

IMPACTS OF AIR POLLUTION ON HEALTH AND COST ILLNESS IN DKI JAKARTA



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ABSTRACT

Background: Poor air quality has been strongly linked to non-communicable diseases, including chronic heart and lung disease, and adversely affects children and the elderly, our most vulnerable members of society. This study quantifies the health and economic impacts of air pollution in Jakarta Province, the capital of Indonesia, including 1) adverse health outcomes in children, premature mortality, and daily hospitalizations and 2) the cost of air pollution-related health impacts.

Methods: We evaluated the health and economic impacts of PM_{2.5} and Ozone, both of which exist at levels exceeding the Indonesian National Ambient Air Quality Standard and the World Health Organization's health-based guidelines. We selected the following health outcomes: adverse health outcomes in children, adverse birth outcomes, mortality, and hospitalizations. We calculated the annual average concentration of PM_{2.5} and O₃ to estimate mortality and adverse health outcomes in children attributable to air pollution. Meanwhile, the 24-hour average (for PM_{2.5}) and the 8-hour average (for O₃) were calculated to estimate hospitalizations attributable to air pollution. The health burdens attributable to air pollution were estimated using the latest Global Burden of Disease Study 2019 study methodology and best available concentration-response functions. The economic burdens were calculated using cost-of-illness and the value of statistical life-year approaches.

Results: In Jakarta, over 7,000 adverse health outcomes in children, over 10,000 deaths, and over 5,000 hospitalizations can be attributed to air pollution each year. The total cost per year of the health impact of air pollution reached approximately IDR 41.2 trillion, around 2.2% of Jakarta province GDRP.

Conclusions: The current study fills important knowledge gaps about the health impacts of air pollution in children. The study findings also provide timely and valuable input for the Environmental Agency's Grand Design to identify and understand the full magnitude of air pollution burden in Jakarta, and to formulate clean air solutions.

INTRODUCTION

Air pollution is a major threat to the 10 million people living in the Jakarta area. Based on the data from the Environmental Agency of DKI Jakarta, the annual ambient PM_{2.5} concentrations in Jakarta are the highest among all of Indonesia's urban centers. Conservative estimates from the Global Burden of Disease study suggest that air pollution had caused 5,054 deaths and 168,000 years lost to ill-health, disability, or premature death in DKI Jakarta Province in 2019.

Global evidence on the adverse health impacts of air pollution is consistent and clear. Air pollution has detrimental effects to all age groups in our society. Poor air quality has been strongly linked to non-communicable diseases (NCDs), such as cardiovascular and chronic respiratory diseases and lung cancers, and it adversely affects children, our most vulnerable members of society. Being exposed to polluted air may have prolonged impacts on children's health (e.g., impaired cognitive and socioemotional development), and can lead to increased risk of chronic respiratory illness, cardiovascular disease, and diabetes, throughout life.

This study quantifies the health and economic impacts of air pollution in DKI Jakarta Province, the capital of Indonesia. First, this study calculates the health impacts due to air pollution, focusing on adverse health outcomes in children, premature mortality, and daily hospitalizations. Second, the study estimates the economic impact associated with air pollution-related health impacts. The results of this study will deliver valuable input for the Grand Design conducted by the Environmental Agency to identify and understand the full magnitude of air pollution burden in Jakarta, and to the formulation of solutions to address priority sources of pollution.

METHODS

We evaluated the health and economic impacts of PM_{2.5} and ground-level ozone, both of which exist at levels exceeding the Indonesian National Ambient Air Quality Standard (NAAQS) and the World Health Organization's health-based guidelines. We calculated the annual average concentration of PM_{2.5} and O₃ to estimate mortality and adverse health outcomes in children attributable to air pollution. Meanwhile, the 24-hour average (for PM_{2.5}) and the 8-hour average (for O₃) were calculated to estimate hospitalizations attributable to air pollution. Daily air pollution data for 2019 were provided by the Environmental Agency of DKI Jakarta. Daily average concentration levels for PM_{2.5}, O₃, NO₂, and SO₂ were collected from the air quality monitoring stations located in five districts: Central Jakarta, North Jakarta, South Jakarta, East Jakarta, and West Jakarta.

According to the available risk estimates from the Global Burden of Disease (GBD) Study 2019 and the epidemiologic literature, we selected the following health outcomes:

- Adverse health outcomes in children: stunting, infant deaths, and adverse birth outcomes (preterm births and low birth weight);
- Mortality: total mortality and six categories of cause-specific mortality (ischemic heart disease (IHD), chronic obstructive pulmonary disease (COPD), stroke, lung cancers, type 2 diabetes mellitus, and lower respiratory infection (LRI)); and
- Hospitalizations: two hospital admissions from cardiovascular diseases and respiratory illnesses.

The health burdens attributable to air pollution were estimated using the latest GBD Study 2019 study methodology and best available concentration-response functions. The economic burdens associated with the health impacts of air pollution were calculated using cost-of-illness and the value of statistical life-year approaches.

RESULTS

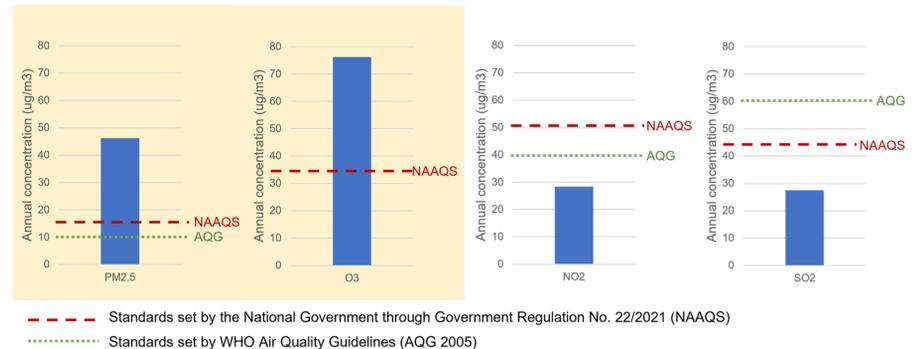


Figure 1. Air quality levels in Jakarta, 2019.

Table 1. Impacts of annual exposure to PM_{2.5} and Ground-level Ozone on mortality and adverse outcomes in children, 2019

Health outcomes	Total burden	Air Pollution Attributable Indicators	
		Number of cases	Rate
PM_{2.5} (annual mean: 52 µg/m³)			
Adverse outcomes in children (2019)			
Infant deaths	986	327	2 per 1,000 births
Stunting	11,211	6,153	7 per 1,000 children under 5
Low birth weight	1,269	680	5 per 1,000 births
Preterm births	1,919	62	4 per 10,000 births
Mortality (2019)*	23,430 [^]	9,692	88 per 100,000

Ground-level O₃ (annual daily max 8-h average: 162 µg/m³)

Mortality due to COPD (2019)* 3,635 310 5 per 100,000 aged 25+

* Hybrid approach: mortality count is calculated by multiplying Jakarta population (from BPS) with mortality rate (from GBD 2019 Study).

[^] Total mortality include deaths from ischemic heart disease, stroke, COPD, type 2 diabetes, lower respiratory infections, and lung cancer.

Table 2. Impacts of daily exposure to PM_{2.5} and Ground-level Ozone on hospitalizations, 2019

Hospitalizations	Cause of hospital admission	
	Cardiovascular disease	Respiratory disease
PM_{2.5}		
Total hospitalizations	150,272	108,560
PM _{2.5} attributable indicators		
Number of cases	3,043	455
Rate (per 100,000 population)	29	4
Ground-level O₃ *		
Total hospitalizations	37,039	12,147
O ₃ attributable indicators		
Number of cases	1,357	182
Rate (per 100,000 population age 65+)	281	38

*Ozone-related outcomes are only for age 65 years and over

Table 3. Annual economic cost of health impact attributable to air pollution in DKI Jakarta (in billion IDR), 2019

	Adverse Children Health Outcomes				
	Infant deaths	Stunting	Adverse birth outcomes*	Mortality	Hospitalizations
Health burden	327	6,153	742	10,002	5,037
Economic cost (in IDR)	1,301	11	15	39,794	87

*Combining babies born low birth weight and preterm birth

CONCLUSION

We estimated that each year, **air pollution causes more than 10,000 deaths, more than 5,000 hospitalizations for cardio-respiratory diseases, and more than 7,000 adverse health outcomes in children.** The total economic burden attributable to air pollution was estimated to be **IDR 52.1 trillion (2.2% of GRDP).** The study findings provide valuable input for the Environmental Agency's Grand Design to identify and understand the full magnitude of air pollution burden in Jakarta, and to formulate clean air solutions.

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