

Impact of Air Pollutants (NO₂ and CO) on the Incidence of ARI in Toddlers in Palangka Raya 2024: Retrospective Study

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ABSTRACT

Palangka Raya, as the capital city of Central Kalimantan, has unique environmental characteristics because it often experiences forest and land fires (karhutla) which result in an increase in air pollutants. This study aims to analyze the association between exposure to Nitrogen Dioxide (NO₂) and Carbon Monoxide (CO) pollutants and the incidence of Acute Respiratory Tract Infection (ARI) in toddlers in Palangka Raya in 2024. This retrospective study was conducted in Palangka Raya City, with data on the incidence of ARI in toddlers obtained from the Palangka Raya City Health Office. Determination of NO₂ and CO levels using the Google Earth Engine (GEE) platform that analyzes TROPOspheric Monitoring Instrument (TROPOMI) satellite data from the Sentinel-5 precursor. Geographic Information System (GIS) software was used to process spatial data and map layout. The relationship between CO and NO₂ levels and ARI incidence was analyzed using linear regression tests, followed by multiple linear regression tests if there was a significant correlation. All statistical tests were conducted using a web-based platform. The conclusion of this study was that the linear regression test showed that NO₂ levels only contributed 2.07% ($p=0.6555$) and CO contributed weakly ($p=0.4981$) to the incidence of ARI. This indicates that other factors are more dominant in causing ARI in Palangka Raya.

Keywords: ARI; NO₂; CO; Palangka Raya; Google Earth Engine

INTRODUCTION

Acute Respiratory Infection (ARI) is an inflammation of the respiratory tract, both upper and lower. It is generally caused by a viral or bacterial infection. Common symptoms of ARI include cough, runny nose, and fever, and this condition is highly contagious, affecting all age groups, especially children and the elderly who have lower body resistance (Wikananda et al., 2021;

Azhari et al., 2022)

ARI in Indonesia ranks first in the list of diseases in various health services (Lazamidarmi et al., 2021). Data from the Indonesian Health Survey in 2023 showed that the prevalence of ARI in children under five increased dramatically, from 12.8% in 2018 to 34.2% in 2023. The substantial increase in ARI prevalence among children under five in Indonesia reflects the vulnerability of the health system and the direct impact of environmental degradation (Oktari et al., 2023).

Palangka Raya, as the capital city of Central Kalimantan Province, has unique environmental characteristics, especially related to the incidence of forest and land fires that often occur in the region (Wahyudi, 2021; Satispi et al., 2025). History shows that Central Kalimantan, including Palangka Raya, experienced the worst forest fires that resulted in significant air pollution in 2015. The direct impact of these forest fires was the emergence of acute respiratory diseases in the community, as well as health problems such as asthma, coughing, and shortness of breath felt by residents of Central Kalimantan (Meytriani et al., 2024).

Data from the Palangka Raya City Health Office that from January to September 2023 showed an increase in the number of people with ARI. This indicates that Palangka Raya remains vulnerable to air quality fluctuations that can affect the incidence of ARI, especially NO₂ and CO (Azhari et al., 2022).

Exposure to NO₂ consistently induces an inflammatory response in the airway, characterized by neutrophil infiltration. This inflammation can exacerbate existing inflammatory conditions, damage epithelial cells, and disrupt the integrity of the alveolar-capillary barrier (Han et al., 2017). The respiratory epithelium serves as a physical and immunological barrier that protects the lungs from harmful agents (Lu et al., 2024). Meanwhile, Carbon monoxide (CO) has a high affinity for haemoglobin (Hb) in the blood, about 200-250 times greater than oxygen (O₂). When CO is inhaled, it binds to Hb to form carboxyhaemoglobin (COHb), which significantly reduces the blood's ability to transport oxygen to vital organs such as the heart and brain (Yuan et al., 2022). This leads to tissue and cellular hypoxia, which manifests as symptoms such as fatigue, headache, confusion, dizziness, and at very high levels, can lead to unconsciousness and death (Jiang et al., 2024).

Based on this, a fundamental question arises regarding the extent to which these two pollutants contribute to the incidence and severity of ARI in this region. Therefore, this study will analyse the relationship between exposure to Nitrogen Dioxide (NO₂) and Carbon Monoxide (CO) pollutants and the incidence of Acute Respiratory Tract Infection (ARI) in Palangka Raya in 2024.

METHOD

This study was a retrospective study and was conducted in Palangka Raya city. The incidence of ARI for children under five was obtained from the Palangka Raya City Health Office. Determination of NO₂ and CO levels used the Google Earth Engine platform. Google Earth Engine (GEE) is a cloud-based spatial data computing platform developed by Google, which offers world-scale environmental data analysis. GEE is used for satellite data analysis to produce pollutant concentration distributions. Another software used is Geographic Information System (GIS) software (Santamajati et al., 2024). GIS software is used to process spatial data and map layouting. The data processed is TROPospheric Monitoring Instrument (TROPOMI) data. TROPOMI is a satellite instrument installed on the Copernicus Sentinel-5 precursor satellite launched on October 13, 2017. Sentinel-5P satellite data is used for monitoring NO₂ and CO pollutant gas concentrations (Tagatorop et al., 2023). The relationship between CO and NO₂ levels and the incidence of ARI was analyzed using linear regression. If there was a significant

correlation, multiple linear regression was used. All statistical tests used a web-based platform with the address <https://stats.blue/index.html>.

RESULTS AND DISCUSSION

Based on the monitoring results using GEE, the NO₂ and CO levels in Palangka Raya during 2024 are presented in Table 1 below.

Tabel 1. Average NO₂ and CO Levels in 2024

	NO ₂ (10 ⁵ mol/m ²)	CO (10 ² Mmol/m ²)
Average ± SD	3.78 ± 0.26	3.03 ± 0,30
Maximum	4.22	3.63
Minimum	3.40	2.63
Median	3.76	3.07

Meanwhile, the NO₂ and CO distribution maps are presented in Figures 1 and 2 below.

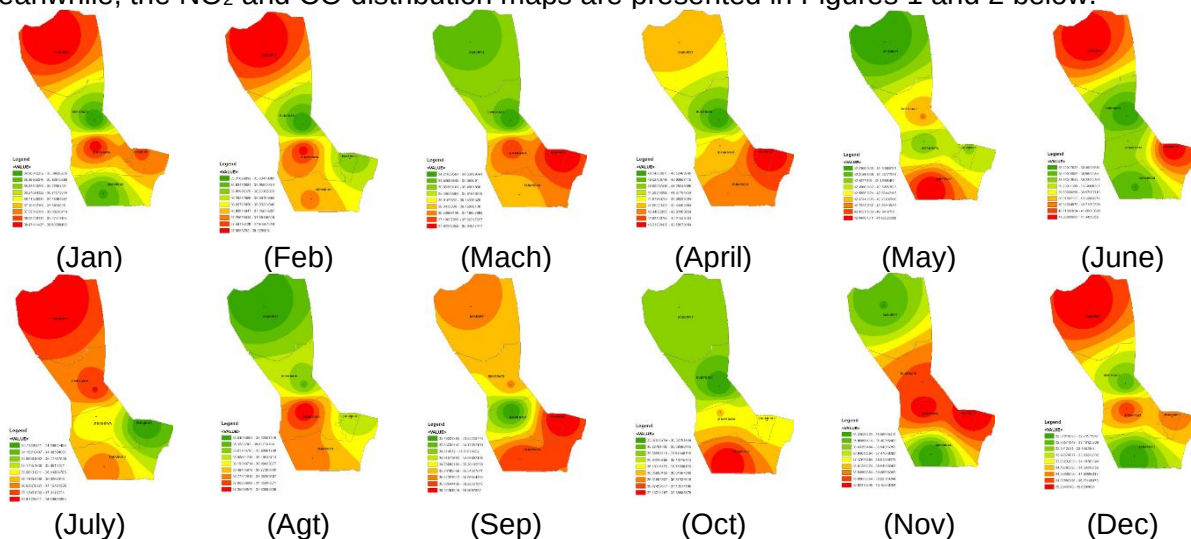
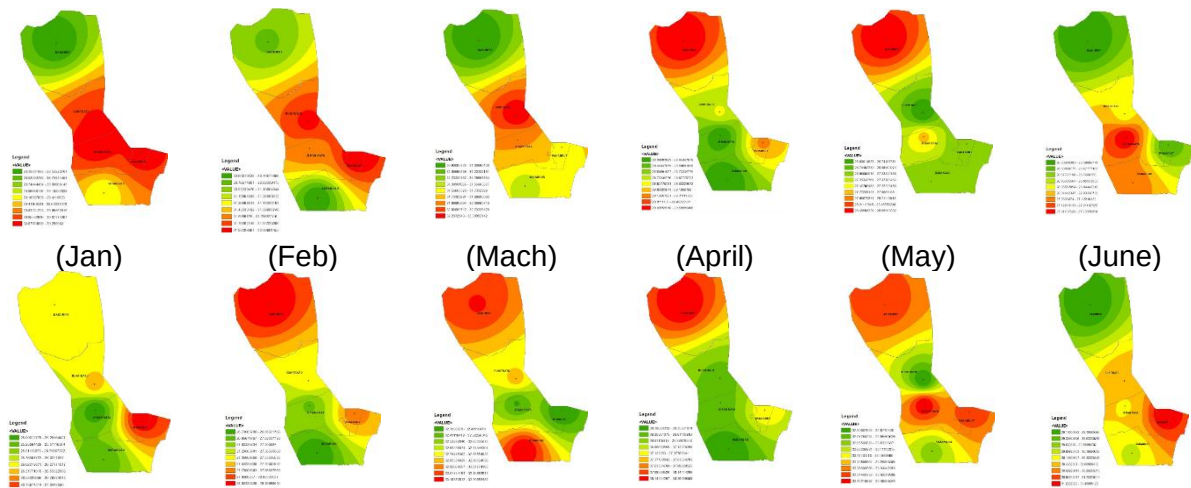


Figure 1. Distribution of NO₂ levels in Palangka Raya January-December 2024

In addition to NO₂ levels, the distribution of CO levels in Palangka Raya also varies in Figure 2.



(July) (Agt) (Sep) (Oct) (Nov) (Dec)
Figure 2. Distribution of CO levels in Palangka Raya January-December 2024

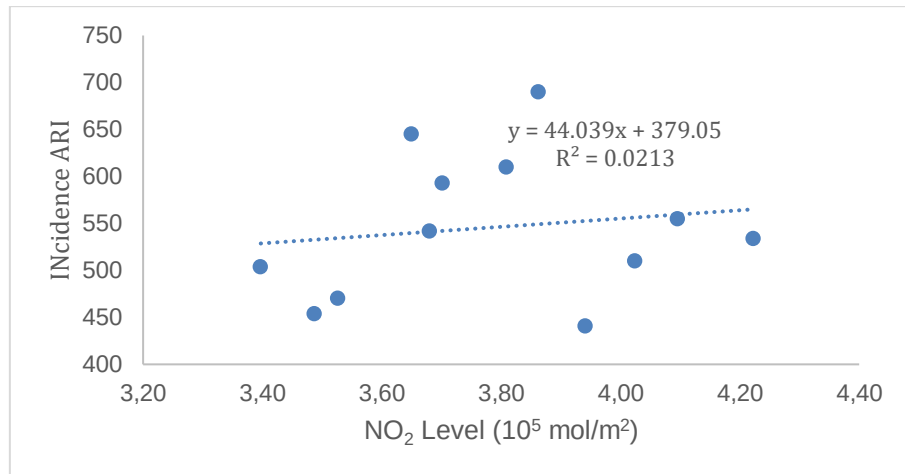


Figure 3. Relationship between ARI incidence and NO₂ levels

Figure 3 shows that the R² value = 0.0207 ($p=0.6555$; $p>0.05$), which means that NO₂ levels only contribute 2.07% in causing ARI. Meanwhile, 97.93% is caused by other factors not examined in this study. In addition to NO₂ levels, CO levels also had a weak association with the incidence of ARI ($p=0.4981$; $p>0.05$). This can be seen in Figure.

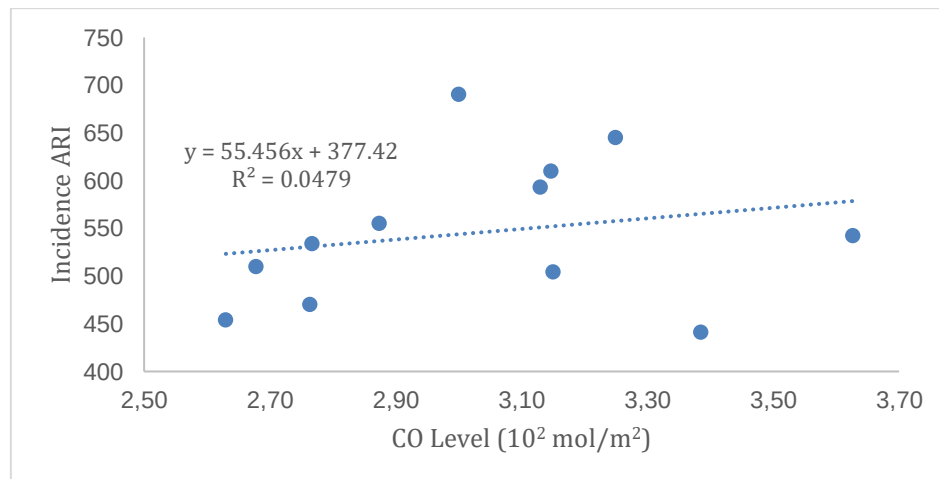


Figure 4. Relationship between ARI incidence and CO

The results showed that there was no significant relationship or only a weak correlation between NO₂ and CO levels and the incidence of ARI in Palangka Raya. This is because the incidence of ARI is not solely triggered by exposure to air pollutants such as NO₂ and CO, but is also strongly influenced by other factors, such as the nutritional status of children (Haris et al., 2021).

Nutritional status is one of the important factors that influence the risk of ARI (Acute Respiratory Tract Infection) in children. Poor nutrition directly weakens the immune system and increases the body's susceptibility to respiratory infections. The results of a study at Julia Likupang

Clinic (North Sulawesi) showed that undernourished and severely malnourished toddlers had a proportion of ARI of 74% and 67%, respectively. The study also found a significant association between nutritional status and the incidence of ARI ($p = 0.0488$) (Molenaar, 2025). A study in Banjar District, South Kalimantan, revealed that 71.4% of children under five with ARI had poor nutritional status, compared to 4.1% in the group without ARI (Yati, 2018; Biworo, 2025).

In addition to nutritional status, home ventilation is also a contributing factor to ARI. Poor ventilation in the home significantly increases the risk of Acute Respiratory Tract Infection (ARI) in children because the air is damp and the collection of pathogens is not well dispersed, thus facilitating the transmission of respiratory germs. A study in Aceh Besar in 2023 found that toddlers living in homes with inadequate ventilation were 1.6 times more likely to develop ARI than those living in homes with good ventilation ($p \text{ value} < 0.05$) (Walliyudin et al., 2024). In addition, a study in the Indramayu region, showed a significant association between poor home ventilation and the incidence of ARI in children under five ($p = 0.004$). Adequate ventilation allows fresh air exchange, thereby reducing the concentration of pathogenic aerosol and indoor humidity that favors microbial growth. If windows are rarely opened or there are no cross-ventilation channels, then the air will be stagnant, and respiratory droplets from people with ARI will remain in the room longer, facilitating transmission to other children (Sudirman et al., 2020).

Second hand smoke exposure irritates the respiratory tract, weakens mucociliary clearance, and decreases the local immune response. Research by Utami, et al (2024) showed that children living in homes with active smokers had a 1.8 times higher risk of ARI than those from homes without smokers ($p < 0.01$) and showed increased frequency of cough and fever symptoms.

CONCLUSION

The results showed that the average NO_2 level in Palangka Raya in 2024 was $3.78 \pm 0.26 \times 10^5 \text{ mol/m}^2$, and CO was $3.03 \pm 0.30 \times 10^2 \text{ Mmol/m}^2$. The distribution of pollutants shows high concentrations in Rumakit Sub-district, mainly due to heavy traffic and peatland fires during the dry season. However, linear regression tests showed that NO_2 levels only contributed 2.07% ($p=0.6555$) and CO contributed weakly ($p=0.4981$) to the incidence of ARI. This indicates that other factors are more dominant in causing ARI in Palangka Raya.

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