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Metals in ultrafine particles resuspended from road dust (Toronto, Canada)

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In urban environments, resuspension of road dust is a major source of airborne particulate matter (PM), including ultrafine particles (UFP; < 0.1 μm). The chemical composition of UFP remains ill-defined and their characterization is critical for assessing their toxicological impact on human health. This study identifies key metals and determines their concentrations in UFP isolated from road dust samples collected from expressways, arterial roads and local roads in Toronto, the most populated city in Canada.

In the laboratory, the road dust samples were resuspended using a fluidized bed aerosol generator connected to a cascade impactor. The 13-stage cascade impactor allowed for the separation of particles into size fractions ranging from 0.01 to 10 μm, which included 4 nano-scale fractions. Each sample was aerosolized in triplicate. Following gravimetric analysis of the PM-loaded filter samples, they were acid digested (HNO_3/HF) and elemental concentrations were measured using ICP-MS or OES.

The < 0.1 μm fractions accounted for around 2% of the total aerosolized mass of the road dust (min–max: 0.23–8.36%). Compared to the parental road dust (< 10 μm), a marked enrichment was observed for Cd, Cr, Zn and V in UFP (nano to bulk ratio ≥ 2). UFP from arterial roads contained two times more Cd, Zn and V and nine times more Cr than UFP from local roads. Zn median concentration was the highest at the expressway site. Studies have shown that concentrations of transition metals released by vehicle exhaust or non-exhaust emissions (e.g. tires, brake pads) are elevated in urban road dust compared to local background. This study shows that Cd, Cr, Zn and V are especially enriched in UFP relative to the parental road dust. The capacity of transition metals and UFP to induce cellular oxidative stress is hypothesized to play a central role in the development of respiratory diseases. While UFP constitutes a small mass fraction of particulate matter, they dominate in terms of number of particles. Therefore, the elevated concentrations of transition metals in UFP may contribute to an increased potential to cause oxidative stress in lung cells, compared to the parental dust.