Uncovering the Hidden Risks of $PM_{2.5}$ Exposure Among School-Aged Children in Jakarta

POLICY BRIEF

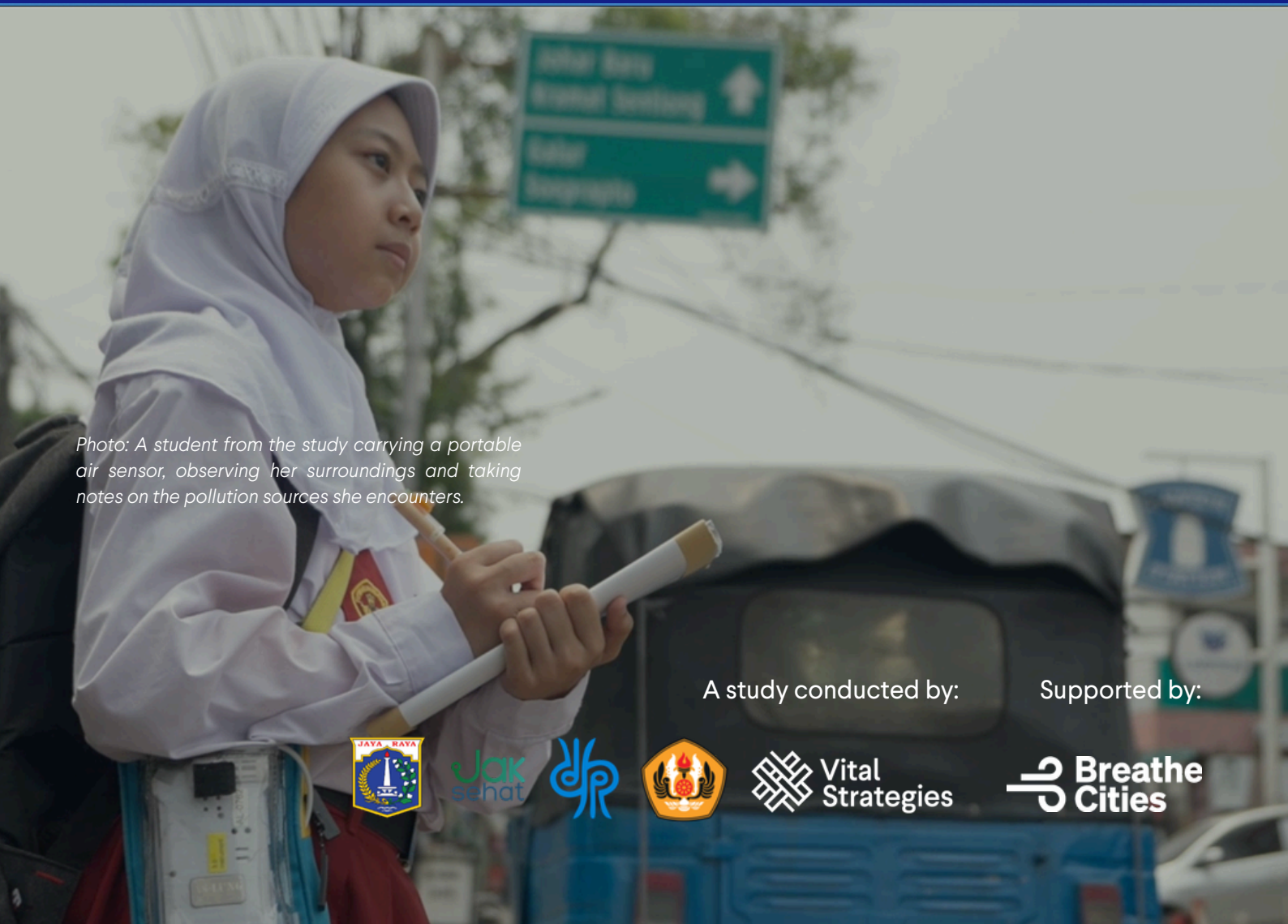

Photo: A student from the study carrying a portable air sensor, observing her surroundings and taking notes on the pollution sources she encounters.

A study conducted by:

Supported by:

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This study obtained ethical clearance from the research ethics committee of Universitas Padjadjaran with ethical approval number 378/UN6.KEP/EC/2025 on 5 May 2025. All participating students submitted written consent signed by their parents or legal guardians.

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About Breathe Cities:
Breathe Cities is a global initiative supporting cities to clean the air and enhance public health—delivered by Bloomberg Philanthropies, Clean Air Fund and C40 Cities, and implemented together with Vital Strategies in Jakarta. The initiative offers cities tools to take ambitious clean air action by expanding access to data and raising public awareness. Launched in 2023 by Michael R. Bloomberg, the UN Secretary-General's Special Envoy on Climate Ambition and Solutions and founder of Bloomberg Philanthropies, and Sadiq Khan, Mayor of London and C40 Cities Co-Chair, Breathe Cities is accelerating action in 14 cities to improve the air 77 million people breathe. To learn more, visit Breathe Cities' website or follow on Instagram and LinkedIn.

Children playing outdoors at one of the study schools, with smoke from open waste burning visible in the background.

Children in Jakarta are exposed to harmful air pollution levels throughout the day — often far exceeding what reference monitoring stations indicate.

The study shows that exposure is driven not only by ambient air quality but also by daily activities and household sources, with secondhand cigarette smoke, waste burning and cooking identified as other major contributors. Protecting children requires policies that reduce emissions, improve household environments and strengthen health-based early warning systems.

The Problem

Air pollution is one of the leading environmental health risks in Jakarta, contributing to preventable illness and substantial economic losses [1]. In 2024, the city experienced 90 days of unhealthy air quality, posing serious health risks to people vulnerable to the effects of unhealthy air, including children [2]. Although Jakarta has installed air quality monitoring sensors to monitor outdoor (ambient) air pollution, those measurements do not fully reflect the actual exposure experienced by children in their daily activities [3–5]. To address this gap, this study used personal low-cost sensors to measure 24-hour exposure to air pollution among school-age children, using $PM_{2.5}$ as an indicator, which is fine particulate matter in the air. The study aimed to identify their daily exposure patterns, assess variations across different microenvironments, and identify students' perceptions of air pollution sources in their surroundings.

Jakarta air quality monitoring station installed at school.

Why This Study Matters

This study provides new evidence to guide policies that directly reduce exposure and protect children's health because:

- Children are more vulnerable to air pollution because their lungs are still developing and they breathe faster, increasing pollutant intake [6].
- Both short- and long-term exposure can impair lung function and increase the risk of chronic asthma [7–11].
- Personal exposure depends on where children spend their time (at home, at school and during commuting), not just on overall ambient air quality levels [12–15].

Approach

WHO
51 elementary school students

WHEN
July 2025–January 2026

WHERE
Two public primary schools, located in Central Jakarta and South Jakarta

HOW
Citizen Science
Each student carried a personal sensor for 24 hours on one school day and recorded their daily activities and potential pollution sources.

Key Findings

4 IN 5 CHILDREN BREATHE HAZARDOUS AIR

About 4 in 5 children participating in the study experienced high $PM_{2.5}$ exposure (≥55 µg/m³) during the 24-hour monitoring period, exceeding Indonesia's daily air quality standard (55 µg/m³) [16].

THERE IS NO TRULY SAFE TIME OF DAY

Children inhale dangerous pollution doses daily. The exposure occurs throughout the day, with the highest peak recorded between 11:00 p.m. and 1:00 a.m.

HOME IS WHERE MOST EXPOSURE HAPPENS

$PM_{2.5}$ exposure occurs across multiple daily settings, with the home as the dominant one—where children spend around 70% of their time.

MORNING COMMUTES CARRY THE HIGHEST EXPOSURE RISK

Due to heavy traffic congestion and concentrated street-level pollution, children are more likely to encounter $PM_{2.5}$ levels that surpass the national standard (55 µg/m³) during their morning commute to school.

OTHER LEADING SOURCES OF HOUSEHOLD POLLUTION IDENTIFIED INCLUDE SECONDHAND CIGARETTE SMOKE, OPEN WASTE BURNING AND COOKING

Secondhand smoke added an estimated +17 µg/m³ to children's daily $PM_{2.5}$ exposure—more than other sources of emissions identified by students.

Policy Recommendations

STRENGTHEN CROSS-SECTORAL COLLABORATION ON AIR QUALITY CONTROL

- Empower health cadres to deliver air pollution education during routine community activities (e.g., Posyandu/community health centre), focusing on household-level sources.
- Integrate air pollution and health topics into school curricula to promote protective behaviors from an early age.
- Establish low-emission zones around schools and enforce restrictions on open burning near residential areas.

PROTECT CHILDREN DURING HIGH-RISK TIMES AND LOCATIONS

- Manage traffic around schools; restrict heavy vehicles near schools; improve walking routes.
- Promote mask use for children commuting on poor air quality days.
- Reschedule outdoor school activities during high pollution periods to limit direct exposure.

ADDRESS EXPOSURE INEQUALITIES

- Personal exposure data may inform air quality policies to protect the most vulnerable residents.

EXPAND THE CITIZEN SCIENCE APPROACH

- Embed citizen science in community empowerment programs to build awareness through direct experience.
- Engage students, parents, and communities as active local air quality monitors.
- Connect community-generated data to formal channels to inform policy.

STRENGTHEN EARLY WARNING SYSTEMS

- Develop real-time air quality surveillance and forecasting shared across agencies.
- Alert schools and health facilities during high-pollution episodes.
- Prepare health services for respiratory illnesses during pollution peaks.

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Protecting children from air pollution requires coordinated action across sectors.

Evidence from personal exposure monitoring shows that reducing emissions alone is not enough — policies must also address exposure in homes, schools, and during daily commutes.