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Metals Released by Burning Fuel Oil May Damage Children's Developing Lungs

Establishing link between components of air pollution and health effects would help direct targeted reforms to protect public health.

ATS 2016, SAN FRANCISCO ─ A new study investigating the health impact of the chemical components of air pollution is reporting that two metals, nickel and vanadium (Ni and V), may be damaging to the developing lungs of children. The results were presented at the ATS 2016 International Conference.

Prior research on the effects of air pollution on children's developing lungs has associated small particulates such as $PM_{2.5}$, very small bits of dust and soot that can move easily into the lungs, with poor lung function. However, very few research studies have identified the specific components of particulate matter that are associated with the observed harmful effects.

Robert Urman, PhD, of the University of Southern California, and his co-authors examined health records of 1,911 elementary school-aged children from 8 Southern California communities who were part of the Children's Health Study. "Each community varied in concentrations of specific air pollutants including metals," said Dr. Urman. "Some of the highest levels of Ni and V were found in Long Beach, where significant port activity exists. Examining the differences in health of children across these communities allowed us to identify the effects of these metals. When we analyzed the data, we found that teenaged children in the most polluted communities had an estimated decrease of approximately four percent in their lung function compared to similar children in the least polluted communities."

In Southern California, Ni and V are mainly emitted by the burning of fuel oil from vessels and cargo ships such as those entering and leaving seaports along the Pacific coast. This includes the combined ports of Long Beach and Los Angeles, which comprise the largest seaport complex in

the United States. Dr. Urman noted that the communities in this study show a wide range of $PM_{2.5}$ exposures, with some areas among the most highly polluted in the U.S. (e.g., Mira Loma and Upland) while others were well below the national standard (e.g., Santa Barbara).

"More studies are needed to establish a cause-and-effect relationship between specific components of particulate matter and any health-related endpoint," said Dr. Urman. "A recent study from the Children's Health Study showed that reductions in overall levels of air pollution have been linked with significantly better lung function in children. The National Ambient Air Quality Standards currently regulate $PM_{2.5}$ mass as a whole, but the United States EPA may consider taking $PM_{2.5}$ composition into account in conducting health-risk assessments."

"This study adds to the epidemiological evidence on the health effects of $PM_{2.5}$ components. If we could establish a link between these components and health- related outcomes, then more targeted regulations could be enacted to better protect the health of the general population," added Dr. Urman.

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Abstract 8592

Exposure to Transition Metals in Particulate Matter Air Pollution and Children's Lung Function in the Southern California Children's Health Study

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Abstract Body

Rationale: Numerous studies have reported adverse effects of particulate matter (PM) on lung function in children, but there has been little investigation of the chronic effects of PM composition. Transition metals are biologically plausible agents contributing to these effects. Aerosol size and water-solubility may be important determinants of metal toxicity.

Methods: As part of the Children's Health Study, repeated measurements of forced expiratory volume in 1 second (FEV1) and forced vital capacity (FVC) were assessed on 1,911 children between the ages of 11 and 15 in eight Southern Californian communities. Size-resolved PM samples were collected at participants' elementary schools using modified Harvard cascade impactors with multiple collection stages to capture quasi-ultrafine (PM0.2), accumulation mode fine (PM2.5-0.2), and coarse (PM10-2.5) fractions. The total and water-soluble concentrations of copper (Cu), iron (Fe), nickel (Ni), vanadium (V), and zinc (Zn) were measured with inductively-coupled plasma mass-spectroscopy (ICP-MS) at the Wisconsin State Laboratory of Hygiene. The water insoluble fraction of each metal was calculated by taking the difference of

the water soluble fraction of a particular metal from the total concentration. Adjusted linear regression models were used to assess the relationship between lung function and these exposures.

Results: Water-soluble Ni and V in the fine fraction were associated with a 4.4% (95% confidence interval: 6.5% to 2.2%) and 3.9% (6.2% to 1.6%) deficit in attained FVC level at age 15 across the 5%-95% distribution of each metal. Associations of similar magnitude were observed for total Ni and V in the fine fraction and with water-soluble V in the coarse fraction. In the ultrafine fraction, water-insoluble Zn was associated with deficits in attained FVC. Ni and V associations in each size fraction were generally robust to adjustment for total PM mass. Associations of FEV1 were observed with fine PM mass but not with any of the metals.

Conclusion: These results suggest that specific water-soluble transition metals in PM, generally those related to fuel oil burning, might explain some of the adverse effects of PM exposure on childhood lung function. These findings can inform PM air quality standards that are based on composition and not mass alone.