

Where Dirty Air Hurts Children Most

A District Vulnerability Index for Pollution, Child Health, and Household Fragility in Pakistan

Introduction

Across the **111 districts** covered in this analysis, annual microscopic airborne particles under 2.5 micrometers in diameter - **PM_{2.5}** - **levels exceed the WHO-recommended safe limit of 5 µg/m³**. This analysis then connects **air pollution** to **under-five respiratory illness, child stunting, poverty, low maternal education, and crowded housing**. Finally, we used a composite district vulnerability index to identify where clean-air and child-health investments can deliver the greatest equity and public health gains.

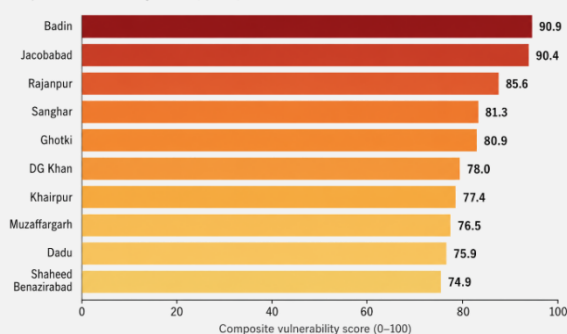
Key findings

High-risk districts form regional clusters, not isolated hotspots: PM_{2.5} exposure and under-five acute respiratory infection show spatial clustering. This means risk is shared across neighboring districts and cannot be addressed through district-level action alone. Air pollution moves across administrative boundaries. Clean-air planning must therefore focus on wider airsheds and regional exposure patterns.

Southern Punjab and rural Sindh emerge as the main vulnerability belt: The composite index identifies a high-priority belt across **southern Punjab and rural Sindh**. Districts including **Badin, Jacobabad, Rajanpur, Sanghar, Ghotki, Dera Ghazi Khan, Khairpur, and Muzaffargarh** rank among the most vulnerable because pollution overlaps with child illness, stunting, poverty, low maternal education, and household crowding.

Top 10 Most Vulnerable Districts

Composite vulnerability score (0–100)



A vulnerability index gives a sharper targeting tool than pollution data alone: Pollution levels alone do not identify where children and households face the greatest risk. The composite index combines PM_{2.5} exposure, ARI prevalence, stunting, poverty, maternal no education, and crowding to help

governments and development partners target districts where clean-air action should be linked with primary healthcare, nutrition, and social protection.

Vulnerability Index Components & Weightages

-  **PM_{2.5} exposure (25%)**
-  **ARI prevalence (25%)**
-  **Child stunting (15%)**
-  **Poverty (15%)**
-  **Maternal no education (10%)**
-  **Household crowding (10%)**

Key takeaways



Prioritize the most vulnerable districts using the District Vulnerability Index.



Plan and implement clean-air measures across shared airsheds, especially in southern Punjab and rural Sindh, targeting brick kilns, crop burning, transport emissions, and industrial sources.

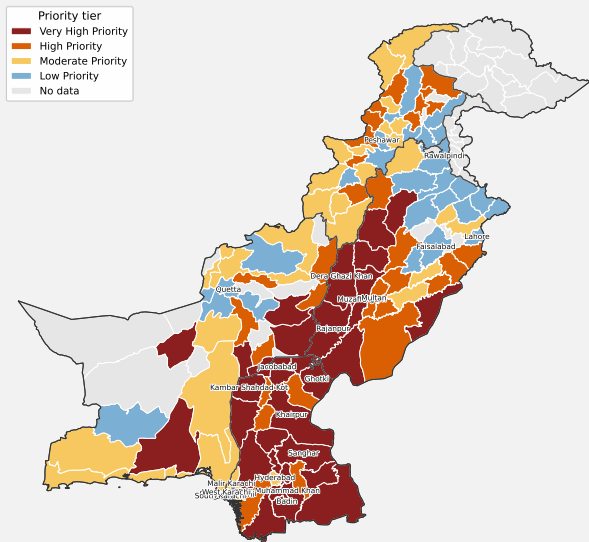


Align public budgets, donor support, and climate finance with integrated interventions that combine pollution control, primary healthcare, nutrition, education, and social protection.

Methodology: This analysis links satellite-derived PM_{2.5} exposure, MICS 6 child health and household indicators, and 2023 Census under-five population across 111 districts. Results identify districts for priority targeting; they should not be read as proof of individual-level causation.

Composite District Risk Index for PM_{2.5}-ARI Vulnerability

District priority tiers based on air pollution, ARI burden, child vulnerability, poverty, education and crowding



Note: Composite score combines percentile ranks for PM_{2.5} exposure, ARI prevalence, stunting, low wealth, maternal no education and household crowding. Priority tiers are quartiles of the district score distribution. Grey areas are administrative units present in the shapefile but not included in the MICS-based analytical dataset. For mapping, Kohistan and Chitral risk values were assigned to both corresponding shapefile polygons.

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