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CLEAN **AIR** RESEARCH PROGRAM

NEW MODELS BEING DEVELOPED TO ESTIMATE EFFECTS OF PARTICULATE MATTER AT DIFFERENT DOSES

Issue:

Why are some people's lungs more affected by the same level of air pollutants than others? How does it impact them differently? What is the relationship between a particular exposure condition and the amount of pollutant that they inhale?

Research that examines the "dose" received from an air pollutant is bridging the gap between measurable air pollutants and known health outcomes such as pulmonary disease. It also contributes to an understanding of why people may respond differently to the same air pollutants.

The dose to the lung can vary widely among individuals depending on genetics, age, sex, health status, and lifestyle.

For example, a dose of particulate matter (PM) inhaled into certain regions within the lung's airways can be many times more harmful in individuals with obstructive airway disease than in healthy individuals. Therefore, the susceptibility of an individual to a dose needs to be better understood.

In addition, PM is a complex mixture of different sized particles and chemical compounds. Thus, the lungs can be impacted in different ways depending on how much of a PM type is deposited and where the deposition occurs.

The knowledge gained from the study of dose (or dosimetry research) can be used to evaluate risks to individuals and susceptible groups and assist the U.S. Environmental Protection Agency in establishing effective air pollution regulations.

Science Objective:

The Clean Air Research Program in EPA's Office of Research and Development addresses key questions about PM dosimetry, including the following:

- What host and PM-specific factors determine the dose and distribution in the lung?
- How best can the internal dose be measured and characterized?
- Who experiences greater internal dose from exposure and thus is at greater risk?
- How can we accurately estimate or predict internal dose from daily exposures to PM?

EPA researchers have developed a new method of measuring

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deposition of PM in the lung and have applied this method to characterize lung dose in various groups, including young and older adults, and individuals with obstructive lung disease (e.g., asthma and chronic bronchitis). These data are being used to develop a simple, empirical "lung-deposition model."

Although practical, most dosimetry models are designed for only healthy adults and simple exposure conditions. Therefore, EPA investigators are also developing a comprehensive and more versatile mathematical model to apply to the variety of real-world exposure conditions.

The model must be customizable to estimate dose for people of varying personal lifestyles, health status, and places of residence. Such a model will be valuable for analyzing various exposure scenarios taking place in the real world and identifying the kinds of exposure conditions under which people are subjected to high lung dose and thus high risk of harm from exposure to PM.

Application and Impact:

EPA scientists have made significant advances in the development of models to improve our understanding of the relationship between exposure to PM and the amount of dose received in the lung. Findings include:

- PM lung dose is determined primarily by particle size and how people breathe (e.g., slow, fast, shallow, deep). Slow and deep breathing or exercise can increase lung deposition.
- Within the lung, not all regions receive the same dose. Certain lung regions are subject to much greater dose than others. Therefore, these high-dose regions may be more vulnerable to PM effects.
- Nano (ultrafine) PM deposits in almost the same regions of the lung as do coarse, micron-size particles. Thus, very small and large PM may exert a compounded impact to those regions where they deposit.
- Generally, PM dose is comparable between healthy young and older people in both men and women, but regional (hotspot) doses can be greater in individuals with obstructive lung disease.

ORD's research on PM dosimetry helps to address the health risks of PM by informing air pollution standards and public health advisories.

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