# Air Pollution and Health Status in Indonesia: An Ecological Study in Jakarta, Palembang, and Bandung

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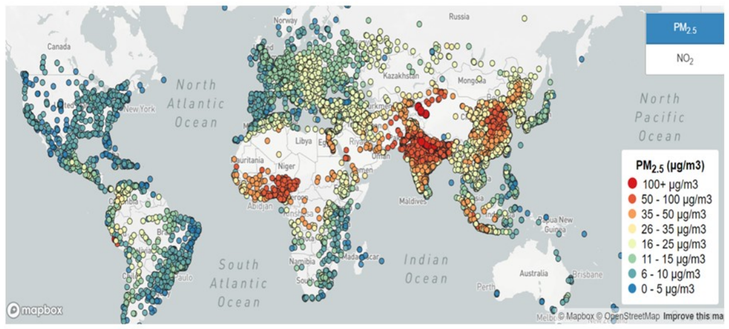
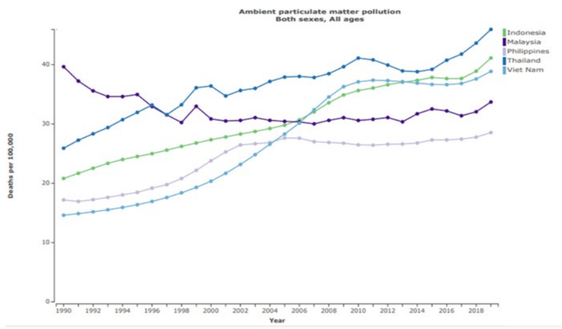
## BACKGROUND

Air pollution in major cities, especially in developing countries, has reached a crisis point. The bad air quality is responsible for the death of 7 million people each year and presents a dilemma for millions worldwide that suffer asthma, lower respiratory diseases, cardiovascular diseases, and lung cancer. The transportation sector contributes the most (80%) to the air pollution followed by emissions from industry, forest fires and domestic activities. In many countries in Asia, vehicle emissions are expected to increase over the next few decades, as the vehicle population increases. The large number of vehicles together with lack of infrastructure results in major traffic congestions resulting in high levels of air polluting substances, which have a significant negative effect on public health. Indonesia, and especially its capital Jakarta, is just subjected to Air Pollution just like any other countries in Asia. The latest annual IQAir quality report on the world's most polluted countries in 2020 ranks Indonesia 9th and is listed as having generally unhealthy air quality index (AQI). According to IQAir.com air quality is gradually getting worse. In 2017 a PM2.5 figure was recorded of 29.7 µg/m³ or "Moderate". In 2018 this figure rose to 45.3 µg/m³ or "Unhealthy for Sensitive Groups" and showed another increase in 2019 when concentrations measured 49.4 µg/m³, on average. These figures were recorded in the capital Jakarta but reflect the general trend throughout most of Indonesia. This study aims to analyze the association between PM2.5 concentration and disease outcomes in Jakarta, Palembang, and Bandung.




Global annual average $PM_{2.5}$ concentration in cities 2019




## METHODS

Study design of ecologic time trend of aggregated data 2011-2020 was used for analyzing the association of air quality parameters with diseases-related to air pollution and estimating the trend up to 2030 in the city of Palembang, Jakarta, and Bandung. The parameters involved in the study were PM10, PM2.5, and SO2 concentrations from Dinas Lingkungan Hidup (DLH) and Lembaga Antariksa dan Penerbangan Nasional (LAPAN). The diseases data were obtained from Dinas Kesehatan Kota dan BPJS Kesehatan. The statistics correlation and regression were implemented. The estimates were then used to extrapolate the total amount of illness caused by air pollution and here we shall assume that the population is subject to the same exposure.

## RESULTS

1. Air quality data for 3 cities: Bandung, Palembang, and Jakarta have been obtained, which includes parameters PM10, PM2.5, SO2, & NO2. Sources of data from the Department of the Environment (DLH) and LAPAN. Time-series data from DLH varies between cities, such as in Bandung not available, in Palembang 2014-2020 but SO2 in 2017-2020, and in Jakarta 2012-2020. Time-series data from LAPAN in all cities are available for 2011-2020.

2. Data on diseases related to air pollution in 3 cities include: Asthma, Bronchopneumonia, Acute Respiratory Infection (ARI) and Pneumonia which are sourced the monthly reports of the City Health Office and the Claims of the National Health Insurance Administration Agency (BPJS). Disease data were collected from 2011 to 2020, but due to the availability of different data, such as in Bandung all disease data were available in 2012-2020, in Palembang ARI & pneumonia data were available in 2014-2020, and in Jakarta disease data was available for 2012-2020, and also due to the large number of unreported data, both air quality parameter concentration data and disease data, statistical correlation analysis and partial regression can only be carried out on 2017-2020 data. The following are the prevalence figures.

Asthma disease was found to have a higher prevalence in Palembang (1.5%-2.5%) compared to Bandung (1%-1.5%) and Jakarta (0.5% -0.8%). Bronchopneumonia was found to have a higher prevalence in Bandung (0.4%-0.6%) compared to Jakarta (0.3%-0.4%) and Palembang (0.1%-0.2%). The prevalence of ARI symptoms was found to be higher in Bandung (1.9%-15.5%) compared to Jakarta (2.5% -6.7%) and Palembang (1.6%-4.2%). Pneumonia was found to be higher in Jakarta (0.4%-0.5%) compared to Bandung (0.2%-0.3%) and Palembang (0.1%).

3. With the available data available, statistical correlation tests, regressions and multiple regressions have been applied. For statistical correlation tests, a significant positive correlation between PM2.5 and Pneumonia was found in Palembang (0.47), and its significant negative correlation was found in Jakarta (-0.63). Significant positive correlation between SO2 and Pneumonia was found in Palembang (0.54). A significant positive correlation between PM10 and ARI was found in Palembang (0.62). Significant negative correlation between PM2.5 and Bronchopneumonia was found in Bandung (-0.24).

Table 1. Statistic regression between air quality parameters and disease outcomes in the city of Bandung, Palembang, and Jakarta.

| Cities | Parameters (µg/$M_3$) | Diseases | Regression | | p-value | Regression Line equation |
|---|---|---|---|---|---|---|
| | | | r | $R^2$ | | |
| Bandung | $PM_{2.5}$ | Pneumonia | 0.23 | 0.06 | **0.06** | **Pneumonia = 742.3 - 4.3*$PM_{2.5}$** |
| | $SO_2$ | | 0.23 | 0.05 | 0.38 | Pneumonia = 518.1 - 1.7*$SO_2$ |
| | $PM_{2.5}$ | Bronchopneumonia | 0,26 | 0.07 | **0.04** | **Bronchopneumonia = 1853.5 - 12*$PM_{2.5}$** |
| | $SO_2$ | | 0.19 | 0.04 | 0.47 | Bronchopneumonia = 1197.2 - 5.3*$SO_2$ |
| | $PM_{2.5}$ | Asthma | 0.05 | 0.002 | 0.98 | Asthma = 2433.7 - 4.4*$PM_{2.5}$ |
| | $PM_{10}$ | ARI | 0.22 | 0.05 | 0.40 | ARI = 670.4 + 16.2*$PM_{10}$ |
| Palembang | $PM_{2.5}$ | Pneumonia | 0.44 | 0.20 | **0.0001** | **Pneumonia = 334.7 + 0.7*$PM_{2.5}$** |
| | $SO_2$ | | 0.17 | 0.03 | 0.29 | Pneumonia = 332.9 + 0.03*$SO_2$ |
| | $PM_{10}$ | ARI | 0.44 | 0.19 | **0.0001** | **ARI = 4401.3 + 11.3*$PM_{10}$** |
| Jakarta | $PM_{2.5}$ | Pneumonia | 0.64 | 0.41 | **0.0001** | **Pneumonia = 4060.2 - 22.3*$PM_{2.5}$** |
| | $SO_2$ | | 0.47 | 0.22 | **0.0001** | **Pneumonia = -477.5 + 90.5*$SO_2$** |
| | $PM_{10}$ | ARI | 0.32 | 0.10 | **0.03** | **ARI = 20913.2 - 172.9*$PM_{10}$** |

## CONCLUSION

An increase per 10 mg/m3 PM2.5 was associated with a 5.7% increase of Pneumonia cases
An increase per 10 mg/m3 SO2 was associated with a 6.7% increase of Pneumonia cases
An increase per 10 mg/m3 PM10 was associated with a 1.4% increase of Acute Respiratory Infection cases