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The Difference in Carboxyhemoglobin Levels in Blood between Grilled and Non-grilled Food Vendors in Medan, Indonesia

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Abstract

BACKGROUND: Carbon monoxide (CO) is air pollutants that have continued to increase in level. It might affect the body through the binding of CO with hemoglobin (Hb) in blood to form carboxyhemoglobin (COHb). In addition to cigarettes, another pollutant that might affect the COHb levels in the blood is the smoke produced from grilled food.

AIM: Thus, this research was done to identify the difference in COHb levels in blood between grilled and non-grilled food vendors.

METHODS: A comparative analysis study with a cross-sectional design was done between October and November 2020 at Jalan Dr. Mansyur, Medan. The sample for the measurement of COHb levels of each subject was taken from blood plasma. COHb levels were measured with Human COHb Elisa Kit, Size 96 Wells, Brands Bioassay TL at the integrated research laboratory of Universitas Sumatera Utara. Data analysis was done using SPSS version 24.0. Normality test of COHb levels in blood between grilled and non-grilled food vendors was done using Shapiro–Wilk test, where $p > 0.05$ indicated a normal distribution of data.

RESULTS: A total of 50 subjects (25 from grilled food vendors and 25 from non-grilled food vendors) met the research criteria. Thirty-two subjects (64%) aged 20–30 years, where 19 of them were grilled food vendors (59.4%) and 13 (40.6%) were non-grilled food vendors. COHb levels were 500.22 ng/ml with minimum and maximum levels of 106.21 ng/ml and 1204.14 ng/ml observed, respectively. The median of COHb levels in grilled food vendors (352.81 ng/ml) was found to be lower than that in non-grilled (513.58 ng/ml). Comparative analysis results showed $p = 0.204$ ($p > 0.05$).

CONCLUSION: There was no significant differences in COHb levels in blood between grilled and non-grilled food vendors in Medan.

Introduction

Air pollution arising from toxic substances is known as one of the world's leading health issues. Based on data from the World Health Organization (WHO) in 2004, more than 700 deaths in children and adolescents were due to exposure to toxic substances. Air pollution can be explained through three processes, attrition, evaporation, and combustion. Combustion was found to be the most dominant process in the ability to produce pollutants [1].

Data from Kementerian Lingkungan Hidup (The Ministry of Environment and Forestry of Indonesia) showed that, in 2013, Indonesia was reported as one of the countries with the highest pollution level, where approximately 70% of health-related issues were observed in the area with high pollution levels, such as Jakarta, Medan, Batam, and Solo [2]. Medan was stated to be one of the cities with pollution levels that required special attention. Furthermore, between 2017 and 2018, Medan was mentioned as the city with dangerous pollution levels as the pollutant particles have reached 110 microns in diameter [3].

One of the air pollutants that brought negative health effects is carbon monoxide (CO). CO is a toxic gas produced through the combustion of carbon-based fuel or organic fuel with little oxygen supplies [4]. CO will bind with hemoglobin (Hb) to form carboxyhemoglobin (COHb). The increase in the COHb levels in the blood can slow down the oxygen (O_2) flow due to the higher affinity between Hb and CO compared to O_2. As a result, individuals exposed to high levels of CO might experience hypoxia which could be fatal and deadly [5]. The immune system could determine the body's tolerance against the presence of CO. CO poisoning can be observed through light symptoms such as dizziness, headache, and nausea [6].

Prolonged exposure to CO was often seen in individuals working in close contact with the combustion-related processes. Grilled food (i.e., satay, grilled meatballs, and chicken) vendor is one of the examples

of the job at risk. These individuals were exposed daily to the smoke produced from charcoal used as the heat source or fuels for cooking [7].

Epidemiological and analytical studies examining the difference in COHb levels between grilled and non-grilled food vendors were still extremely limited. In Medan alone, there were no specific data that have identified the issue. Thus, this study was done to identify the difference in COHb levels in blood between grilled and non-grilled food vendors, especially in Medan.

Methods (Study Design and Sampling)

A comparative analysis study with a cross-sectional design was used in this research. Twenty-five grilled food vendors and 25 non-grilled food vendors along Jalan Dr. Mansyur, Medan, were chosen as research subjects. This research was done between October 2020 and November 2020 and had been approved by the Health Research Ethics Committee, Faculty of Medicine of Universitas Sumatera Utara, Medan, Indonesia. All research subjects have previously agreed and signed approval letters to take part in the research.

Consecutive sampling was used as the sampling technique with the following inclusion criteria for grilled food vendors: (1) At least 20 years of age, (2) working actively as vendors with exposure to smoke from grilled food for at least 1 month, and (3) charcoal was used as the source of fuel. On the other hand, inclusion criteria for non-grilled food samples were included in the study: (1) At least 20 years of age and (2) non-grilled food vendors with no or minimal exposure to smoke for the past month. Exclusion criteria for both samples were vendors who refused to sign the approval letter and have suffered from respiratory diseases such as lung tuberculosis, chronic obstructive pulmonary disease, asthma, and lung cancer, also non-respiratory diseases which could affect the COHb levels such as coronary artery disease and hemolytic anemia that could limit the ability of the subjects to participate in the study.

COHb measurement

Measurement for COHb levels in blood was done by taking 5 ml of a venous blood sample which was then inserted into a blood collection tube containing EDTA as an anti-coagulant. Samples were analyzed within 24 h through spectrophotometric measurement of blood gas analysis using Human COHb Elisa Kit, Size 96 Wells, Brands Bioassay TL at the integrated research laboratory of Universitas Sumatera Utara.

Data analysis

Collected samples were analyzed using SPSS version 24.0. Shapiro–Wilk test of normality was used to examine the COHb levels in blood between grilled and non-grilled food vendors, where $p > 0.05$ indicated a normal distribution of the data.

Results

Research subjects characteristics

There were 50 subjects who took part in this research, which consisted of 25 grilled food vendors and 25 non-grilled food vendors. The characteristics of these research subjects are seen in Table 1.

Based on the COHb levels measurement, the median COHb level across all subjects was 500.22 ng/ml with minimum and maximum levels of 106.21 ng/ml and

Table 1: Baseline characteristics

Variable	Total	Street vendor	
		Grill street vendor	Non-grill street vendor
		(n = 25)	(n = 25)
Age (Year)			
20–29	32 (64.0)	19 (59.4)	13 (40.6)
30–40	12 (24.0)	4 (33.3)	8 (66.7)
>40	6 (12.0)	2 (33.3)	4 (66.7)
Gender			
Male	50 (100.0)	25 (50.0)	25 (50.0)
Female	0 (0,0)		
HbCO (ng/ml)	500.22 (106.21 – 1204.14)	352.81 (213.02-1204.14)	513.58 (106.21-932.48)
Working hours			
0-5	26 (52.0)	12 (46.2)	14 (53.8)
6-10	24 (48.0)	13 (54.2)	11 (45.8)
Working Experience			
<1 year	21 (42.0)	4 (19.0)	17 (81.0)
> 1 year	29 (58.0)	21 (72.4)	8 (27.6)
Smoking Status			
Smoker	50 (100.0)	25 (50.0)	25 (50.0)
Never Smoker	0 (0.0)		
Cigarettes/day (pack)	1.37 (0.5–6)	1 (0.5–6)	1 (0.5–3)
Length of smoking (years)	8.5 (2–42)	9 (3–42)	8 (2–23)
Use of mask			
Yes	8 (16.0)	5 (62.5)	3 (37.5)
No	29 (58.0)	21 (72.4)	8 (27.6)

1204.14 ng/ml, respectively. The median of COHb level in grilled food vendors (352.81 ng/ml) was found to be lower than that in non-grilled (513.58 ng/ml).

The difference in COHb levels in blood between grilled and non-grilled food vendors

The difference in blood COHb levels between the two groups of food vendors is seen in Table 2. COHb levels in non-grilled food vendors were higher than that in grilled. The median of COHb levels in grilled food and non-grilled food vendors was 352.81 (213.02–1204.14) ng/ml and 513.42 (106.21–932.48) ng/ml, respectively. Statistically, there was no significant difference observed between the median of COHb levels in both vendors with p = 0.204 (p > 0.05).

Table 2: The difference in COHb levels in blood between food vendors

	Grill Street Vendor	Non-Grill Street Vendor	p-value
COHb (ng/ml)	352.81 (213.02–1204.14)	513.42 (106.21–932.48)	0.204

*Data presented in median using Mann–Whitney test.

The difference in COHb levels in blood between grilled and non-grilled food vendors based on time and duration of working

The difference in blood COHb levels between the food vendors based on the time and duration of working is seen in Table 3. From the analysis, there was no significant difference observed in the median of COHb levels in blood between grilled and non-grilled food vendors working between 0 and 5 h with p = 0.212 (p > 0.05) and those working for 6 and 10 h with p = 0.649 (p > 0.05).

Table 3: The difference in COHb levels in blood between food vendors based on time and duration of working

COHb (ng/ml)	Street vendor		p-value
	Grill street	Non-grill street	
Working Hours			
0–5	362.02 (224–885)	534.52 (106.21–803.32)	[a]0.212
6–10	307.18 (213,02–1204.14)	513.42 (243.16–932.48)	[a]0.649
Working Experience (years)			
<1 year	591.22±44258	572.73±149.46	[b]0.883
>1 year	466.14±262.98	470.89±248.83	[b]0.965

[a]Data presented in median (minimum–maximum) using Mann–Whitney test. [b]Data presented in mean±standard deviation using paired sample t-test.

No significant difference was observed in the mean of COHb levels in blood between food vendors working < 1 year with p = 0.883 (p > 0.05) and those working for > 1 year p = 0.965 (p > 0.05).

Discussion

This research was done to analyze the difference in COHb levels between the roadside grilled and non-grilled food vendors in Medan. There was no significant difference observed in the median of COHb levels in both groups, where median OHb levels in grilled food vendors were found to be lower, 352.81 (213.02–1204.14) ng/ml than that in non-grilled, 513.42 (106.21–932.48) ng/ml. Another similar research is done in Medan, Indonesia also reported that there was no significant difference between COHb levels and lung functions between the two groups of food vendors [8].

Madani *et al.* did a study to observe the COHb levels in individuals working in the grilled food business. The study involved 100 workers whose main duty was to grill meat using charcoal. COHb levels were measured before and after work within the same day. A significant increase in COHb levels was observed in the after-work measurement, both in smokers and non-smokers participants. Mean COHb levels in smokers before and after work were 3.8% and 8.1%, respectively, whereas the levels in non-smokers were found to be 2.4% and 6.2%, respectively. These results suggested that grilling food using charcoal could increase the blood CO levels significantly and steps to reduce this exposure to workers were required [9].

In our study, the relationship between the duration of working and COHb levels in the two vendor groups was also observed. However, no significant difference was found between the two groups, both working 0–5 and 6–10 h. Moreover, no significant difference in COHb levels was observed in individuals working less and more than a year in each group.

It is known that CO levels in blood were dependent on many factors. Numerous studies had been done to analyze the factors that might affect the CO and COHb levels.

The history of smoking was one of the leading factors that could affect the COHb levels in the blood. A study by Buha *et al.* reported that the median of COHb levels in non-smokers subjects was 0.81%, whereas levels of 5.33% were observed in smokers. Moreover, a strong negative correlation was seen between the time interval of the last smoked cigarette and blood sampling on COHb levels (Pearson correlation, r = −0.529). It was found that COHb levels were significantly higher in smokers who smoked 30 min before blood sampling [10]. In our study, uniform sampling on smoker subjects was not done and there were no exclusion criteria for smoker subjects who smoked in the last 30 min. Further studies are required to analyze the correlation between the time interval of the last smoked cigarette and blood sampling on COHb levels in grilled food vendors.

In addition to smoking history, age was another contributing factor that could affect the COHb levels in the blood. A study by Pratiwi *et al.* showed that more than half of the participants (58.33%) with the age of > 40 years had a higher mean in COHb levels, 11.54%, compared to the ≤ 40 years age group, which was 6.24%. This indicated that most of the participants with the age of > 40 years had a high COHb level

exceeding the 5% limit [11]. Furthermore, Khoiriyah *et al.* stated that age was correlated with COHb levels in Indonesian Traffic Warden (Dinas Perhubungan) with a moderate correlation (r) of 0.405 [12]. Age was one of the susceptible factors in individuals, as there is a decline in cardiovascular capacity due to the aging process, as well as the reduction in the function of lung tissues elasticity, which resulted in the decrease in breathing capacity. This also indicated that individuals would become more susceptible to CO exposure with increasing age, hence, the higher COHb levels [13]. Our study did not analyze the correlation between age and COHb levels. This could be another factor that caused the COHb levels in the blood to be lower in the grilled food vendors group as age could be considered as a bias.

Factors such as vendor location and place to sit or stand during working hours could also affect the amount of CO inhaled. As mentioned in the study by Madani *et al.*, one of the research subjects was a charcoal grill worker. This subject was sitting nearby the grilling area during sampling for COHb levels before work and the result proved that the subject was exposed to CO as the COHb levels before working commenced was found out to be fairly high, 16.7%. However, during after-work sampling, the subject was sitting outside the grilling area, and thus, lower COHb levels were observed, which was 13.6%. This indicated that the sampling location might affect the COHb levels obtained. This observation should be brought to attention when used in other research with similar methods [9]. In our study, there was no uniformity in the location of sampling for grilled food vendors. For example, sampling location could be done in the area far from the grilling area; thus, COHb levels observed from the samples were found to be lower.

The subjects in this research were roadside food vendors in Medan. Road situation which was related to pollution levels and the number of passing vehicles could also affect the COHb levels in the blood. Pratiwi *et al.* showed that CO level in ambient air around Demeling Village, Sidoarjo District, was low due to the small number of passing vehicles at the time of sampling [11]. Acute health effects such as neurological or cardiovascular-related problems due to high CO levels had been well documented in the literature. A meta-analysis by Kunzli *et al.* concluded that air pollutants derived from vehicle fuels were partly contributed to the deaths in half of the population within the study [14]. This was supported by similar research which showed the decline in the Forced Vital Capacity (FVC) function in gas station workers at Medan Amplas Sub-district, where workers were exposed to pollution from vehicles >8 h/day for more than a year [15].

In addition to the number of vehicles, the bright, and cloudy, weather during sampling might have caused the increase in air temperature and decrease air density, which resulted in the CO concentration in the air is being lower. In high humidity, water vapor could react with air pollutants to either produce less hazardous substances or to become secondary pollutants, which reduced the overall CO concentration in ambient air. A low level of CO at ambient air was affected by high wind speed as the pollutants will disperse further, thus, the decline in the level of pollutants. Moreover, wind direction also affected the spread of air pollutants. The wind that moved toward the southeast direction was parallel to the road; thus, pollutants would disperse rapidly as there were no obstructions from buildings [11].

A similar study was done by Cattaneo *et al.* which assessed the CO levels in traffic police officers in Italy. It was mentioned that meteorological variables such as wind speed and mixed layer depth were the critical variables that could affect the exposure to hazardous gas and pollutants in humans. Linear regression analysis which estimated the relationship among pollutants exposure with meteorological variables showed a negative correlation between personal CO level and wind speed (p ANOVA <0.001). This wind speed was found to cause variabilities in the personal CO level to 18% [16]. In our study, no analysis has been done to examine the relationship between the use of Personal Protective Equipment (PPE) and COHb levels during grilling. A study by Soeroso *et al.* showed that there was a significant difference between expiratory CO levels upon the use of N95, carbon, and surgical mask. These masks were proven to be effective in reducing the COHb levels in blood [17].

The limitation in this research was the lack of uniformity in the time of sampling between the two groups. Thus, factors such as numbers of vehicles, weather, wind speed, air temperature, and other factors affecting the difference in CO levels could not be justified between the two groups. Furthermore, some of the factors mentioned above were not well documented which creates a bias that might have contributed to the non-significant results in the research.

Conclusion

Median COHb levels in blood in grilled and non-grilled food vendors were 352.81 and 513.58 ng/ml, respectively. There was no significant difference observed in the COHb levels in blood between grilled and non-grilled food vendors in Medan, Indonesia. Only a small number of vendors were using masks while working.

Statement of Participants Agreement

The first author was responsible to confirm the agreement for the participants to take part in the research.

Writers' Contribution

Each writer was involved in the accuracy and integrity of every part of the research.

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