Exhaled Carbon Monoxide Levels of Scavengers in Bantar Gebang Landfill, Bekasi

Agus Dwi Susanto*, Dita Kurnia Sanie, Fahrial Harahap
Department of Pulmonology and Respiratory, Faculty of Medicine, Universitas Indonesia – Persahabatan Hospital

ABSTRACT

Background: Scavengers in landfills have high risk to pollution exposure. Carbon monoxide (CO) is one of important pollutants produced by burning process. Exhaled CO levels in scavengers is predicted to increase, caused by pollution exposure in workplace area. There has been no data on exhaled CO levels in scavengers, especially in Bantar Gebang, Bekasi. Methods: This study used cross-sectional design to the scavengers who work and live in Ciketing Udik, Bantar Gebang, Bekasi. This study was conducted in January - March 2015, by doing interviews and giving questionnaires, and conducted exhaled CO test. Results: Total sample was 108 subjects. Exhaled CO test result was 46 subjects (42.6%) had exhaled CO 5-10 ppm, 36 subjects (33.3%) > 10 ppm, and 26 subjects (24.1%) ≤ 4 ppm. Multivariate analysis between exhaled CO levels with characteristics of the subjects found smoking habits were significantly correlated with CO exhalation levels (p=0.000). Conclusion: There were 33.3% scavengers who had exhaled CO > 10 ppm. Smoking habits were the only factor that significantly correlated with CO in scavengers’ exhalation.

Keywords: scavengers, carbon monoxide exhalation

INTRODUCTION

Waste disposal at landfills is increasingly causing concern for the health of residents who live nearby, especially with hazardous waste being disposed of. Studies on health regarding disposal sites have been carried out, especially in North America. Sanitation workers, especially garbage collectors in urban areas, are one of the occupations that posed high risk to health and safety. Increased volume, influx of hazardous waste streams, manual handling of waste, inadequate personal protective equipment (PPE), lack of awareness about health, poor sanitation, and poor environmental management at landfill sites expose workers to environment and hazardous work. Even though the incidence and prevalence of hazards to waste sector workers are increasing, very little research has been done in developing countries. Many researches were carried out in developed countries, but the data cannot be directly extrapolated to developing countries.

There have been reported occupational health hazards associated with handling waste which include skin, eye, and respiratory system infections, accidents such as bone and muscle disorders resulting from handling heavy containers, wound infections due to contact with sharp objects, poisoning and chemical burns due to contact with small amount of hazardous chemical waste mixed with general waste, and other injuries due to workplace accidents at landfills or from methane gas explosions at landfill sites. Based on the research conducted by Abdou, there are four major health problems due to working in landfills, namely respiratory infections and/or allergies (65.5%), eye infections (48.3%), gastrointestinal infections (20.7%), and musculoskeletal injuries (17.2%). A study in Karachi, Pakistan, showed that diseases arising include tuberculosis (TB), gastric problems, respiratory problems, skin infections, and ulcers.

Workers at landfills have a significantly higher prevalence of upper and lower airway disorders and they more often suffer from diarrhea, fungal infections, skin ulceration, burning sensation in the extremities, tingling or numbness, temporary memory loss, and depression. Another study in Delhi, India, in 1995 reported that workers in landfills and plant incineration had an increased risk of lung and digestive disorders. Gas in landfills consists of a mixture of different gases, including methane (45%-60%) and carbon dioxide (40%-60%). It also includes small amounts of nitrogen, oxygen, ammonia, sulfide, hydrogen, carbon monoxide (CO), and non-methane organic compounds (NMOCs) such as trichlorethylene, benzene, and vinyl
chloride. These gases also have an impact on the health of workers in the landfills, especially pulmonary health problems.

The aim of this study was to obtain data on levels of exhaled CO in scavengers in Bantar Gebang and the factors that influence it.

METHODS

This study used cross sectional study design. This research was part of a research on respiratory disorders and pulmonary function in the scavengers in Bantar Gebang, Bekasi. The place of research was at RT 01/05, Biketing Udik, Bantar Gebang, Bekasi. The research was conducted in January - March 2015. The sample of the study was all scavengers living in the area of Biketing Udik, Bantar Gebang, Bekasi, and met the research criteria. The minimum total sample needed was 97 subjects, rounded to 100 subjects.

The sampling technique was done by consecutive sampling in which every affordable population that met the research criteria was included as a sample to meet the required sample size. The inclusion criteria were male and female, >14 years old, were able to perform the lung function test and exhaled CO examination properly, signed the consent form, and were willing to complete the research procedures. The samples were excluded if the spirometry examination was not acceptable and was not reproducible. Subjects were given a basic questionnaire and underwent spirometry examination and exhaled CO examination. The basic questionnaire contained respondent’s identity and sociodemographic data. Exhaled CO levels were measured using Bedfont piCO+™ Smokerlyzer® device. Data on the content of air pollutant gases including CO levels in the air were obtained from the examination results of DKI Jakarta Provincial BPLHD (Regional Environmental Management Department). This research was approved by Ethics Committee of Faculty of Medicine, Universitas Indonesia.

RESULTS

This research was conducted on scavengers who live and work in Bantar Gebang TPST (Integrated Waste Disposal), Bekasi. Samples collected were 120 samples. From 120 samples, only 108 samples met the research criteria.

Characteristics of the Subjects

Characteristics of the subjects consisted of gender, age group, nutritional status, level of education, smoking habits, distance of the house, length of exposure, and years of service. In this study, most subjects were female, which were 80 subjects (74.1%), while male subjects were only 28 subjects (25.9%). The age of the subjects consisted of 15-35 years old as many as 51 subjects (47.2%) and >35 years old as many as 57 subjects (52.8%). Body mass index (BMI) of the subjects were normal category in 60 subjects (55.6%), less in 10 subjects, overweight in 31 subjects, and obesity in 7 subjects. The level of education of the subjects were 21 subjects (19.4%) never attend formal education, 78 subjects (72.2%) graduated from Elementary Schools, 7 subjects (6.5%) graduated from Junior High Schools, and 2 subjects (1.9%) graduated from Senior High Schools. Based on smoking habits, subjects were found to be non-smokers in 75 subjects (69.4%) and smokers in 33 subjects (30.6%). The distance between the house and landfill was 81 subjects (75%) ≤200 meters and 27 subjects (25%) >200 meters. Based on years of service, subjects were divided into ≤10 years in 49 subjects (45.4%) and >10 years in 59 subjects (54.6%). The length of exposure in a day was divided into 1-6 hours/day in 48 subjects (44.4%) and >6 hours/day in 60 subjects (55.6%). All 108 subjects (100%) did not use personal protective equipment (PPE).

Exhaled carbon monoxide levels

Exhaled carbon monoxide (CO) examination results have an abnormal distribution with a median value of 7 ppm, the lowest value of 2 ppm, and the highest value of 23 ppm. While COHb results obtained a median value of 1.8% with the lowest value of 1% and the highest value of 4.4%. Exhaled CO of ≤4 ppm was found in 26 subjects (24.1%), 5-10 ppm was found in 46 subjects (42.6%), and >10 ppm was found in 36 subjects (33.3%). The distribution of subjects based on exhaled CO examination can be seen in table 1.

| Exhaled CO levels | n (subjects) | Percentage (%) |
|-------------------|-------------|----------------|
| ≤ 4 ppm           | 26          | 24.1           |
| 5-10 ppm          | 46          | 42.6           |
| > 10 ppm          | 36          | 33.3           |

Pollutant levels from samples of airborne particles

Data on air analysis was obtained through inspection by DKI Jakarta BPLHD (Regional Environmental Management Department). The examination was carried out for 4 times on different days (test results 1, 2, 3, and 4, as can be seen in table 2). Based on the data, the air quality at Bantar Gebang landfill was still below the quality standard.

| Parameters | Denomination | Test results | Quality Threshold |
|------------|--------------|--------------|------------------|
| NO₂        | ug/Nm³       | <10          | 400              |
| SO₂        | ug/Nm³       | <27          | 900              |
| H₂S        | ug/Nm³       | <8           | 35               |
| NH₃        | ug/Nm³       | 45.5–95.5    | 100              |
| CO         | ug/Nm³       | 342–1026     | 30000            |
| TSP        | ug/Nm³       | 134–271      | 230              |
| Pb         | ug/Nm³       | 0.03–0.14    | 1                 |
Relationship between characteristics of the subjects and exhaled carbon monoxide (CO) levels

Analysis of exhaled CO levels with independent variables, including gender, age group, nutritional status, level of education, smoking habits, distance of the house, length of exposure, and years of service was conducted with Mann Whitney test. The results of the analysis of exhaled CO levels on age (p = 0.058), level of education (p = 0.409), nutritional status (p = 0.074), distance of the house (p = 0.743), and years of service (p = 0.294) have no statistically significant relationship (p > 0.05). Only gender (p = 0.000), smoking habits (p = 0.000), and length of exposure (p = 0.007) have a significant relationship with exhaled CO levels (table 3).

Table 3. Relationship between characteristics of the subjects and exhaled carbon monoxide (CO) levels

| Variable                      | Exhaled CO levels | p-value |
|-------------------------------|-------------------|---------|
| Gender                        |                   |         |
| Male                          | 15 (4-23)         | 0.000   |
| Female                        | 6 (2-14)          |         |
| Age                           |                   |         |
| 15-35 years old               | 6 (2-21)          | 0.058   |
| >35 years old                 | 7 (2-23)          |         |
| Education                     |                   |         |
| In school                     | 6 (2-23)          | 0.409   |
| Not in school                 | 7 (2-22)          |         |
| Nutritional status            |                   |         |
| Normal                        | 7 (2-23)          | 0.074   |
| Abnormal                      | 7 (2-21)          |         |
| Smoking habits                |                   |         |
| Non-smokers                   | 6 (2-14)          | 0.000   |
| Smokers                       | 15 (4-23)         |         |
| Distance of the house         |                   |         |
| ≤200 meters                   | 7 (2-23)          | 0.743   |
| >200 meters                   | 7 (2-21)          |         |
| Length of exposure            |                   |         |
| ≤1 hours                      | 7 (2-19)          | 0.007   |
| >1 hours                      | 11 (2-23)         |         |
| Years of service              |                   |         |
| ≤5 years                      | 7 (2-21)          | 0.294   |
| ≤10 years                     | 7 (2-23)          |         |

*Fisher test

Further multivariate analysis of exhaled CO levels was performed on independent variables with p < 0.25, including age, nutritional status, gender, length of exposure, and smoking habits (table 4). The results of the linear regression analysis showed that the variables that were significantly related to exhaled CO levels were gender and smoking habits (p = 0.015 and p = 0.000, respectively). Correlation analysis on gender and smoking habits were -0.302 and -0.504, thus an adjusted R² = 0.636 was obtained. In other words, gender and smoking habits affect exhaled CO levels by 63.6%, and the rest was influenced by other variables.

Table 4. Linear regression analysis of exhaled carbon monoxide levels

| Variable              | R      | p-value  |
|-----------------------|--------|----------|
| Age                   | 0.022  | 0.717    |
| Nutritional status    | 0.060  | 0.319    |
| Distance of the house | -0.083 | 0.224    |
| Gender                | -0.302 | 0.015    |
| Smoking habits        | -0.504 | 0.000    |

DISCUSSION

This research was conducted with the aim of understanding the levels of exhaled carbon monoxide (CO) in scavengers who work at Bantar Gebang landfill. Exhaled CO examination results in this study obtained a median value of 7 ppm with the lowest value of 2 ppm and the highest value of 23 ppm. The largest percentage of exhaled CO was 5-10 ppm as many as 46 subjects (42.6%), followed by > 10 ppm as many as 36 subjects (33.3%), and ≤ 4 ppm as many as 26 subjects (24.1%). Exhaled air CO levels have long been used extensively in assessing a person's smoking status indicator.5 It is also a potential biomarker associated with outdoor air pollution exposure.10 The research conducted by Maga, et al. who assessed the effect of air pollution and smoking habits on exhaled air CO levels, found that in non-smokers, higher levels of exhaled CO were found in subjects living in large city areas compared to smaller cities.11 In this study, analysis of exhaled CO levels on gender, smoking habits, and length of exposure had a significant relationship. The relationship of exhaled CO levels to gender cannot be concluded because most the majority of the subjects were women who mostly did not smoke, thus it can cause bias. Based on multivariate analysis, it was found that the variables that correlated significantly with exhaled CO levels were smoking habits (p = 0.000). The results of the study are in accordance with the research conducted by Inayatillah, et al. which found that exhaled CO levels in smokers were higher than non-smokers.12 The research conducted by Maga, et al. assessed the effect of air pollution and smoking habits on exhaled CO levels and also found that exhaled CO levels in smokers were higher than non-smokers.11

Based on the data from the samples, CO levels in Bantar Gebang landfill is still below the quality standard threshold value. Therefore, the increase of exhaled CO levels in subjects was more due to their smoking habits and not due to length of exposure at work. This also caused distance of the house and years of service did not have a significant relationship with exhaled CO levels. The data in this study is in accordance with the literature which shows that the amount of CO in the landfill area is very small.9 The smoking habits of the scavengers in this study is closely related to exhaled CO levels. Smoking habits at work have a high risk of respiratory disorders in workers. According to Mustajbegovic, et al., smoking has a close relationship with respiratory disorders in the workplace.13 The research conducted by Eisner, et al., also supports this, that smoking is a risk factor that can cause health problems in the workplace.14

CONCLUSION

Total of 36 subjects (33.3%) had high levels of exhaled carbon monoxide (CO) which were above 10 ppm. Exhaled CO levels in scavengers was not associated with exposure to pollutants at work, but was significantly related to smoking habits.
REFERENCES

1. Vrijheid M. Health Effects of Residence Near Hazardous Waste Landfill Sites: A Review of Epidemiologic Literature. *Environ Health Perspect*. 2000; 108 Suppl 1: 101-12.

2. Roopa S, Padmavathi R, Akolkar A, et al. Respiratory Functions of Conservancy Workers Working in Solid Waste Management Sector of Chennai, India [Version 2; Peer Review: 1 Approved, 1 Approved with Reservations]. *F1000Research*. 2013; 1.

3. Abdou M. Health Impacts on Workers in Landfill in Jeddah City, Saudi Arabia. *The Journal of the Egyptian Public Health Association*. 2007; 82: 319-29.

4. Programme UNE. Health Impacts of Solid Waste. In: Nations U, (Ed.). *Online*. 1996.

5. Middleton ET and Morice AH. Breath Carbon Monoxide as an Indication of Smoking Habit. *Chest*. 2000; 117: 758-63.

6. Rouse JR. Seeking Common Ground for People: Livelihoods, Governance and Waste. *Habitat International*. 2006; 30: 741-53.

7. Ray MR, Roychoudhury S, Mukherjee G, Roy S and Lahiri T. Respiratory and General Health Impairments of Workers Employed in a Municipal Solid Waste Disposal at an Open Landfill Site in Delhi. *International Journal of Hygiene and Environmental Health*. 2005; 208: 255-62.

8. Poulsen OM, Breum NO, Ebbehoj N, et al. Sorting and Recycling of Domestic Waste. Review of Occupational Health Problems and Their Possible Causes. *The Science of the Total Environment*. 1995; 168: 33-56.

9. Registry AFTSD. Landfill Gas Primer - An Overview for Environmental Health Professionals. 2001.

10. Lawin H, Ayi Fanou L, Hinson V, et al. Exhaled Carbon Monoxide: A Non-Invasive Biomarker of Short-Term Exposure to Outdoor Air Pollution. *BMC Public Health*. 2017; 17: 320.

11. Maga M, Janik MK, Wachsmann A, et al. Influence of Air Pollution on Exhaled Carbon Monoxide Levels in Smokers and Non-Smokers. A Prospective Cross-Sectional Study. *Environmental Research*. 2017; 152: 496-502.

12. Inayatillah IR, Syahrudin E and Susanto AD. Kadar Karbon Monoksida Udara Ekspirasi pada Perokok dan Bukan Perokok serta Faktor-Faktor yang Mempengaruhi. *J Respir Indo*. 2014; 34: 180-90.

13. Mustajbegovic J, Zuskin E, Schachter EN, et al. Respiratory Findings in Chemical Workers Exposed to Low Concentrations of Organic and Inorganic Air Pollutants. *American Journal of Industrial Medicine*. 2000; 38: 431-40.

14. Eisner MD, Yelin EH, Katz PP, Lactao G, Iribarren C and Blanc PD. Risk Factors for Work Disability in Severe Adult Asthma. *The American Journal of Medicine*. 2006; 119: 884-91.