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Chemical characterization, airborne exposure and bioavailability of nanoparticulate cadmium and lead from wood pellet home heating stoves

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Indoor home heating with wood and pellet burning stoves is viewed as a more sustainable and economic alternative to fossil fuel heating. However, concerns remain regarding particulate matter emissions from these stoves. We have shown that fractions of ash from pellet burning stoves can be highly enriched in cadmium and lead, as these elements are volatile and concentrate/condense in hotter areas of the stove. We now report on further characterization of these particles and the potential implications for human health. We have isolated the < PM 10 and < PM 2.5 fractions from bulk pellet ash as a proxy for what may be exhausted from the stove into room air and to the outside environment. Simple leaching/extraction studies showed that the Pb and Cd from these ashes were insoluble in DI water or PBS buffer, however solubility of Pb and Cd was markedly increased when extracted in BALF medium, a commercial surrogate solution that mimics the Bronchial-alveolar Lavage Fluid. We hypothesize that peptides/proteins in the BALF solution could solubilize Cd and Pb from particulates and used size exclusion ICP-MS to investigate the binding of these elements in the BALF extract. We also used single particle ICP-TOF-MS to investigate the nanoparticulate composition of the PM2.5 and PM10 suspensions. Lead was present in a major proportion of nanoparticles in each size fraction, and also increased in % prevalence, compared to the total number of particles, in the PM2.5 fraction compared to the PM 10 fraction. Pb (and most other cations) appeared to be present individually as the sole metal in nanoparticles, presumably in the oxide or sulphate form. For Pb, the highest frequency particle contained ca. 15 fg of Pb and, assuming it is present as the sulfate, of a particle size of 150 -200 nm. The small size of these particles makes them a health risk due to inhalation deep into the lungs and the potential enhanced solubility of Pb and Cd in biological fluids could exacerbate their toxicity.