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Association between Noise Levels, Particulate Matter Concentrations and Traffic Intensities in a Near-Highway Urban Area

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Abstract : Both traffic-generated particles and noise have been associated with the development of cardiovascular diseases, especially in near-highway environments. Although noise and particulate matters (PM) have different mechanisms of dispersion, sharing the same emission source in urban areas (road traffics) can result in a similar degree of variability in their levels. This study investigated the temporal variation of and correlation between noise levels, PM concentrations and traffic intensities near a major highway in Tehran, Iran. Tehran particulate concentration is highly influenced by road traffic. Additionally, Tehran ultrafine particles (UFP, PM<0.1 µm) are mostly emitted from combustion processes of motor vehicles. This gives a high possibility of a strong association between traffic-related noise and UFP in near-highway environments of this megacity. Hourly average of equivalent continuous sound pressure level (Leq), total number concentration of UFPs, mass concentration of PM2.5 and PM10, as well as traffic count and speed were simultaneously measured over a period of three days in winter. Additionally, meteorological data including temperature, relative humidity, wind speed and direction were collected in a weather station, located 3 km from the monitoring site. Noise levels showed relatively low temporal variability in near-highway environments compared to PM concentrations. Hourly average of Leq ranged from 63.8 to 69.9 dB(A) (mean ~ 68 dB(A)), while hourly concentration of particles varied from 30,800 to 108,800 cm-3 for UFP (mean ~ 64,500 cm-3), 41 to 75 µg m-3 for PM2.5 (mean ~ 53 µg m-3), and 62 to 112 µg m-3 for PM10 (mean ~ 88 µg m-3). The Pearson correlation coefficient revealed strong relationship between noise and UFP (r ~ 0.61) overall. Under downwind conditions, UFP number concentration showed the strongest association with noise level (r ~ 0.63). The coefficient decreased to a lesser degree under upwind conditions (r ~ 0.24) due to the significant role of wind and humidity in UFP dynamics. Furthermore, PM2.5 and PM10 correlated moderately with noise (r ~ 0.52 and 0.44 respectively). In general, traffic counts were more strongly associated with noise and PM compared to traffic speeds. It was concluded that noise level combined with meteorological data can be used as a proxy to estimate PM concentrations (specifically UFP number concentration) in near-highway environments of Tehran. However, it is important to measure joint variability of noise and particles to study their health effects in epidemiological studies.

Keywords : noise, particulate matter, PM10, PM2.5, ultrafine particle
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