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DOI: [10.31965/infokes.Vol21.Iss4.1397](https://doi.org/10.31965/infokes.Vol21.Iss4.1397)Journal homepage: <http://jurnal.poltekkeskupang.ac.id/index.php/infokes>**RESEARCH****Open Access****The Effect of Exposure to Carbon Monoxide (Co) Gas in Pregnant Women on The Incident of Weight Infants Born in Makassar City****Arnita Rapang^{1a}, Farida Tandi Bara^{2b*}, Yuni Kusmiyati^{3c}, Supahar^{4d}, Nopiyanti^{5e}**¹ STIKES Nusantara Lasinrang Pinrang, Pinrang, South Sulawesi, Indonesia² STIKes Bhakti Pertiwi Luwu Raya, Palopo City, South Sulawesi, Indonesia³ Poltekkes Kemenkes Yogyakarta, Yogyakarta, Indonesia⁴ Universitas Negeri Yogyakarta, Yogyakarta, Indonesia⁵ Akademi Kebidanan Aisyah Kabupaten Pangkep, South Sulawesi, Indonesia^a Email address: lady12arwen@gmail.com^b Email address: faridatandibara@gmail.com^c Email address: yuni_kusmiyati@yahoo.co.id^d Email address: pahar.fis@gmail.com^e Email address: nopiyantiandiabbas@gmail.com

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Abstract

Exposure to vehicle emissions, particularly carbon monoxide (CO), during pregnancy has been identified as a potential factor contributing to low birth weight in infants. CO's impact on the body involves binding with hemoglobin (Hb) in red blood cells, leading to placental dysfunction and alterations in oxygen flow efficiency to the uteroplacental. Such disruptions can adversely affect fetal growth. This study focuses on Makassar City, a rapidly developing urban area experiencing substantial growth in infrastructure and transportation. This research aims to assess the impact of carbon monoxide exposure on birth weight in pregnant women residing in Makassar City. The method of this study is a quantitative approach employing a descriptive cross-sectional design, which was adopted for this study. The research sample consisted of 120 pregnant women categorized based on their CO exposure levels—30 with low exposure, 60 with moderate exposure, and 30 with high exposure. Simple random sampling was utilized for participant selection. CO levels were measured using the Adalog 7000 multi-gas monitor. Data analysis included One Sample ANOVA and Linear Regression. The results show that data analysis indicated that pregnant women with low CO exposure had an average birth weight of 3110.83 grams. In contrast, those with moderate and high CO exposure exhibited average birth weights of 2840.33 grams and 2667.33 grams, respectively. The regression coefficient for CO exposure was -221,750, indicating that a 1 μm increase in carbon monoxide gas correlated with a decrease in birth weight by -221,750. The conclusion is that pregnant women who are exposed to high and moderate carbon monoxide gas during pregnancy had an effect on birth weight than mothers who are exposed to low carbon monoxide gas. Future research is needed to measure CO levels in the blood of pregnant women about birth weight.

Keywords: Carbon Monoxide Exposure, Pregnant Woman, Birth Weight.***Corresponding Author:**

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1. INTRODUCTION

Large cities are generally characterized by traffic jams that lead to higher pollution concentrations. Pollutants produced by motorized vehicles, such as carbon monoxide (CO), nitrogen oxide (NO_x), hydrocarbons (HC), sulphur dioxide (SO₂), lead (Pb) and carbon dioxide (CO₂), have a negative and dangerous impact on the body (Aini et al., 2019; Czech, Zabochnicka-Świątek, & Świątek, 2020; Ahmed, et al., 2022; Tang, et al., 2020; Zioła, Błaszczak, & Klejnowski, 2021; Bekesiene, & Meidute-Kavaliauskiene, 2022; Eftekhari, et al., 2023). As much as 70% of air pollution in big cities comes from motorized vehicles (Arsandi et al., 2017). The main source of CO emissions is motorized vehicles (Dey & Dhal, 2019). Research by Zubair et al. on the level of air pollution in the city of Makassar in the polluted air pollution category according to the Quality Status Index (ISM) and the moderate-hazardous category when referring to the Air Pollution Standard Index (ISPU) (Zubair et al., 2013).

Infrastructure and transportation development in Makassar is increasing, and more and more motorized vehicles are on the roads. Carbon monoxide (CO) is a colourless, odourless, and tasteless component that is found in gas form at temperatures above -192 C (McAllister, Kunsman, & Levine, 2020; Kumar, et al., 2022; Nami-Ana, et al., 2021; Rawat et al., 2021). In 2014 Brazil, ambient PM 2.5 and carbon monoxide were also found in low birth weight babies. The result of this research states that pregnant women who are exposed to burning biomass or waste (garbage) containing PM 2.5 and CO from the beginning of the trimester to the last trimester have the potential for low birth weight babies, even though the mother is exposed in the second trimester, it still has the same effect on the birth outcomes. (Cândido da Silva et al., 2014). The effect of pollutants on birth weight and IUFD proves that CO has a greater influence than other pollutant variables (Salam et al., 2005).

The reprotoxic effects of pollutants in the air can bind directly to hemoglobin, forming carboxyhemoglobin and thereby reducing the oxygen-carrying capacity of the blood, which can result in adverse health effects on the cardiovascular system (Dalefield, 2017). The ability of hemoglobin to bind oxygen decreases, as does the ability to release oxygen to tissues. Overall, oxygen levels in cells decrease. The amount of CO bound to hemoglobin as carboxyhemoglobin (COHb) is a key marker for health effects (Rumchev et al., 2011). Hemoglobin's affinity for CO gas is 200 times greater than its affinity for oxygen. Free Co in plasma can interfere with mitochondrial respiratory function, resulting in cell damage (Friedman, 2015).

During pregnancy, the mother's physiological adaptation to her pregnancy occurs. Changes in the cardiovascular and hematological systems during pregnancy are physiological adaptations that play an important role in supplying oxygen to the fetus. This system is sensitive to environmental changes, such as the biological environment. During pregnancy, CO production increases due to the enzymatic activity of microbes, increased erythrocytes, and the fetus (Friedman, 2015). CO gas in the air further increases the mother's CO exposure and affects the mother's health, impacting the pregnancy and fetus. The impact on the fetus causes placental dysfunction and changes in the efficiency of oxygen flow in the blood to the uteroplacental, which can prevent the fetus from achieving its genetic growth. The incidence of LBW is influenced by environmental factors, including air pollution by 45% (Hapsari et al., 2020).

Epidemiological studies on the impact of pollutants in the air still receive little attention in Indonesia itself, especially in the city of Makassar. Based on the description above, this research aims to determine the effect of pregnant women's CO exposure on the birth weight of their babies.

2. RESEARCH METHOD

Quantitative descriptive research uses a cross-sectional study design. The chi-square test and One-Way ANOVA were used to test the level of exposure to the baby's birth weight. CO

exposure data uses retrospective data. The baby's birth weight is obtained from the KIA book. CO is measured using the Adalog 7000 multi-gas monitor made by ThermoFisher. Specifications on CO range from 0-500 ppm, and the resolution is 1 ppm.

The inclusion criteria were mothers who had lived at the research location since pregnancy. The population is mothers who gave birth at term in September-October 2018 in the Rappocini District area. The total sample was 120 people: 30 in the moderate exposure group, 60 in the medium exposure group, and 30 in the high exposure group. The number of samples was determined using the Lemeshow formula and a simple random sampling technique.

The research procedure is CO gas sample data collection was carried out in Rappocini District, Makassar at location point 1: T-junction Pelita Raya Street is categorized in the low CO group ($24,228.57 \mu\text{m}/\text{mg}^3$), Point 2: Hertasning Street intersection is categorized in the medium CO group ($29,714.29 \mu\text{m}/\text{mg}^3$), Point 3: Minasa Upa Street intersection is categorized in the high CO group ($48,457.14 \mu\text{m}/\text{mg}^3$), Point 4: Mangasa Street was categorized in the medium CO group ($29,485.71 \mu\text{m}/\text{mg}^3$). After that, a search was conducted for mothers who had given birth within the previous 2 months and obtained a sample of 120 mothers giving birth who were grouped into each exposure. Operators sampled CO exposure from the Environmental Health Laboratory of the Health Polytechnic, Ministry of Health, Makassar. This research has received ethical approval from the Politeknik Kesehatan Kemenkes Yogyakarta Ethics Committee with the number LB.01.01/KE-02/VIII/102/2018.

3. RESULTS AND DISCUSSION

Table 1. Characteristics of Respondents

Characteristics	Low	CO Exposure Moderate	High	p-value*
Age				
<20 and >30 year old	11 (26.1)	18 (42.9)	12 (31)	0.09
20-30 year old	19 (24.4)	42 (53.8)	17 (21.8)	
Education				
Low	8 (44.4)	7(38.9)	3 (16.7)	0.9
Middle	13 (23.6)	29 (52.7)	13 (23.6)	
Higher	9 (19.1)	24 (51.1)	14 (29.8)	
Work				
Mother works	12 (22.6)	25 (47.2)	16 (30.2)	0.6
Doesn't work	18 (26.9)	35 (52.2)	14 (20.9)	
Parity				
Primipara	11 (29.7)	15 (40.6)	11 (29.7)	0.52
Multiparous	19 (22.9)	45 (54.2)	19 (22.9)	

Table 1 shows that the p-value is >0.05 . Maternal characteristics at each level of CO exposure were not different.

Table 2. Results of normality analysis of baby birth weight data.

Variable	Mean	SD	p-value
Borth weight	2861.58	383.841	0.99

Table 2 shows that the asymp sig value for birth weight is 0.99. The p-value is > 0.05 , so it can be concluded that the data is normally distributed.

Table 3 . Effect of Exposure to Carbon Monoxide Gas on Birth Weight of Babies.

Exposure Group	Birth Weight		
	Mean	SD	p-value
Low	3110.83	322.92	0.000
Moderate	2840.33	353.27	
High	2667.33	303.22	
Total	2864.71	367.56	

From table 3, It is known that the higher the level of CO gas exposure, the lower the baby's weight $p\text{-value} = 0.000 < \alpha = 0.05$ ($p\text{-value}$ is smaller than $\alpha = 0.05$). Birth weight in the carbon monoxide gas exposure group with low exposure was 3110.83 grams, medium exposure 2840.33 grams, and high exposure 2667.33 grams. There is a significant influence between exposure to carbon monoxide gas and the baby's birth weight.

Table 4. Exposure to CO by pregnant women on birth weight of babies.

Variable				
CO Exposure Group	-221.750	-5.15	0.000	0.428
Contant	3308.208			

Table 4 shows that exposure to carbon monoxide gas significantly affects the birth weight of babies $0.000 (p < 0.05)$. The analysis results show that exposure to carbon monoxide gas has a regression coefficient of -221,750, meaning that every 1 μm increase in carbon monoxide gas will decrease the birth weight of the baby by -221,750. This model has an *adjusted R2 value* of 0.428, meaning that exposure to carbon monoxide gas can predict birth weight by 42.8%.

The increase in the concentration of carbon monoxide gas influences birth weight incidence. The value 3308.208 is *the point* where the line can pass through the Y axis (*intercept point* of increasing exposure to carbon monoxide gas on birth weight). The value - 221,750 is the regression coefficient or *slope* of the regression line to explain the increase in exposure to carbon monoxide gas on birth weight. Based on *linear* regression equation analysis, Birth weight = $3308.208 - 221.750x_1$. By looking at the results of the regression equation above, it can be interpreted that if the value of exposure to carbon monoxide gas is 0 μm , then the baby's birth weight is 3308.208 grams. If exposure to carbon monoxide increases the value by 1 μm , then the baby's birth weight decreases by 221,750 grams.

During pregnancy, oxygen requirements increase as gestational age increases. This is due to the increased need to support fetal and placental growth. Increased respiratory rate and volume do not compensate for changes during pregnancy. Exposure to air pollution will reduce oxygen needs and increase the risk of air pollutants. Exposure to air pollution during pregnancy is associated with fetal developmental problems, premature birth, and pregnancy complications, including pregnancy-induced hypertensive disorders (PIH) (Mozzoni et al., 2022).

Data shows that the higher the exposure to CO gas during pregnancy, the lower the birth weight. Exposure to carbon monoxide gas is significantly related to the baby's birth weight. In a meta-analysis study, increasing concentrations of particles with aerodynamic diameters of 10 μm (PM 10) and 2.5 μm (PM 2.5) across pregnancy were associated with an increased risk of low birth weight (<2,500 g) and reduced birth weight among births term (37 weeks gestation) (Dadvand et al., 2013). Reduced exposure to ambient air pollution late in pregnancy is associated with increased birth weight among pregnant women (Septiawati & Listianti, 2019).

Pregnant women's exposure to PM 2.5, PM 10, SO₂, and CO during the entire pregnancy and the first and second trimesters significantly reduces birth weight and increases the risk of

infant birth weight (Mitku et al., 2023). Exposure to air pollution is also associated with the incidence of pre-eclampsia in pregnancy and prematurity. The possible cause is that exposure to air pollution increases ROS and inflammation during pregnancy (Chiarello et al., 2023).

Hemoglobin (Hb) functions as a carrier of O₂ in the form of oxyhemoglobin (O₂ Hb) from the lungs to body cells and CO₂ in the form of CO₂ Hb from body cells to the lungs (Dey & Dhal, 2019). COHb is formed when CO binds to hemoglobin with an affinity 200 times greater than oxygen, thereby reducing oxygen transport capacity (Bleecker & Lotti, 2015). Studies on COHb in the fetus were obtained from research on maternal smoking exposure during pregnancy. Pregnant women who are exposed to cigarette smoke are at greater risk of giving birth to LBW babies because increased CO levels in maternal blood cause intrauterine growth disorders (Chelchowska et al., 2013)

Pollutant compounds from the air in the placenta of a healthy pregnancy decrease their presence in the fetal blood, indicating that under normal conditions, the placenta acts as a reservoir, reducing transfer from mother to fetus (Dong et al., 2018). CO dissolved in maternal plasma crosses the placenta by passive diffusion and then combines with fetal hemoglobin. The resulting fetal COHb levels are 10–15% higher than maternal levels (Culnan et al., 2018) because fetal hemoglobin has a higher affinity for CO than adult hemoglobin. In addition, CO elimination in the fetus takes longer because CO dissociates much more slowly from fetal hemoglobin than from adult hemoglobin (Aubard & Magne, 2000). The elimination half-life of the fetus may be 4-5 times longer than that of the mother. Therefore, the severity of fetal poisoning cannot be judged solely based on the mother's condition.

The effects of carbon monoxide on fetal development vary depending on the period. During the embryonic phase, CO can cause various congenital disabilities. During the fetal stage, congenital anomalies are less common, but death or permanent neurological damage may occur (Chiarello et al., 2023).

4. CONCLUSION

The conclusion is that pregnant women who are exposed to high and moderate carbon monoxide gas during pregnancy have a greater effect on birth weight than mothers who are exposed to low carbon monoxide gas. Future research is needed to measure CO levels in the blood of pregnant women about birth weight.

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