



Risk Factors of Workers' COHb Levels in Automotive Workshops

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Abstract—CO comes from incomplete combustion. CO can bind with hemoglobin 245 times faster than with oxygen. Workshop workers are one of the jobs that are at risk of being exposed to carbon monoxide every day. This systematic study aims to describe the factors associated with COHb levels in workshop workers. The research was conducted online using a systematic review by accessing journal databases such as Google Scholar, Portal Garuda, PubMed, Scopus, Proquest, ScienceDirect 2010-2020. It was screened by inclusion criteria (publication period, full-test access, observational research, independent and dependent variables) and exclusion criteria; seven articles matched the criteria. The results showed that the CO in the air could affect the COHb levels of workers. Especially the workers, as mechanics, have unacceptable levels of COHb. The duration of exposure and working period can increase the risk factors of COHb levels.

Keywords—Automotive, Carbon monoxide, COHb levels, Repair Shop, Workers.

I. INTRODUCTION

Carbon monoxide, the chemical formula CO, is an odorless, colorless and poisonous gas. (Mukhopadhyay et al., 2018) Carbon monoxide can bind to hemoglobin 245 times faster than oxygen and is unconsciously poisoning. (Buchelli Ramirez et al., 2014) Carbon monoxide poisoning can cause sudden death in situations where carbon monoxide exceeds the threshold. (Downs, 2015)

Approximately 60% of carbon monoxide levels are generated from human activities, one of which is a motor fuel engine that uses fossil fuels. (Varma, Mulay, & Chemtob, 2015) Based on data from the Central Bureau of Statistics, in 2018, the number of motorbikes in Indonesia reached 120,101,047 units. (Statistik, 2018) The number of motorbikes is in line with the high need for automotive workshops, where air pollution is not safe for workers. Workshop workers who are in direct contact with machines will receive direct exposure to vehicle emissions compared to people in general.

Carbon monoxide is formed by combustion and enters the body into the alveoli. Circulation throughout the body can cause obstruction of oxygen circulation. The US Centers for Disease Control and Prevention (CDC) reported that during 1999-2012, about 440 deaths were caused by accidental carbon monoxide poisoning. (Cope, 2020) WHO states that people with heart and lung disease should not be exposed to carbon monoxide gas, increasing COHb levels above 2.5% because people with heart and lung disease are more sensitive to CO exposure. CO exposure of 35mg/m³ for 1 hour and 20 mg/m³ for 8 hours is equivalent to the formation of COHb in the blood. So WHO stipulates that standard CO exposure should not exceed 25 ppm (29mg/m³) for 1 hour and 10 ppm (11/m³) for 8 hours. (WHO, 1999)

Based on previous research, workshop workers with COHb levels did not meet the requirements to be 87% of the total 23 samples. (Basri, Mallapiang, Ibrahim, Ibrahim, & Basri, 2017) Another study found that workshop workers who worked 6-7 hours per day had a higher concentration than workers who worked 3-5 hours

per day.(Seprianto & Sainab, 2015) The systematic research aims to collect the results of previous research on risk factors related to COHb levels of workshop workers.

II. METHODS

The research was conducted using a systematic review method to summarize the results of previous reseach. Data sources were collected from national journals and international journals. The journal search was performed by specifying the keywords "CO exposure," "COHb levels," " risk factor of CO," "repair shop," and "automotive." A search for articles was carried out through Google Scholar, Portal Garuda, PubMed, Scopus, ProQuest, ScienceDirect.

The search results showed that 312 articles were found in the international journal database, and 582 articles were obtained from the national journal database. From a total of 894 articles, 860 were excluded because the title and abstract did not match. Furthermore, a full-text review was carried out by sorting the articles based on inclusion and exclusion criteria. The inclusion criteria were 1) Articles published in the 2010-2020 period, 2) Articles can be accessed in full text, 3) Articles with observational research studies, 4) The dependent variable in the research article is the worker's COHb level, 5) The independent variable in the research article are age, duration of exposure, working period, and smoking activities of

workshop workers. The exclusion criteria were articles whose measurement results were not COHb levels and the research location was not in an automotive workshops. After that, a full-text review was carried out and found seven articles that met the criteria. The next step is to conduct a critical review to assess the quality of the articles found. The guide used for conducting critical studies is Critical Appraisal Tools from The Joanna Briggs Institute. The data that has been obtained were then arranged in the form of a table of results. The results of the analysis were presented in a narrative form.

III. RESULTS

All reviewed articles were related to the association of CO exposure with COHb levels of workshop workers, and the articles focused on analyzing the relationship between age, duration of exposure, working period, and smoking activity and looking at the effects of COHb levels and short term memory abilities. The type of research used in this article is an observational analysis. Six articles used a cross-sectional design, and one article used a cohort design. The number of samples in the articles studied varied from 18 to 199 people. The places where the measurements were taken also varied from one workshop to 6 workshops. The age range of the youngest respondents was 15 years old and the oldest was 55 years old.

Table.1 Distribution of articles based on variabels studied

Journal	Age	Working Duration	Working Period	Smoking Activity
Kevin L, 2019	√			√
Citra, 2019				√
Izzatul, 2019		√		
Putri, 2016				
Sri Septrianto, 2015	√	√		√
Syamsuryana, 2017	√	√	√	√
Oguzhan, 2018				√
Percentage	43%	43%	14%	71%

Based on table 1, three articles research on the relationship between age and working duration with COHb levels. Furthermore, as many as five articles research on smoking activity, one article discusses the relationship of

working period. The results reveal a relationship between CO exposure in a workshop and COHb level of workshop workers from the seven articles reviewed.

Table.2 Distribution of risk factor age and working duration related to COHb levels

	Age		Working Duration	
	N	%	N	%
Related	1	33.0	2	67.0
Not Related	2	67.0	1	33.0
Total	3	100.0	3	100.0

Of the three articles examining age, two (67%) indicated that age did not affect COHb levels. Of the 3 articles that discussed the working duration, 2 (67%)

indicated that the working duration can affect the COHb level of workers.

Table.3 Distribution of risk factor working period and smoking activity to COHb levels

	Working Period		Smoking Activity	
	N	%	N	%
Related	1	100.0	2	40
Not Related			3	60.0
Total	1	100.0	1	100.0

Only one article examining the relationship of the working period to COHb workers' levels showed that age did not affect the COHb workers' level. Of the 5 articles that discussed smoking activity, 3 (60%) indicated that working duration did not affect COHb workers' levels.

IV. DISCUSSION

Carbon monoxide in the air contributes to impaired respiratory function, often not life-threatening if levels are small. However, workers who work indoors, such as workshop workers, with high levels of exposure and frequent intensity of exposure will cause chronic CO poisoning. Carbon monoxide is also often discussed as an important cause of death, whether accidental or accidental.(WHO, 2010)

The high level of carbon monoxide in the room is influenced by several factors, such as the location of the workshop, the area of the workshop building, and the availability of ventilation. Workshops located on the side of the road will get exhaust emissions resulting from vehicle combustion. Especially during peak hours, more carbon monoxide is produced.

4.1 The Relationship of Age of Workers with The Levels of COHb Workshop Workers

Age factor is a crucial determinant such as immunity and physiological activity, the course of a person's disease. Decreased function also occurs in the circulation, as

indicated by a decrease in cardiac output and respiratory rate, which are directly related to oxygen transport. In addition, muscle strength will decrease in the older age group. Despite age, one factor can affect the body's abilities, but other factors are more important. Based on the results of the study, 2 of the 3 articles reviewed stated that there was no relationship between age and COHb workers' levels. In Sri's article (2015) the age group 15-19 years shows the percentage If high COHb levels are unacceptable, one of the respondents has a higher COHb level (10.84) with a work duration of only two months. In Syamsuryana's article (2017), similar things were found in the 19-22 year age group; 8 workers with COHb levels cannot be accepted because these workers are mechanics who have worked >3 years with a work duration of 8 hours a day and have a smoking habit.(Basri et al., 2017; Seprianto & Sainab, 2015). The high CO content is found in the blood of younger workers because workers spend most of their time working in the welding and engine parts of vehicles. The effect caused by pollutants depends on the exposure associated with the dose/level of the pollutant.

4.2 The Relationship of Working Duration with The Levels of COHb Workshop Workers

The results of the analysis of the relationship between working duration and COHb levels showed a connection. The COHb level is unacceptable in relation to the type of work being performed. The amount of exposure received can be distinguished by the type of work - the amount of exposure received by workers such as mechanics and

administrative workers is different. The difference is the amount of substances that enter the body. Poisoning of a chemical depends on the dose of exposure. Suppose a pollutant is at a high level, even though it can cause fatal effects in a relatively short time. Conversely, if the exposure level is low, the effect is not felt immediately. Even if there is no build-up of toxic substances, it is possible that the symptoms will increase several times due to the cumulative effect. Causing too frequent exposure to pollutants can cause the body to become more sensitive and the symptoms to get worse. (Yulianto & Amaloyah, 2017)

The effects of poisoning will be more pronounced if workers are exposed to CO for a long time in indoor buildings. (Fitriana & Oginawati, 2012) Based on the articles reviewed, most were not partially exposed to different groups and did not expose them directly. Even though it is still in the same workshop worker, the dose of exposure received by each individual can be different.

4.3 The Relationship of Working Period with the Levels of COHb Workshop Workers

Based on the result reviewed, the risk factors for tenure are directly related to the type of work, as well as the working duration. The type of work is directly related to the dose of exposure each worker receives - the amount received for mechanics and workers as the administration differs. The potential risk hazards will not occur if these terms are not met. The terms in question are the toxicity risk agent concerned and the pattern of exposure. Toxic risk agents will not harm health if not exposed to certain doses and times. (Wahyuni, 2018)

Workers who handle machines directly will receive more exposure than other workers. So it is found that workers with 2 months time but the level of COHb are not acceptable. Measuring the amount of risk can be done by measuring the exposure assessment to determine the risk agent dose obtained by each worker as an intake. Then, workers were grouped based on the dose of exposure they received to measure their COHb levels later. Doing so is expected to clarify the risk factors associated with COHb levels

4.4 The Relationship of Smoking Activity with The Levels of COHb Workshop Workers

Smoking activity will produce smoke which has toxic effects in the form of nicotine and carbon monoxide. Carbon monoxide can affect COHb levels of smokers themselves and those around them. Carbon monoxide in cigarette smoke is found up to five times more in smoke than in primary smoke. (Janah & Martini, 2017) Carbon monoxide can last for several hours after a smoker smokes.

Based on the results of the review, it was found that workers who had smoking habits but COHb levels were still acceptable. The reason is, the workers are still classified as light smokers. The amount of cigarette consumption does not affect COHb levels. Another study stated that non-smoking workers had unacceptable levels of COHb. According to Sri's article (2015), passive smokers are more at risk than active smokers. Passive smokers receive exposure to smoke released by active smokers. (Seprianto & Sainab, 2015)

4.5 The Effects can be caused by High Levels of COHb

The effect of research on high COHb levels is in the Kevin and Putri article, but in Kevin's article shows that high COHb levels do not affect short-time memory. (Leonardo, Handini, & Nawangsari, 2018) In Putri's article, research on high CO levels is associated with work fatigue. A total of 41 workshop workers measured COHb levels and obtained a median value of 6.68%. To see the relationship between workers' COHb levels and work fatigue, workshop workers were measured using a questionnaire. The results obtained by $p < 0.05$ which showed a significant difference in COHb levels and work fatigue. (Drilna, 2016)

Carboxyhemoglobin levels can affect work fatigue because all tissues in the body are susceptible to CO exposure, and organs such as the heart and brain need oxygen to disrupt and affect oxygen capacity. Heart cells contain many mitochondria; organelle energy depends on oxygen. Aerobic metabolism in mitochondria to produce energy depends on oxygen demand. In a state of oxygen deprivation, carbon dioxide and H^+ are released and the body will activate anaerobic processes and produce lactic acid which can cause fatigue (Bol, Koyuncu, & Günay, 2018; Drilna, 2016). Fatigue from work occurs due to lack of oxygen and a build-up of muscle metabolites that enter the bloodstream. (Verawati, 2017)

V. CONCLUSION

Risk factors can affect COHb levels, such as working duration and working period. For further research, an Environmental Health Risk Analysis approach can be used to see the magnitude of health risks and identify uncertainty factors.

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