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Epidemiological and toxicological studies with particular focus on the role of composition of ultrafine particles

Particulate matter (PM) is a complex mixture of particles suspended in the air that vary in size and composition depending on their sources. Particles from mobile sources tend to fall into a bimodal distribution referred to as nuclei mode and accumulation mode. Nuclei mode particles are less than 50 nm in diameter and are generally made of hydrocarbons, sulfur, and metallic ashes. Accumulation mode particles range in size from about 50 nm to 500 nm and contain elemental and organic carbon, nitrate, sulfate, and various metallic ashes. After they have been emitted, particles undergo chemical reaction in the air, so their composition and size distribution vary depending on proximity to sources, weather, and other factors.

Ambient particles generally fall into a trimodal distribution: ultrafine (< 100 nm), fine (between 0.1 and 1um), and coarse (>1 um). The US Environmental Protection Agency and other agencies around the world regulate the levels of ambient particles smaller than 10 um in diameter (PM_{10}). Some agencies, including the US EPA, also regulate particles smaller than 2.5 um in diameter ($PM_{2.5}$).

A large number of epidemiologic studies over the last decade have reported associations between short-term increases in exposure to PM_{10} and $PM_{2.5}$ and increases in morbidity and mortality, particularly among those people with respiratory and cardiovascular diseases. Recently, scientists have also begun to investigate the effects of ultrafine particles. Although these particles contribute very little to the mass of $PM_{2.5}$ and $PM_{2.5}$, they are present in very high numbers. Some scientists have proposed that ultrafine particles may be especially toxic: smaller particles have a greater total surface area than larger particles of the same mass, may be more likely to penetrate and interact with cells deeper in the lung than larger particles, and are thought to move rapidly to tissues outside the airways. A review of the studies comparing effects of particles of different size leads to the following conclusions: a) epidemiologic studies, using multiple exposure metrics and different lag periods, show an association between ultrafine particle number and mortality, respiratory function, or respiratory symptoms, but these effects are also associated with other pollutants (sulfate, PM2.5, PM10); b) repeated intratracheal instillation studies indicate that ultrafine particles induce more potent inflammatory responses than other sized particles; and c) inhalation studies have not produced consistent results, suggesting that the composition and solubility of particles –as well as size- are important properties.

The presentation will review the literature on effects of ultrafine with particular emphasis on the effects of metals.

back to index