THE RELATIONSHIP BETWEEN AIR QUALITY AND THE INCIDENCE OF UPPER RESPIRATORY TRACT INFECTIONS (URTIS) IN CHILDREN IN INDUSTRIAL AREAS

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Abstract

Industrial activity is known to contribute significantly to ambient air pollution, which poses a major risk to respiratory health, particularly in children. Objective: This study investigates the relationship between air quality (measured by PM2.5, PM10, SO2, and NO2 levels) and the incidence of Upper Respiratory Tract Infections (URTIs) among children aged 1–10 years in an industrial area. Methods: A cross-sectional design was employed, using air quality monitoring data and medical records from local health centers over a 12-month period. Results: Significant positive correlations were found between the levels of PM2.5 and NO2 and increased incidence of URTIs ($r = 0.62$ and 0.59, respectively; $p < 0.01$). Conclusion: Poor air quality in industrial areas is strongly associated with a higher prevalence of URTIs in children. Public health interventions and stricter environmental policies are recommended.

Keyword: Air Pollution, URTI, Children, Industrial Zone, Environmental Health

Introduction

Air pollution is one of the most pressing environmental health issues globally. Children, due to their developing respiratory systems and higher minute ventilation relative to body weight, are particularly vulnerable to air pollutants. Upper Respiratory Tract Infections (URTIs) are among the most common diseases in children and can be exacerbated by exposure to air pollutants such as particulate matter (PM2.5, PM10), nitrogen dioxide (NO2), and sulfur dioxide (SO2).

Industrial activities release a significant amount of pollutants into the atmosphere. These pollutants, particularly fine particulate matter and gaseous compounds, can penetrate deep into the lungs and trigger respiratory illnesses. While various global studies have reported on the association between air quality and respiratory health, studies focusing on children in industrial areas in developing countries, including Indonesia, are limited.

This study aims to examine the association between ambient air pollutant levels and the incidence of URTIs among children in a designated industrial area. The findings can inform targeted policy interventions and community-level health responses.

Several studies have documented the health risks associated with air pollution. Pope et al. (2009) found that long-term exposure to PM2.5 is associated with increased mortality and morbidity related to respiratory and cardiovascular conditions. Gauderman et al. (2004) observed reduced lung development in children exposed to polluted air over time.

A study in China by Zhang et al. (2016) revealed a significant increase in hospital visits for pediatric respiratory diseases during periods of high air pollution. In Indonesia, recent air quality reports by the Ministry of Environment and Forestry indicate that several industrial zones frequently record pollutant levels exceeding WHO-recommended limits.

Despite these findings, there is a gap in localized research focusing on pediatric populations in industrial zones. This study contributes to filling that gap, particularly by utilizing real-time air quality monitoring data in conjunction with epidemiological records.

Research methods

Study Design and Location This study employed a quantitative, cross-sectional design conducted in an industrial district in West Java, Indonesia, known for high concentrations of factories and manufacturing plants.

Sample and Data Collection Medical data on URTI cases in children aged 1–10 years were collected from three community health centers over a one-year period (January to December 2024). Air quality data were obtained from a fixed monitoring station maintained by the Environmental Agency, recording daily average levels of PM2.5, PM10, SO2, and NO2.

Variables and Analysis The independent variables were the average monthly levels of PM2.5, PM10, NO2, and SO2. The dependent variable was the monthly count of reported URTI cases. Data were analyzed using Pearson correlation and linear regression models to determine the strength and significance of associations.

Results and Discussion

Descriptive Statistics The average monthly concentration of PM2.5 ranged from 35 µg/m3 to 92 µg/m3, with peaks during dry seasons. The highest recorded NO2 level was 76 µg/m3. An average of 187 URTI cases per month was reported across the three centers.

Correlation Analysis There was a strong positive correlation between PM2.5 levels and URTI incidence ($r = 0.62$, $p < 0.01$), as well as between NO2 and URTIs ($r = 0.59$, $p < 0.01$). PM10 and SO2 showed moderate correlations ($r = 0.42$ and 0.38, respectively; $p < 0.05$).

Regression Analysis Multivariate linear regression revealed that PM2.5 was the most significant predictor of URTI incidence ($\beta = 0.43$, $p < 0.001$), followed by NO2 ($\beta = 0.35$, $p = 0.003$).

Discussion

he study findings support the hypothesis that air pollution, particularly fine particulate matter and nitrogen dioxide, significantly contributes to the burden of URTIs in children. The stronger correlation with PM2.5 is consistent with global literature, which highlights its ability to bypass upper respiratory defenses and deposit deeply in the lung tissue.

This study is among the first in Indonesia to combine real-time environmental data with pediatric health records in an industrial setting. The results emphasize the urgent need for stricter industrial emission controls and routine health screening in at-risk communities.

Children in industrial zones are doubly disadvantaged: not only are they exposed to higher pollutant concentrations, but many also lack access to adequate healthcare and live in households with additional indoor pollution sources (e.g., biomass fuels). Public health strategies must be multisectoral, integrating environmental regulation with education and healthcare outreach.

Closing

This research confirms a significant association between poor ambient air quality and the incidence of URTIs in children living in industrial areas. Among the pollutants studied, PM2.5 and NO2 had the strongest correlation with infection rates. These findings underscore the need for robust air quality management and targeted pediatric health interventions in industrial regions.

Bibliography

Gauderman, W. J., Avol, E., Gilliland, F., et al. (2004). The effect of air pollution on lung development from 10 to 18 years of age. *New England Journal of Medicine*, 351(11), 1057–1067.

Pope, C. A., Ezzati, M., & Dockery, D. W. (2009). Fine-particulate air pollution and life expectancy in the United States. *New England Journal of Medicine*, 360(4), 376–386.

World Health Organization (2021). *WHO global air quality guidelines: Particulate matter (PM2.5 and PM10), ozone, nitrogen dioxide, sulfur dioxide and carbon monoxide.* Geneva: WHO.

Zhang, Y., Liu, X., Zhang, L., & Pan, Y. (2016). Association between air pollution and hospital outpatient visits for pediatric respiratory diseases in Shanghai, China. *Environmental Science and Pollution Research*, 23(12), 12235–12243.

Ministry of Environment and Forestry of Indonesia. (2023). *Annual Air Quality Report*. Jakarta: MoEF.

Bandura, A. (1986). *Social foundations of thought and action: A social cognitive theory*. Prentice-Hall.

Chen, X., Wang, Y., & Zhang, Y. (2021). The role of mobile health apps in improving adolescent nutrition: A meta-review. *JMIR mHealth and uHealth, 9*(3), e23456. https://doi.org/10.2196/23456

Chau, M., Burgermaster, M., & Mamykina, L. (2018). The use of mobile technologies for health promotion among adolescents: A systematic review. *Journal of Adolescent Health, 62*(4), 467–478.

Nour, M., Yeatman, H., & Kelly, B. (2019). Digital health interventions for improving diet and physical activity in adolescents: A systematic review and meta-analysis. *BMJ Open, 9*(6), e025047.

Nutbeam, D. (2000). Health literacy as a public health goal: A challenge for contemporary health education and communication strategies into the 21st century. *Health Promotion International, 15*(3), 259–267.

Sahoo, K., Sahoo, B., Choudhury, A. K., Sofi, N. Y., Kumar, R., & Bhadoria, A. S. (2015). Childhood obesity: Causes and consequences. *Journal of Family Medicine and Primary Care, 4*(2), 187–192.

Stephens, J., Allen, J., & Dennison, C. R. (2020). Mobile phone interventions to improve adherence in adolescents with health issues: A systematic review. *JMIR Pediatrics and Parenting, 3*(1), e12971.

van Dijk, J. (2020). *The digital divide*. Polity Press.

World Health Organization. (2020). *Guidelines on physical activity and sedentary behavior*. WHO.

Kemenkes RI. (2022). *Profil Kesehatan Indonesia Tahun 2021*. Kementerian Kesehatan Republik Indonesia. Retrieved from https://pusdatin.kemkes.go.id

Nutbeam, D. (2000). Health literacy as a public health goal: A challenge for contemporary health education and communication strategies into the 21st century. *Health Promotion International, 15*(3), 259–267. https://doi.org/10.1093/heapro/15.3.259

World Health Organization (WHO). (2019). *Primary health care on the road to universal health coverage: 2019 global monitoring report*. World Health Organization. Retrieved from https://www.who.int/publications/i/item/9789240029040

Setiawan, B., & Anwar, A. F. (2020). Determinants of clean and healthy lifestyle behavior in urban slum areas. *Jurnal Kesehatan Masyarakat Nasional (National Public Health Journal), 15*(2), 85–94. https://doi.org/10.21109/kesmas.v15i2.3562

Susilowati, I. H., & Sari, R. N. (2021). Community participation and PHBS behavior among urban households: A cross-sectional study. *BMC Public Health, 21*(1), 1–9. https://doi.org/10.1186/s12889-021-10291