Exposure Modeling of Residential Air Exchange Rates for NEXUS Participants

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Due to cost and participant burden of personal measurements, air pollution health studies often estimate exposures using local ambient air monitors. Since outdoor levels do not necessarily reflect personal exposures, we developed the Exposure Model for Individuals (EMI) to improve exposure estimates in health studies. A critical aspect of EMI is estimation of the air exchange rate (AER) for individual homes where people spend most of their time. The AER, defined as the airflow into and out of buildings, can substantially impact indoor air pollutant concentrations and resulting occupant exposures. Our goal was to evaluate and apply an AER model to predict residential AER for the Near-Road Exposures and Effects of Urban Air Pollutants Study (NEXUS), which is examining traffic-related air pollution exposures and respiratory effects in asthmatic children living near major roads in Detroit, Michigan. We developed a model to predict AER based on building characteristics related to air leakage, local airport temperatures and wind speeds. Cross validation was used with a subset of NEXUS homes (N=24) with daily AER measured on five consecutive days during fall 2010 and spring 2011. Individual predicted and measured AER closely matched with median absolute differences of 36% and 24% for the fall and spring, respectively. The model was then applied to predict daily AER metrics for multiple time periods (e.g., AM/PM rush hours, overnight) for all NEXUS homes (N=193) during the study (Jan. 2010 - Dec. 2012). The AER predictions show (1) substantial house-to-house (spatial) variations (0.1 – 2.6 h^{-1}) from building leakage differences; (2) slow AER oscillations from seasonal temperature changes; and (3) large transients from wind speed fluctuations. This study demonstrates the ability to predict spatiotemporal variability of residential AER in support of improving health study exposure assessments.