDN Percobaan	9.221
		Park of SDN Percobaan	6.916
2	Non Vegetated	Gate of SDN 17 Gunung Pangilun	17.520
		Park of SDN 17 Gunung Pangilun	7.377

The concentration of PM10 at each point has not passed the quality standard based on the Government Regulation of the Republic of Indonesia Number 41 of 1999 on the Control of Environmental Pollution, in this rule the quality standard of PM10 is 150 µg / Nm3 (KNLH 1999). The sampling point of the gate and the field has different concentrations, ie the concentration at the school's gate is higher than in the school's field, this is due to the location of the school gate adjacent to the highway. School with non-vegetated roads had higher PM10 concentrations than school with vegetated roads. This happens because the soil dust or fine sand on the streets and school yard is carried away by the wind and influenced by plants and without any vegetated cover, and the presence of vegetated has an important role in decreasing air pollution.

Characteristics of Anthropometry and Activity Patterns of Respondents

Measurement of anthropometric characteristics and activity pattern was done on 80 respondents, that is 40 respondents from each elementary school. The variables measured were respondent age, body weight (Wb), school length per day (tE), exposure frequency, length of school day in year (fE), and duration of exposure, ie duration of school (Dt). Univariate analysis results of respondent characteristics can be seen in table 2 below.

Table 2: Characteristics of Anthropometry and Real Time Activity Patterns of Respondents

Characteristic	Vegetated School		Non Vegetated School	
	Mean	SD	Mean	SD
Age	10.88	0.273	11.35	0.949
W_b	37.5	9.273	33.85	7.866
t_E	6	0.000	5.5	0.000
f_E	272.23	1.901	272.3	1.620
D_t	5.75	0.439	5.85	0.580

The mean age of respondents was 10.88 years for the school of vegetated and 11.35 years for non-vegetated schools and the highest age was 13 years. The mean body weight (wb) of respondents was 37.5 kg for the highest-weight vegetated school was 59 kg, whereas for non-vegetated schools the average body weight (wb) of respondents was 33.85 kg with the highest body weight was 50 kg. The average daily exposure duration received by the respondents during schooling at the vegetated school was 6 hours per day and 5.5 hours per day for non-vegetated schools. The frequency of exposure (fE) of the average respondent in one year exposed to school vegetated was 272.23 days per year whereas in non-vegetated schools was 272.3. In addition, the duration of exposure (Dt) of the average respondent during schooling in the school of vegetated is 5.75 years and in non-vegetated schools for 5.85 years with the longest duration for 7 years.

Exposure Assessment

The exposure assessment is to measure or calculate the amount of intake of inhaled intake per day by calculating the concentration (C) of PM10 and incorporating the anthropometric characteristic values and activity patterns comprising the intake rate (R), exposure time (tE), exposure frequency (fE) , duration of exposure (Dt), weight (Wb), and average period (tavg) into the formula expressed as intake. The calculation of intake used the following formula.

$$\textit{Intake } (I) = \frac{C x R x t_E x f_E x D_t}{W_b x t_{avg}}$$

Realtime intake at each sampling point can be seen in table 3 below.

Table 3: Comparison Intake Between Vegetated School and Non Vegetated School

Point of Sampling	Intake in Vegetated School (mg/kg/day)	Intake in Non Vegetated School (mg/kg/day)
School's Gate	0.00055	0.001
School's Park	0.00041	0.00044

Based on table 3, it is known that the highest intake of 0.001 mg/kg/day is located at the non-vegetative school gate and the lowest intake of 0.00041 mg/kg/day located in the vegetated school field. Differences in intake values in each sampling site were influenced by different PM10 concentrations. In addition, intake or intake value is inversely proportional to weight. The greater the weight, the smaller the intake received by the respondent or vice versa.

Dose Response Analysis

The reference concentration value (RfC) of PM10 in this study was 0.11 mg/kg/day. The RfC score is different from the research of Suhananto (Suhananto 2013) with RfC of PM10 was 0.0018 mg / kg / day derived from the NAAQS primary standard for 24-hour episodes. In contrast to the values used in the study of Sukadi (Sukadi 2014) and Wulandari with PM10 values of 0.014 mg/kg/day (Wulandari, Hanani and Raharjo 2016).

Risk Characterization

Risk Quotient (RQ) is performed to obtain the value of individual risk based on received intake. If the value of RQ<1 means exposure is still considered safe for humans, whereas if the value of RQ> 1 means exposure is not safe for humans so control needs to be done.

This risk value is expressed in a known risk quotient (RQ) by dividing the intake by the RfC value as follows.

$$RQ = \frac{I}{RfC}$$

Table 4: Risk Quotient (RQ) Values of PM10 Exposure in Vegetated and Non Vegetated School

Point of Sampling	RQ of Vegetated School	RQ of Non Vegetated School	Risk or Not Risk
School's Gate	0.005	0.009	Not Risk
School's Park	0.0037	0.004	Not Risk

The result of realtime risk calculation obtained from comparison between intake and RfC value by using actual exposure duration. RQ value less than 1 in all sampling location. It means exposure is still safe or not risk at elementary school students either students at vegetated school and non vegetated school.

Risk Management

Risk management is performed to reduce the risk of exposure to a risk agent in an individual or risky population (RQ> 1). Risk management can be done by reducing the concentration of risk exposure and exposure time. Although RQ is less than 1, management is still required to reduce risk agents especially PM10, such as by limiting the age of motor vehicles and the use of fuel gas and making vegetated and adding trees to primary school with non-vegetated roads.

Risk Communication

Risk communication is an effort to convey information to the population at risk, the government such as Padang City Environmental Office, Padang City Education Office, and Padang City Health Office, as well as other interested parties.

CONCLUSION

Based on the results and discussion, it can be concluded that the concentration of PM10 at each point has not passed the quality standard based on Government Regulation no. 41/1999 on Environmental Pollution Control where the PM10 standard is 150 µg / Nm3. However, non-vegetated schools have higher PM10 concentrations than vegetated schools. Real-time risk calculations yield less than 1 RQ in all sampling locations, which means that exposure is safe or not risky for elementary school students in vegetated and non vegetated school.

REFERENCES

[1]. Soemirat, J. *Environmental Health.* Yogyakarta, DI Yogyakarta: Gajah Mada University Press, 2015.

[2]. WHO. *Health Aspect of Air Polution with Particulate matter, Ozone and Nitrogen Dioxide.* Geneva: World Health Organization, 2011.

[3]. Pudjiastuti, W. "Dust as a Pollution that Harms Occupational Health in Jakarta." Occupational Health Center, Ministry of Health Republic Indonesia, Jakarta, 2001.

[4]. Suhananto, Z. "Comparison of Risk Levels of PM10 Exposure on Highway Breveted and Brevetated to Population Health." *Journal of Public Health*, 2013.

[5]. Sumantri, A. Environmental Health. Jakarta: Kencana Prenada Media Group, 2013.

[6]. Sukadi. "Health Risks Analysis of PM10 and SO2 Exposure in Kelapa Gading North Jakarta 2014." *Journal of Public Health*, 2014.

[7]. Wulandari, A, D, Y Hanani, and M Raharjo. "Environmental Health Risks Assessment Particulate Matter Exposure (PM10) to Street Transport Traffickers." Journal *of Public Health* 4 (3) (2016).

[8]. KNLH. *Government Regulation No.41 of 1999, Concerning Air Pollution Control.* 1999.