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Identifying health-threats of airborne metal-containing particulate matter in Dhaka, Bangladesh

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Poor air quality poses a significant health concern across low-to-middle-income countries, particularly in South Asia. Air pollution in these cities comprises a mixture of gases and particulate matter (PM). Particulate matter with a size of less than 2.5 μm is particularly problematic, contributing to between 530 and 5000 premature adult deaths annually in Dhaka, Bangladesh alone. Despite some efforts to understand the health impacts of PM in Dhaka, the chemical and physical properties of PM phases that control their health impacts are still unknown. We have collected 62 outdoor air samples from households and industries within Dhaka city using an active air sampler and characterized them using inductively coupled plasma mass spectroscopy (ICP-MS) and scanning and transmission electron microscopy (EM). We observe significant concentrations of both major and trace elements, such as Al, Fe, Mg, Zn, and Pb, often exceeding the recommended airborne PM exposure limits. Additionally, particles occur within a size range of sub-100 nm to 10 μm, posing inhalation risks to both upper and lower respiratory tracts; the finest particles can even penetrate the bloodstream. Lead particles occur as spherical, cylindrical, and rhombohedral single particles with a size range from sub-100 nm to 2.5 μm, with the majority being less than 250 nm. Thus, the health risks associated with exposure to Pb-containing PM are accentuated relative to considerations of typical PM 2.5. Our results should contribute to identifying the magnitude of PM health threats and aid in developing effective solutions to mitigate respiratory exposure risks faced by local communities.