Soluble Ions with ICP-MS are Superior to Total Elements with XRF in Assessing Component-specific Cardiovascular Effects of Fine Particulate Matter (PM$_{2.5}$)

Neas LM$^1$, Schneider A$^2$, Kovačik KD$^3$, Herbst MC$^4$, Hinderliter A$^4$, Case M$^1$, Williams RW$^3$, Cascio WE$^1$, Peters A$^2$, Devlin RB$^1$

$^1$Environmental Public Health Division, EPA, RTP, NC
$^2$Helmholtz Zentrum München, Institute of Epidemiology II, Neuherberg, Germany
$^3$Human Exposure and Atmospheric Sciences Division, EPA, RTP, NC
$^4$University of North Carolina, School of Medicine, Chapel Hill, NC

Background: We previously reported that total fine particulate matter (PM$_{2.5}$) was associated with flow-mediated dilation (FMD), interleukin-6 (IL-6) and tumor-necrosis-factor-alpha (TNFα) in 22 individuals with type 2 diabetes.

Objectives: We now compare two laboratory methods of assessing PM$_{2.5}$ constituents.

Methods: We conducted a prospective panel study with four repeated measurements. Total elemental composition was analyzed by x-ray florescence (XRF). Water-soluble extractions were analyzed using inductively coupled plasma mass spectrometry (ICP-MS). Results from models with random patient effects are presented as %-changes [95%-confidence intervals] for a method-specific interquartile change.

Results: Moderate Pearson correlations between ICP-MS and XRF measurements were seen for copper (0.55), zinc (0.67), iron (0.61), and selenium (0.70). The association of copper and FMD (lag0) was much stronger with ICP-MS (-16.2% [-26.9 to -5.6] per 16.4μg/L) than with XRF (-12.7% [-27.6 to +2.2] per 1.9ng/m$^3$). The association of selenium and FMD (lag0) was identical, but more precise, with ICP-MS (-11.9% [-22.3 to -1.6] per 19.7μg/L) than with XRF (-12.0% [-26.7 to +2.7] per 1.4ng/m$^3$). The association of zinc and IL-6 (lag2) was stronger with ICP-MS (+21.3% [8.6 to 34.0] per 146.9μg/L) than with XRF (+10.9% [-3.7 to +25.6] per 6.6ng/m$^3$). The association of iron and TNFα (lag2) was stronger with ICP-MS (+12.2% [6.1 to 18.2] per 275.8μg/L) than with XRF (+8.2% [3.3 to 13.2] per 44.1ng/m$^3$).

Conclusions: Water-soluble components measured with ICP-MS are superior to total elements measured with XRF in assessing component-specific cardiovascular effects.

This abstract of a proposed presentation does not necessarily represent EPA policy.

Keywords: air pollution, diabetes, ICP-MS, XRF, sources, components

249 words