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Outdoor Concentration versus Personal Exposure in Urban Residents: Which PM2.5 Metric Is Associated with Respiratory Pathophysiology?

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Objective: Contemporary outdoor PM2.5 levels are generally low in Western cities, which may make indoor contributions to personal exposure more significant. We aim to compare acute effects of PM2.5 measured as outdoor concentration versus personal exposure on respiratory pathophysiologic indicators in adults with or without asthma.
Methods: From 2021-2023, we conducted a panel study in 42 adults (17 with and 25 without asthma) residing in London, UK. Each participant was measured in a summer month and a winter month for airway resistance (R5, R20, and R5–R20), lung function (FEV1), and pulmonary inflammation (FeNO). Outdoor PM2.5 concentration was estimated hourly over the 48 hours preceding each health assessment using the inverse distance weighting (IDW) method using the data measured at 3 nearby monitoring stations. Personal PM2.5 exposure was measured over the same period using Airspeck-P wearable sensor attached to participants. Mixed-effects models combined with distributed lag models (DLMs), including an interaction term for asthma status, were applied to evaluate the effects of 4-hour averaged outdoor and personal PM2.5 exposure, respectively.
Results: Outdoor PM2.5 concentrations were higher than personal concentrations, with median (IQR) being 6.03 (6.21) μg/m³ and 2.71 (4.36) μg/m³, respectively. We observed significant associations of increasing outdoor PM2.5 concentrations with increased airway resistance (effect lagged by 8-19 hours) and with decreased lung function (effect lagged by 8-31 hours) only in asthmatic participants (not in healthy participants). In contrast, personal PM2.5 exposure was not significantly associated with any of the respiratory pathophysiology indicators.
Conclusion: Individuals with asthma showed worsened respiratory pathophysiology 8 –31 hours after an increase in 4-hour averaged outdoor PM2.5 concentration. Substantially lower personal PM2.5 exposure compared to outdoor PM2.5 concentration suggests that indoor PM2.5 levels were lower. Sources and factors associated with indoor PM2.5 exposure may have attenuated the respiratory effects of outdoor PM2.5 under contemporary air quality conditions in London.

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