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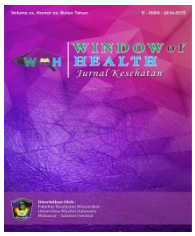

ARTICLE RESEARCH

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The Effect Of Carbon Monoxide Gas Exposure Levels On Oxygen Saturation In Parking Attendants (Case Study At Kapasan Market Parking Area, Surabaya)

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ABSTRACT

Parking attendants are susceptible to health problems due to their ongoing exposure to vehicle-related air pollution. A significant contaminant called carbon monoxide (CO) binds to hemoglobin 200 times more strongly than oxygen, forming carboxyhemoglobin (COHb) and causing a decrease in blood oxygen saturation. This study aims to investigate how CO exposure affects the oxygen saturation levels of parking attendants at Surabaya's Kapasan Market. The study uses a cross-sectional methodology and quantitative analysis. Thirteen people made up the study's sample size, including all parking attendants at Kapasan Market in Surabaya. The concentration of CO gas, the workday length, and the oxygen saturation levels were the variables examined. The Spearman's rank correlation test was used to examine the data. The average CO gas level was 3.53 PPM, the average workday for the attendants was 7.5 hours, and the average oxygen saturation was 95%, according to the findings. CO levels and oxygen saturation showed a strong correlation ($p = 0.010$), as did work time and oxygen saturation ($p = 0.005$). It is advised that parking attendants take frequent breaks from their duties to breathe in fresh air, take vitamins and supplements, eat a healthy diet, and engage in little physical activity.

Keywords : Carbon monoxide ; Parking attendants ; Work duration ; Oxygen Saturation

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Surabaya City is the capital of East Java Province, with a population of 2,848,583 people and an area of 326.81 km². As the largest metropolitan city in East Java, Surabaya has developed and experienced various growths due to the increasing number of industries and motor vehicles. The number of vehicles in Surabaya City has increased by an average of 7.03% per year and has never decreased, making this human activity a significant burden on the air due to high levels of air pollutants. Air pollution originates from 60% of the transportation sector and 40% from the industrial sector. [1,2] Emissions from the transportation sector consist of 90% carbon monoxide (CO) (2). Carbon monoxide is the result of the incomplete combustion of carbon-containing materials such as petroleum and natural gas [3]. Transportation generates the most CO emissions compared to other pollutants because petalite produces more CO emissions at low and high engine speeds than premium at moderate engine speeds. [4]

Multi-story parking lots are built to adapt land and buildings to save space and area. Unfortunately, multi-story parking lots have a less beneficial impact on the health of the people inside them because air circulation is inadequate. The air in enclosed spaces is constrained and influenced by human activities such as parking, especially in shopping centers [5] like wholesale markets. Limited parking space and inadequate ventilation systems lead to pollutants, including carbon monoxide, not being properly released into the open air. [6] The innovation in this research is the measurement of oxygen saturation in parking attendants exposed to air pollution from motor vehicles, particularly carbon monoxide gas.

The high-risk group for air pollution exposure in parking areas is parking attendants. They are at risk due to their dense working hours and constant contact with air pollution. According to Aryagita's research (2017), the CO levels in the Kapasan Market parking area in Surabaya were 15.18 PPM, resulting in all parking attendants being at risk to their health due to CO gas exposure (RQ) > 1. [7] The human respiratory process occurs through gas exchange in the alveoli. Gases present in the atmosphere are inhaled and enter the bloodstream. If the air contains pollutants, including CO gas, it will enter the body and diffuse through the alveolar membrane. [6] CO gas binds with hemoglobin (Hb) instead of oxygen. Still, CO has a bonding strength 200 times stronger than oxygen, causing oxygen to easily detach from red blood cells or Hb, leading to the formation of HbCO in the human body. HbCO (carboxyhemoglobin) can lessen the blood's capacity to carry oxygen to bodily tissues, cutting down on the amount of oxygen cells receive. [8,9]

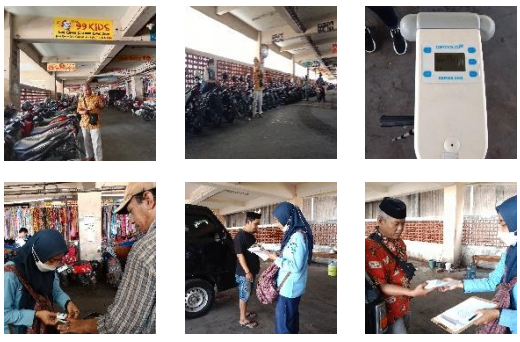
The problem identified in this research is that the parking area of Kapasan Market in Surabaya is where air quality degradation occurs due to human activities involving motor vehicles. Approximately 1,107 vehicles enter the Kapasan Market parking area daily, producing carbon monoxide gas. This research aims to inform the public that jobs involving direct contact with motor vehicle emissions can endanger health, particularly regarding oxygen saturation levels in the body. It also provides preventive measures to minimize the risk of CO gas exposure in the workplace. This research aims to analyze the

effect of CO gas exposure levels in the air on the oxygen saturation of parking attendants at Kapasan Market, Surabaya.

METHOD

This study research location is in the parking area of Kapasan Market Surabaya, from the 1st to the 4th floor, conducted from December 2022 to May 2023. This research has obtained an ethical clearance certificate with the number No.EA/1459/KEPK-Poltekkes_Sby/V/2023. The study was conducted in the parking area of Kapasan Market Surabaya on the 1st to the 4th floors. The population total was 14 individuals. The data collection technique used simple random sampling, resulting in a sample of 13 individuals who were randomly selected from the total population until 13 parking attendants were chosen.

The research procedure is divided into sources and types of data. The primary data in this study includes the results of physical air measurements (temperature, humidity, and wind speed), chemical air measurements (CO gas), oxygen saturation, and interviews. The secondary data for this study was obtained from PD Pasar Surya. The research instruments consist of observation sheets and interviews to support the study. Air sampling was carried out by technicians from the Environmental Engineering Laboratory of ITS Surabaya using the NDIR method according to SNI 7119.10:2011, the testing method for carbon monoxide levels. The examination of oxygen saturation levels was conducted using a pulse oximeter, following the procedure of having the parking attendants wash their hands with hand sanitizer, ensuring their fingers were not injured and free of nail polish, turning on the oximeter, and recording the measurement results.[10] The implementation of the research was carried out with the following steps:



a) Determining easurement point b) Measuring physical air parameters
c) Measuring CO gas levels d) Measuring oxygen saturation
e) Recording measurement result f) Giving antiseptic to people

Statistical testing was conducted using bivariat correlation (spearman's r), with the rejection if the p-value <0,05.

RESULTS

The univariate analysis in this study aims to understand the distribution of data concerning respondent characteristics, including CO gas measurements, work duration, and oxygen saturation levels of parking attendants at Kapasan Market, Surabaya. The results of the univariate analysis in this research are as follows:

Table 1 Measurement of CO Gas Levels, Work Duration, and Oxygen Saturation

Variable	Percentage (%)
CO Gas Levels	
According to quality standards	100
No, according to quality standards	0
Total	**100**
Work Duration	
7 hour/day	53,85
8 hour/day	46,15
Total	**100**
Oxygen Saturation	
Normals	53,85
Abnormal	46,15
Total	**100**

Based on the results of CO gas measurements, all measurement points were found to be below Government Regulation No. 22 of 2021, where the standard for CO gas concentration is 8.7 PPM. The work duration of parking attendants at Kapasan Market, Surabaya, is 7 hours/day (53.85%) and 8 hours/day (46.15%). There are seven parking attendants with normal oxygen saturation levels (53.85%) and 6 parking attendants with abnormal blood oxygen levels (46.15%).

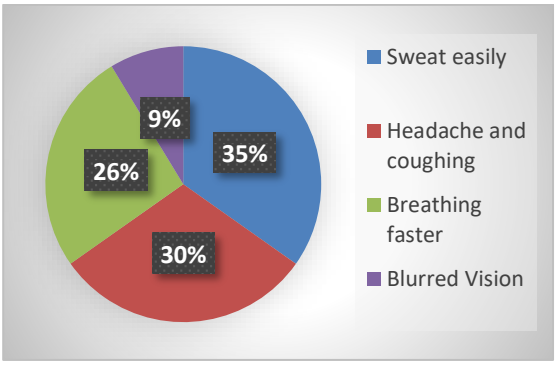


Figure 1 Diagram of Health Complaint among Parking Attendants at Kapasan Market, Surabaya

Figure 1 shows that among parking attendants at Kapasan Market, Surabaya in 2023, the most common health complaint is excessive sweating, with a percentage of 61.54%. This is followed by headaches and coughing at 53.85%, faster-than-usual breathing at 46.13%, and blurred vision at 15.38%.

Bivariate analysis aims to determine the correlation between variables. This study focuses on two variables: the impact of CO gas concentration and work duration on oxygen saturation levels among parking attendants.

Based on Spearman's rank correlation test, there is a significant relationship between the CO gas levels and the oxygen saturation levels with a p-value of 0,010 and a correlation coefficient (r) of -0,638, also the work duration and the oxygen saturation levels of the parking attendants at Kapasan Market, Surabaya, with a p-value of 0.005 and a correlation coefficient (r) of -0.678.

DISCUSSION

Based on the oxygen saturation measurements of parking attendants shown in Table 1, there are seven (53.85%) with normal oxygen saturation levels and six other (46.15%) with abnormal levels. The statistical test using Spearman's correlation method yielded a p-value of 0.010 (< α 0.05). This indicates that CO gas concentration will influence the oxygen saturation of parking attendants at Kapasan Market, Surabaya, in 2023. The obtained correlation coefficient r is -0.638, indicating a negative correlation between the two variables, suggesting that higher CO gas concentrations are associated with lower blood oxygen saturation levels. This study is consistent with the understanding that blood oxygen levels decrease with continuous exposure to CO gas from motor vehicle exhaust. (11)

Manurung et al. explained that normal oxygen levels in the body range from 95-100%. (12) According to Amiar et al., abnormal oxygen saturation can result from oxygen's inability to penetrate the blood cell walls, resulting in lower hemoglobin oxygen levels. (13) This is attributed to exposure to carbon monoxide gas breathed in while working as a parking attendant at Kapasan Market in Surabaya. Decreased blood oxygen levels can occur due to the binding of CO gas to Hb. (14) It's known that CO to Hb is 200 times stronger than oxygen. This aligns with Khairina et al., who found that CO levels at Shopping Center X in Malang City can affect COHb levels in parking attendants (15) and Jusuf et al. stated that there is, in fact, a substantial relationship between blood oxygen and CO2 levels. in the Buata Village (16). Another study consistent with this research is by Soemarwoto, a CO gas has significant effect on oxygen saturation in sixth-grade students in the Pringsewu District. (17)

Based on the interview results, it was found that the average daily working duration of parking attendants at Kapasan Market, Surabaya, is 7.5 hours, which complies with Government Regulation No. 35 of 2021. CO gas is inhaled by parking attendants during their work for six days per week. This results in impure gas exchange in the alveoli, mixing oxygen with CO gas instead. (18)Based on Table 2, out of 13 respondents whose oxygen saturation was measured, seven parking attendants have normal oxygen saturation levels (53.85%), while six have abnormal oxygen saturation levels (46.15%). The statistical test using Spearman's correlation yielded a p-value of 0.005 (< α 0.05) and a correlation coefficient r of -0.678. The significance of the p-value and r indicates a significant effect between work duration and oxygen saturation levels of parking attendants at Kapasan Market, Surabaya, in 2023, where the longer

the duration of work, the lower the blood oxygen saturation levels. This study aligns with Putri et al., who found that street food sellers with longer work durations did not exhibit normal oxygen saturation levels after measurement [19]. Another study by Hamarno et al. also affirms a similar finding, indicating a relationship between work duration and oxygen saturation among gas station operators in Malang Raya [20]. In her study, Rosari (2020) concluded that bus terminal personnel in South Kalimantan Province who work more than 6 hours per day correlate with their oxygen saturation levels (21). Motor vehicles emit pollutants that impact human health. Vehicle exhaust contains gases such as CO, SO2, NO2, Pb, and others [22]. CO gas emitted by vehicles has the ability to bind to Hb, causing oxygen saturation to decrease due to the high levels of COHb in the blood compared to O_2Hb. [23]

The decrease in blood oxygen levels can be attributed to the influence of CO gas binding to Hb. [14] The binding of Hb by CO gas is known to be 200 times stronger than that of oxygen, leading to an increase in COHb levels in the body. This increase is followed by elevated erythropoietin (EPO) hormone levels, which regulate the production of red blood cell responses. [24–26]

This study is consistent with research conducted by Wimpy (2019), indicating that increased COHb levels lead to increased blood viscosity, which promotes blood clotting and narrowing of blood vessels [27]. Narrowing of blood vessels can cause an increase in blood pressure, commonly known as hypertension [28]. Symptoms of hypertension include mild headaches, blurred vision, rapid breathing, ringing in the ears, and even nosebleeds. [29] Research by Fadillah (2020) stated a significant correlation between oxygen saturation and blood pressure in Yogyakarta nursing students. [30]

Based on Figure 1, it is noted that in 2023, the health complaints most commonly reported by parking attendants at Kapasan Market, Surabaya, are excessive sweating, reported at 61.54% of them, followed by headaches and coughing at 53.85%, faster-than-usual breathing at 46.13%, and blurred vision at 15.38%. These complaints were gathered from interviews conducted with parking attendants at Kapasan Market, Surabaya. These issues arise from exposure to CO gas from motor vehicle emissions, which is associated with blood oxygen saturation levels. Similar complaints were also noted among gas station operators in East Semarang City, where 53.84% of respondents reported excessive sweating due to exposure to motor vehicle exhaust while working. [31] Another study supporting these findings suggests that exposure and increased respiratory complaints lead to faster fatigue among workers involved in Penataransewu Smoked Fish Village, Sidoarjo District. [32]

Parking attendants are advised to practice good hygiene and healthy living behaviors (or, in Indonesian, similar to PHBS), such as consuming nutritious food and avoiding smoking. Cigarette smoke produced by smokers also contains CO gas, which can exacerbate the health of parking attendants. [33]

The management of Kapasan Market in Surabaya should consider using and developing technology to reduce pollution inside parking areas. This includes adding and installing exhaust fans

and blowers to extract air from indoor spaces. According to research by Rochmawati (2019), adding smoke and dust suction devices like exhaust fans indoors can reduce CO gas levels. [34] The management of Kapasan Market in Surabaya can also plant pollutant-absorbing plants such as sirih gading (Epipremnum aureum) and Sansevieria sp. because they have been proven to reduce air pollution levels, particularly from motor vehicle emissions. Sirih gradings can reduce Pb gas by 1.282 mg/L per day and CO gas by 110 PPM per day, [35,36] while lidah mertua (Sansiviera sp.) can absorb 89.50% of CO gas concentration of 300 ppm. [37] The management of Kapasan Market can also enhance the well-being of parking attendants by providing drinks that can increase Hb levels, such as guava juice. Research by Nurhidayah (2022) indicates that consuming guava juice can boost hemoglobin levels, thereby optimizing workers' health. [38]

CONCLUSIONS AND RECOMMENDATIONS

The average temperature is 30.6°C, humidity is 74.2%, and wind speed is 0.43 m/s. The average concentration of CO gas is 3.53 PPM. The average at Kapasan Market in Surabaya is that parking attendants work 7.5 hours daily and have an oxygen saturation rate of 95. There is a strong correlation between CO gas concentration and oxygen saturation, as well as between working length and oxygen saturation. In the future, researchers are encouraged to further investigate by examining COHb levels and blood pressure among parking attendants at Kapasan Market, Surabaya. The management of Kapasan Market can add and install an exhaust and blower to absorb pollutants or plant sirih grading and sansevieria sp. for natural pollutant gas absorption.

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