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Exposure to Particulate Matter and Respiratory Dust Depositions in Schoolchildren's Airways in India

SHRAVAN KUMAR[1] AND DR. KIRPA RAM[2]

[1]INSTITUTE OF SCIENCE
[2]Institute of Science, Banaras Hindu University

Children with their developing tissues and higher inhalation rates relative to body weight are more vulnerable to indoor air quality (IAQ) than adults. Debased IAQ significantly influences the comfort, attention, focus, productivity, and well-being of students. This study assessed air quality in various schools by measuring size-segregated Particulate Matter (PM_{10}, $PM_{2.5}$, PM_1) and their effect on schoolchildren by determining respiratory dust depositions (RDDs) in their different respiratory regions, like head airway (HD), tracheobronchial (TB), and alveolar (AL), for two age groups (7 and 9 years). PM deposition and clearance rates were also measured using the Multiple-Path Particle Dosimetry (MPPD) model (V 3.04). The DAV school shows a minimum PM value due to closed and controlled microenvironments, more vegetation outside, and properly designed classrooms. Results shown in the current investigation portray the alarming micro-environmental conditions in the monitored zone. RDDs values (μg min^{-1}) found for the AL region were 0.091± 0.067 and 0.019 ± 0.021 for PM10, 0.305 ± 0.214 and 0.143 ± 0.114 for PM2.5, and 0.227 ± 0.173 and 0.047 ± 0.034 for PM_1 for children in sitting and light exercise positions, respectively. RDDs values in the AL region significantly increase as PM_{10} (17%), $PM_{2.5}$ (58%), and PM_1 (25%) increase, confirming that the AL region is the most prominent zone affected by fine particles ($PM_{2.5}$). The results showed that more than 95% and 75% of PM_{10} and inhaled $PM_{2.5}$, respectively, were deposited. Due to physiological and structural considerations, children had higher levels of PM deposition in particular lung areas, and differences in lobar deposition patterns were also observed. The 7-year group exhibited the most PM_{10} deposition (35%) in the tracheobronchial (TB) region, whereas the 9-year group's alveolar had the highest $PM_{2.5}$ deposition (40%). The 7-year group had greater $PM_{2.5}$ levels in the left lower (16%) and right upper (11%) lobes, whereas the 9-year group had higher levels in the left upper (6%) and right lower (17%) lobes. It concludes the vulnerability of children towards higher PM concentrations, which primarily affect their respiratory systems.