Airborne $PM_{2.5}$/PM_{10}-Associated Phthalate Diesters in Suburban Area in Shanghai, China

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Air pollution remains a major global public health issue. The general consensus is that harmful contaminants, such as heavy metals and organic compounds absorbed on the surface of particulate matter (PM) play a key role in increasing toxicity, leading to inflammation, oxidative stress, and activation of the innate immune system. Concentrations of nine phthalate diesters in 24-h airborne $PM_{2.5}$ and PM_{10} were determined from October 2011 to August 2012 in a suburban area in Shanghai, China. Dimethyl phthalate (DMP), diethyl phthalate (DEP), di-n-butyl phthalate (DBP), di-iso-butyl phthalate (DIBP), benzyl butyl phthalate (BzBP), and di(2-ethylhexyl) phthalate (DEHP) were frequently detected in airborne PM at sum concentrations of these six compounds ranging from 13.3 to 186 ng/m^3, with an average value of 59.8 ng/m^3 in $PM_{2.5}$, and from 10.1 to 445 ng/m^3, with an average value of 132 ng/m^3 in PM_{10} . DEHP, DBP, and DIBP were the major phthalate diesters found in PM samples. DEHP was found predominantly in coarse (size fraction of between $PM_{2.5}$ and PM_{10}) particles, whereas DMP, DEP, DBP, DIBP, and BzBP were found predominantly in fine ($PM_{2.5}$) particles. The concentrations of phthalates in PM during warm months (207 ng/m^3 for PM_{10} and 71.9 ng/m^3 for $PM_{2.5}$, on average) were significantly higher than those during cold months (76.9 ng/m3 for PM_{10} and 50.4 ng/m^3 for $PM_{2.5}$). Significant positive correlations were found between concentrations of total phthalates, DEHP, and BzBP, with the total mass and organic carbon content of PM. Based on the concentrations of DEHP, incremental lifetime cancer risks (ILCR) from inhalation exposure were estimated using a Monte Carlo simulation. Although the 95% probabilities for the ILCR values for the general population were below the U.S. Environmental Protection Agency (EPA) threshold of 10^{-6}, our result is an underestimate of the actual health risk because we only considered the outdoor inhalation exposure to DEHP in this study.