THE CORRELATION BETWEEN THE CO EXPOSURE TOWARDS COHb LEVEL AND THE VITAL LUNG CAPACITY OF THE PARKING ATTENDANTS AROUND SETIABUDI STREET OF SEMARANG CITY

Moh. Rivandi Dengo¹, Ari Suwondo²,Suroto²

¹ Student of Occupational Safety and Health Department, Master Degree of Health Promotion, Public Health Faculty
²DiponegoroUniversity of Semarang

*Corresponding author: Moh. Rivandi Dengo, Student of Occupational Safety and Health Department, Master Degree of Health Promotion, Public Health Faculty, DiponegoroUniversity of Semarang. Email: moh.rivandidengo@gmail.com

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ABSTRACT

Background: The data from WHO in 2012 shows that approximately 7 million people were reportedly died due to the exposure to air pollution. The CO gas released from the exhaust will remain in the air. If inhaled by the human, it will enter the respiratory tract and into the lungs. The Threshold Score of CO in the working place is 25 ppm by which the concentration of CO in the inhaled air is for 8 hours per day. The concentration threshold of COHb within the blood is 0,2% - 1%.

Materials and Methods: This research used a cross-sectional approach since the independent variable and dependent variable was measured simultaneously. The data were obtained from the questionnaire. Moreover, this research also measures the CO exposure of the parking attendants and the level of CO within the blood (COHb) as well as the vital lung capacity of the parking attendants.

Result: The result of the statistical test using Chi-Square shows that the CO exposure and the level of COHb have the significance of 0,643 (p>α=0,05), while the exposure of CO and the vital capacity of the lungs have the significance of 0,019 (p<α=0,05). The result of the statistical test using Chi-Square shows that the significant level of CO exposure with the COHB is 0,643 (p>α=0,05), while the vital lung capacity is 0,019 (p<α=0,05).

Conclusion: The exposure of CO has no correlation with the level of COHb, while it has the correlation with the vital capacity of the lungs.

Keywords: Exposure of CO, Level of COHb and the Vital Lung Capacity
1.0 Introduction

Air pollution from the toxic materials is one of the world’s health problems. The data from the World Health Organization (WHO) in 2012 reports that 7 million people died due to the air pollution. Of those, 4.3 million died due to the indoor air pollution, while 3.7 people died due to the outdoor air pollution. The research conducted by The Ministry of Environment in 2010 noted that 57.8% or approximately 5 million of the Indonesian people suffered from the disease resulted from air pollution. The research carried out by International Council and Clean Transportation (ICCT) in 2013 revealed that Indonesia was among the 10 largest countries with the greatest early mortality case caused by air pollution as many as 68,954 people died (Hidayahsti et al, 2016).

According to WHO, the CO exposure with the concentration of 100 mg/m³ (87.3 ppm), 60 mg/m³ (52.38 ppm), 30 mg/m³ (26.19 ppm), 10 mg/m³ (8.73 ppm) has the duration of the normal exposure respectively lasts for 15 minutes, 10 minutes, 1 hour, and 8 hours. The resulted exposure from the CO exposure with the concentration and duration that exceed the normal concentration can cause health problems particularly in the system of cardiology, hematology, neurology, and respirology (Rivanda, 2015).

Indonesia is one of the countries with the highest number of population in the world that is followed by the highest number of the workers. The total workers are as many as 114.63 million people. Of the number, 42.38 million people (36.97%) work in the formal sector, while 72.25 million people (63.03%) work in the informal sector. Based on the data from ILO in 2016, a worker died every 15 seconds caused by the working accident or disease. Every 15 seconds, 153 workers experience the working accident. Moreover, as many as 6300 workers died everyday due to the working accident or the disease resulted from their work in which the number is similar to 2.3 million people died every year (Dinda Nur Syakbania, 2017).

Health is the essential factor for the productivity and the improvement of the worker’s productivity as the human resources. The proper health condition is potential to achieve the proper working productivity as well. The work that demands the high working productivity is only done by the worker whose health condition is good. One of the efforts to improve the worker’s health and safety is by controlling the environmental risk either physically or chemically in order to create the working environment that is healthy, safe, and comfortable (Afiani, 2016).

Carbon monoxide or CO is the result of incomplete combustion of the carbon materials or the carbon-containing material. The natural gas combustion or the petroleum can result in 5% of CO. Co is released to the air in the larger amount than other air pollutants every year. The transportation releases the most CO than other sources of CO, particularly the vehicle that uses gasoline as the fuel. The concentration of CO in the air every time in a day is affected by the crowd or the activities of the vehicle. The more crowded the vehicles, the higher the pollution level of CO in the air (Kusumawardhani, 2015).  

CO gas is the main cause of the mortality resulted from the poison in United States and the cause of more than a half number of fatal poisoning in the whole world. Approximately 40,000 patient visits per year to the emergency unit in United States are in accordance with
the intoxication case of CO gas in which the number of mortality ranged from 500-600 per year in 1990. Carbon monoxide poisoning can decrease the capacity of oxygen transportation within the blood by the hemoglobin and the use of oxygen in the cellular level. Carbon monoxide affects the organs of the body. The most destructive organ is those consuming a large amount of oxygen namely brain and heart (Soekamto, 2008).

The amount of COHb that is formed depends on the length of the exposure towards CO. If CO gas enters the lungs, it will block the entry of oxygen to the Hb since HB tends to attach the CO. The bond between CO and HB is called as COHb. The amount of COHb that is formed depends on the length of exposure towards CO. If the carbon monoxide of 26-30 ppm is inhaled by the human for 8 hours during the working hours, the human will suffer the dizziness and nausea. The exposure of carbon monoxide exposure within the human, according to National Institute for Occupational Safety and Health (NIOSH in 1993, is 1807 ppm in 4 hours. The longer CO exposure received by the human will affect the COHb level within the blood (Khoiriyah, 2016).

The carbon and oxygen can combine to form the carbon monoxide compound (CO) as the incomplete combustion and carbon dioxide as the result of complete combustion. Carbon monoxide is odorless, tasteless, and colorless in the normal temperature. Unlike the compound, CO is potential to have the character of dangerous poison since it can form the strong bond with the blood pigments namely hemoglobin (Ya’kut and Arinto Yudi P.W, no date).

Respiration is the process of inhaling the air from the outside which contains the oxygen within the body as well as exhaling the air which contains a large amount of CO as the residual of the oxidation released from the body. In lungs, the exchange between the oxygen from the air entering the blood and the CO2 released through respiratory tract and enters the body through pulmonary venous capillaries. It will enter the left ventricle of the heart (atria synitra), continue to the aorta, and end up by entering the entire body (tissues and cells) in which it the oxidation (combustion) occurs as the residual of the combustion. CO and the substances are released through the circulation of venous blood that enters the heart and goes through the right ventricle. Next, it will be released by the pulmonary artery to the tissues of the lungs that will be released through the epithelium and alveoli layers. (Ahadiansyah, 2017)

Vital lung capacity is the maximum amount of air that can be released from the lungs after the air is maximally filled. Pulmonary capacity is a combination of pulmonary circulation events or expression of two or more lung volumes, namely airway breathing, expiratory reserve volume, and residual volume. Respiratory tract disorders will cause the decrease in function of the lungs. To determine the function of a person’s lungs whether or not they work normally, it can be seen from the measurement of lung volume by checking the spirometry. (Ode, Hariati and Syawal, 2016)

Carbon monoxide threshold score in the working place is 25 ppm. It has been determined by the Regulation of the Ministry of Labor and Transmigration of the Republic of Indonesia Number PER.13 / MEN / X / 2011 for CO concentrations in the air that is inhaled for 8 hours per day and normal CO levels within the blood ranged between 0.2% - 1.0%. The level of CO in the air around Setiabudi Street will be exposed to the parking attendants. It is because their
work activities are in the area around Setiabudi Street. Therefore, the exposure of CO levels in the air exposed to parking attendants will affect the health of the parking attendant.

Based on those conditions, it needs to be investigated especially to find out and analyze the air pollution due to vehicle emissions in the area of Setiabudi Street. Due to the description, a special study was carried out on “The relationship of CO exposure to Oxygen Saturation and Lung Vital Capacity in parking attendants.” The study was aimed at measuring and analyzing the relationship of CO exposure to Oxygen Saturation and Lung Vital Capacity in parking attendants.

2.0 Materials and Methods

This study used quantitative method with observational analytical study methods. It is to determine the exposure between variables. The Cross-Sectional approach was employed because the independent variable and the dependent variable are measured simultaneously. Conducting the observation and measuring variables were only observed once, while variable measurements were done at the time of the examination. The design of this study was carried out economically and the results can be obtained quickly. Moreover, many variables can be collected simultaneously both risk variables and exposure variables. Cross-sectional study design can be used to study many tables at once and it rarely needs to be followed up (dropped out).

This research data were obtained through questionnaire and measured CO levels in parking attendants, measured oxygen saturation, and measured vital lung capacity in parking attendants. The sampling was obtained directly by the researchers in the research field. The secondary data were taken from CO levels in the air which were obtained from the Semarang City Environmental Service and the number of vehicles from the Central Bureau of Statistics in Semarang City.

The Procedures in Measuring CO in a Parking Attendants
a) Turn on the tool by holding the button for 3 seconds, b) Install the D-Piece and Steribreathe Mouthpiece, c) Double clicks the button to start the examination, then inhale, d) Hold your breath during the countdown of 15 seconds, e) The sound "BIB" will be heard in countdown of 3 seconds. Enter the mouth mouthpiece and exhale, f) The screen will display the reading result and the Led light will turn on according to the CO detection level, g) Remove the D-Piece after doing the test and make sure to turn off the button tool for 3 seconds.

The Procedure of COHb level Examination in the blood
a) Erlenmeyer is poured by 20 ml of ammonia solution as much as 20 ml, b) a blood sample of 10 µl is added and mixed until homogeneous, c) Add one spatula shoot of Na2S2O5 solution, mix until homogeneous and d) Read on a spectrophotometer with $\lambda$ is 546 nm.

The first Procedure of Lung Vital Capacity Measurement is asking the respondents to weigh and measuring the respondents’ height. The respondents have to be smoke-free for 2 hours before measurement, the respondents have to be free of asthma medicine consumption for 8 hours before measurement, the respondents are in a standing position using loose clothes, the
instructor explains the purpose and method of taking breath and respondents are asked to follow the instructions from the instructor. In Force Vital Capacity Measurement, the operator presses the FVC button, the respondents inhale a deep breath and exhale through the mouthpiece quickly until all the air can be released as much as possible (minimum 10 seconds of expiration), press the enter button and record the FVC measurement, FVC prediction, FVC%, FEV1 measurement, FEV1 prediction, FEV1%, FEV1 / FVC%.

Data analysis was carried out by testing hypotheses which were conducted in stages, namely by univariate analysis to explain or describe the characteristics of each variable being studied. The shape depends on the type of data. In this research, determine the relationship between CO exposure to COHb level, Oxygen Saturation, Lung Vital Capacity, and Working Fatigue were by reviewing bivariately using a Chi-Square Test at significance level of 95% or $\alpha = 0.05$. If a value is greater than 0.05, it means that H0 is accepted or Ha is rejected. In contrast, if a value is less than 0.05, it indicates that H0 is rejected or Ha is accepted.

3.0 Result

3.1 Measurement Result of CO Exposure

<table>
<thead>
<tr>
<th>Number</th>
<th>CO Exposure</th>
<th>Total</th>
<th>N</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Abnormal</td>
<td>8</td>
<td>26,7</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Normal</td>
<td>22</td>
<td>73,3</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>30</td>
<td>100</td>
<td></td>
</tr>
</tbody>
</table>

Based on the measurement that has been obtained in table 1, it can be determined that the respondents with the abnormal CO exposure are 8 respondents (26,7%), while those with the normal CO exposure are 22 respondents (73,3%).

3.2 Measurement of COHb Level

<table>
<thead>
<tr>
<th>No</th>
<th>COHb Level</th>
<th>Total</th>
<th>N</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Abnormal</td>
<td>22</td>
<td>73,3</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Normal</td>
<td>8</td>
<td>26,7</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>30</td>
<td>100</td>
<td></td>
</tr>
</tbody>
</table>
Based on the measurement that has been obtained in table 2, it can be determined that the respondents with the abnormal COHb level are 22 respondents (73.3%), while those with the normal COHb level are 8 respondents (26.7%).

3.3 Measurement of Vital Lung Capacity

<table>
<thead>
<tr>
<th>No</th>
<th>Lung Vital Capacity</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>N</td>
</tr>
<tr>
<td>1</td>
<td>Abnormal</td>
<td>26</td>
</tr>
<tr>
<td>2</td>
<td>Normal</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>30</td>
</tr>
</tbody>
</table>

Based on the measurement that has been obtained in table 3, it can be determined that the respondents with the abnormal vital lung capacity are 26 respondents (86.7%), while those with the normal vital lung capacity are 4 respondents (13.3%).

3.4 The Relationship between CO Exposure towards COHb Level

Table 4 shows that the proportion of the respondents with the abnormal COHb level within the blood is 62.5% or 5 respondents with the abnormal CO level. It is lesser than the respondents with the normal CO level as many as 17 respondents (77.3%). The statistical test using Chi-Square obtained the p-value of 0.643 (>α=0.05). It indicates that there is no relationship between the CO exposure and the COHb level in the parking attendants around Setiabudi Street in Semarang City.

Table 4: The relationship between CO Exposure and Vital Lung Capacity in the Parking Attendants around Setiabudi Street in Semarang City

<table>
<thead>
<tr>
<th>No</th>
<th>CO Exposure</th>
<th>COHb Level in Blood</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Abnormal</td>
<td>Normal</td>
</tr>
<tr>
<td></td>
<td></td>
<td>n</td>
<td>%</td>
</tr>
<tr>
<td>1</td>
<td>Abnormal</td>
<td>5</td>
<td>62.5</td>
</tr>
<tr>
<td>2</td>
<td>Normal</td>
<td>17</td>
<td>77.3</td>
</tr>
<tr>
<td></td>
<td>Amount</td>
<td>22</td>
<td>73.3</td>
</tr>
<tr>
<td></td>
<td>PR = 0.809</td>
<td>95%CI = 0.452 – 1.448</td>
<td></td>
</tr>
</tbody>
</table>

Table 4 shows that the proportion of the respondents with the abnormal COHb level within the blood is 62.5% or 5 respondents with the abnormal CO level. It is lesser than the respondents with the normal CO level as many as 17 respondents (77.3%). The statistical test using Chi-Square obtained the p-value of 0.643 (>α=0.05). It indicates that there is no relationship between the CO exposure and the COHb level in the parking attendants around Setiabudi Street in Semarang City.
3.5 The Relationship between CO Exposure with Vital Lung Capacity

Table 5: The Relationship between CO Exposure with Vital Lung Capacity in the parking attendants around Setiabudi Street in Semarang City.

<table>
<thead>
<tr>
<th>No</th>
<th>CO Exposure</th>
<th>Vital Lung Capacity</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Abnormal n</td>
<td>Normal n</td>
</tr>
<tr>
<td>1</td>
<td>Abnormal</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>Normal</td>
<td>21</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Amount</td>
<td>26</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>PR = 0,655</td>
<td>95% CI = 0,380 – 1,129</td>
<td></td>
</tr>
</tbody>
</table>

Based on table 5, it shows that the proportion of the respondents with abnormal vital lung capacity is 62.5% or 5 respondents with abnormal CO exposure. It is less than those with the normal CO exposure as many as 21 respondents (95.5%). The statistical test using Chi-Square obtained p-Value of 0.019 (<α=0.05). It indicates that there is relationship between CO exposure towards the vital lung capacity in the parking attendants around Setiabudi Street in Semarang City.

4.0 Discussion

4.1 The Relationship Between CO Exposure towards COHb Levels

Hemoglobin has an affinity for carbon monoxide 250 times greater than oxygen. A volume is known as pure CO gas that is added to a heparinized human syringe or cow blood to produce COHb levels from 0.5% to 90%. An additional satisfactory method is found by mixing the known amount of 95% of COHb blood with normal blood to reach the desired level of COHb (Bickler and Rhodes, 2018)

Based on bivariate analysis, the proportion of the respondents with abnormal CO exposure towards COHb levels in the blood was 65.2% or 5 respondents. It is less than those with normal CO exposure of 77.3% or 17 respondents. The results of Chi-Square statistical analysis show P-Value of 0.643 (> α = 0.05). It indicates that there is no relationship between CO exposure towards COHb levels within the blood of the parking attendants.

The normal COHb levels in the blood are found in respondents with normal CO exposure. The proportion of abnormal COHb levels in the blood is higher than those with normal CO exposure which is also compared to the respondents with abnormal CO exposure. Although there is no correlation between CO exposure towards COHb levels within the blood of the parking attendants, the measurement of abnormal COHb levels within the blood shows that there are 73.3% or 22 respondents which is higher than those with normal COHb levels which are 26.7% or 8 respondents. It may due to the CO exposure towards the workers that do not use the personal safety equipment such as masks.
This study is not in accordance with what was done by Devy Noviandhita Anggarani in which her study showsthat there is a relationship between CO gas concentration and COHb concentration in high-risk communities at the study field (Anggarani, Rahardjo and Nurjazuli, 2016). Meanwhile, the research conducted by Aldila Linda Pratiwi in the result of statistical correlation test Sperarman shows that there is no significant correlation between carbon monoxide and hemoglobin levels, with p = 0.454; r = 0.119. (Pratiwi, 2015)

Carbon monoxide is one of the biggest exhaust gases from motor vehicles that can enter the human body through respiration and can distract the health because its presence in the body can shift the position of oxygen in binding hemoglobin. When humans breathe, gas in the air such as oxygen, nitrogen, carbon monoxide, and other gases will be inhaled into the lungs and flows into the alveoli and into the bloodstream. CO gas poisoning is hard to diagnose because the symptoms are general and similar to flu symptoms. However, CO gas exposure in high doses can affect the brain, cause nausea, and death. (Dewanti, no date)

4.2 Carbon Monoxide Exposure to Lung Vital Capacity

Generally, it consists of two or more primary lung volumes, namely total lung capacity, which is the amount of air in the lungs at maximum inspiration, for instance, in adults with a weight of 70 kilograms is about 6 liters. Vital capacity, which is the amount of air that can be maximized after maximum inspiration, for instance, in adults with a weight of 70 kilograms is about 4.5 liters. Inspiratory capacity, which is the maximum amount of air that can enter the lungs after the final ordinary expiration, for instance, in adults with 70 kilograms of body weight is about 3 liters. Functional residual capacity, which is the amount of air in the lungs at the final ordinary expiration. (Sari, 2013)

Based on bivariate analysis, the proportion of respondents with abnormal CO exposure towards abnormal lung capacity is 62.5% or 5 respondents. It is less than those with normal CO exposure of 95.5% or 21 respondents. The results of Chi-Square statistical analysis obtained P-Value 0.019 (<α = 0.019). It indicates that there is a relationship between CO exposure towards lung vital capacity of the parking attendants. The results of PR = 0.655 with a 95% Confidence Interval (CI) (0.380-1.129). Therefore, these results indicate that parking attendants have a risk of 0.655 times of experiencing the decreased lung vital capacity.

Normal lung vital capacity is mostly found in respondents with abnormal CO exposure. The proportion of normal vital lung capacity is also higher than from the respondents with abnormal CO exposure compared to respondents with normal CO exposure. The results of measurement of lung vital capacity in respondents show that there is abnormal lung capacity of 86.7% or 26 respondents and is higher than normal lung vital capacity of 13.3% or 4 respondents.

The results of this study are in accordance with the research conducted by Rif Atiningtyas Haris, Indriyati, Irwan Cahya Kusuma in which the results of the study show that there is the exposure of air pollution on the function of lung capacity parking attendants in the zone C parking area of Surakarta City (Haris and Kusuma, 2017). It is also related to the research conducted by Setiyawan Nurbiantara in which the calculation results show that a confidence interval of 95% can obtain odds ratio of 5.65 and confidence interval between 1.43-22.28,
Lung damage is caused by dust, vapors or harmful gases inhaled by workers in the working area. Various types of lung diseases can occur due to the gas exposure that arise in the industrialization process. The type of lung disease that arises depends on the type of exposure, but the clinical manifestations of occupational lung disease are similar to other lung diseases that are not related to work. Occupational lung disease turns out to be a major cause of disability, loss of workdays and death in workers (Löfstedt et al., 2017).

Vital capacity (VC) is the maximum amount of air that a person can release from the lungs after inhaling maximum air. It is equal to the amount of inspiratory reserve volume, tidal volume, and expiratory reserve volume. A person's vital capacity can be measured with a wet or ordinary spirometer. In the combination with other physiological measurements, vital capacity can help to diagnose the underlying lung disease. In addition, vital capacity is used to determine the severity of respiratory in muscle involvement in neuromuscular diseases and can guide the treatment decisions in Guillain-Barre syndrome and the Myasthenic crisis. A normal adult has a vital capacity between 3 and 5 liters. Human vital capacity depends on age, gender, height, mass, and ethnicity. Lung volume and lung capacity refer to the volume of air which is related to the different phases of the respiratory cycle. Lung volume is measured directly, while lung capacity is inferred from the volume. (Bhatt and Trivedi, 2018)

5.0 Conclusion and recommendation

Based on the results of research about the relationship of CO exposure to oxygen saturation and vital lung capacity in parking attendants, it can be concluded as follows: CO exposure is not related to oxygen saturation in parking attendants and CO exposure relates to the vital lung capacity in parking attendants.

The researchers further need to select other research locations and a larger number of samples so that the research on CO exposure is more meaningful. For workers, it is suggested to always use personal protective equipment such as masks since they can reduce CO exposure that can cause health problems.

Acknowledgement

This research has been approved by the Health Research Ethics Commission, Faculty of Public Health, Diponegoro University and it has been approved by counselors and examiners.
Declaration

Author(s) declare that the research results are prepared and compiled by themselves and have never been submitted to obtain a degree in any educational program.

Authors contribution

Author 1: Moh. Rivandi Dengo - Data collection, data analysis and draft manuscript
Author 2: Dr. dr. Ari Suwondo, MPH - Review manuscript
Author 3: Dr. Drs. Suroto, M.Pd - Review manuscript

References


Isnaini wahyu laila. 2012. Pengaruh Paparan Gas Karbon Monoksida ( Co ) Terhadap


