$PM_{2.5}$ Trends and Health Implications in an Indonesian Urban Setting: A Case Study of Padang City

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Abstract

Fine particulate matter ($PM_{2.5}$) is a critical air pollutant associated with increased morbidity and mortality. The objective of this research is to analyze $PM_{2.5}$ concentrations and highlight the health implications of $PM_{2.5}$ exposure. This study examines trends in $PM_{2.5}$ levels in Padang City, Indonesia, using 1,465 days of data from the city's Air Quality Monitoring System (AQMS). Results indicate that $PM_{2.5}$ levels exceeded Indonesia's 24-hour air quality standard (55 µg/m^3) on 15 days, while 356 days (24%) surpassed the World Health Organization (WHO) daily guideline (15 µg/m^3). The highest annual average occurred in 2019 at 18.9 µg/m^3, exceeding Indonesia's annual standard (15 µg/m^3). Meanwhile, all five years recorded annual averages (ranging from 8.89 to 18.9 µg/m^3) above the WHO guideline (5 µg/m^3). Although none of the years met the strict WHO targets, annual levels fell between interim targets 2 and 3 (25–37.5 µg/m^3), suggesting gradual progress. To mitigate health risks and promote sustainable urban development, a multi-pronged strategy is required. First, emission inventories must be routinely conducted to identify major pollution sources. Second, to guarantee complete and representative coverage, the ambient monitoring network should be improved and expanded in order to more precisely estimate exposure and take regional variations into consideration. Third, it will be essential to combine epidemiological and toxicological studies to quantify health impacts and guide targeted interventions. Strengthening air quality governance through evidence-based policies is imperative to safeguard public health and improve environmental resilience in Padang City.

Keywords: Fine particulate matter; Air quality standards; AQMS; Human health.