

July 2, 2011

TO: CASAC Ozone Panel Members

FROM: Jon Samet

SUBJECT: Susceptibility and Vulnerability

Colleagues, the issue of developing useful guidance to EPA on the definition of susceptibility remains problematic. I am writing this note to provide background with the goal of focusing our discussion during the phone call on July 6.

As a reminder, the protection of susceptible individuals has been an explicit objective of the NAAQS and the Criteria Documents and consequently the ISA needs to address those populations susceptible to a given criteria pollutant. Findings on susceptibility are relevant to the REA and the Policy Analysis. Some of the legislative history on susceptibility is reviewed in the attached American Thoracic Society's 1990 statement on "What constitutes an adverse health effect of air pollution". Of course, advancing scientific understanding and a broadened set of social considerations have added new dimensions to the definition.

As a starting point for the discussion, I set out the various ways that *at a given concentration*, people could experience increased risk for adverse health effects of air pollution:

1. **Intrinsically increased susceptibility:** this group of individuals have some individual characteristic(s) that increases risk for an effect through a biological mechanism. Examples in this category include the presence of underlying disease, young or old age, and genetics. Notably, this category is growing as the population ages and non-communicable diseases become more common. In general, individuals in these categories would have a steeper concentration-risk relationship, compared to those not in the category. There is a range of susceptibility for individuals within a category and across categories.
2. **Increased dose, given exposure concentration:** this group of individuals has a greater dose of delivered pollutant, given exposure, because of breathing pattern. This category would include persons who work outdoors or exercise outdoors. Additionally, by holding an outdoor job, some people would have greater **exposure** (concentration X time), regardless of the delivered dose to the respiratory track. This category is particularly relevant to ozone.
3. **Increased risk for an adverse outcome:** Socioeconomic factors have been cited as one determinant of susceptibility. One proposed mechanism is access to and quality of health care. For some individuals, e.g., lower SES, there may be a greater risk for an adverse outcome; for example, there may be less favorable medical care to provide treatment for an asthma attack or a cardiac event triggered by air pollution.

These three categories do not include those individuals who might be placed **at risk for experiencing a greater exposure by being exposed at a higher concentration**. For example, individuals in lower SES groups might be exposed at higher PM concentrations consequent to living near busy streets. The term "vulnerability" has been used to refer to this circumstance.

In the Ozone ISA, EPA offers the following definition:

"Individual- and population-level characteristics that increase the risk of O<sub>3</sub>-related health effects in a population including, but not limited to: genetic background, birth outcomes (e.g., low birth weight, birth defects), race, sex, lifestage, lifestyle (e.g., smoking status, nutrition), preexisting disease, SES (e.g., educational attainment, reduced access to health care), and characteristics that may modify exposure to O<sub>3</sub> (e.g., time spent outdoors)."

The preamble text offers the following rationale for this definition:

"As developed in previous ISAs and reviews (Sacks et al., In Press, [664486](#); U.S. EPA, 2009, [179916](#); U.S. EPA, 2010, [626035](#)), an all encompassing definition for "susceptible population" is used to circumvent the need to distinguish between susceptible and vulnerable, and to identify the populations at greater risk for O<sub>3</sub>-induced health effects."

The definition in the final PM ISA was:

"Populations that have a greater likelihood of experiencing health effects related to exposure to an air pollutant (e.g., PM) due to a variety of factors including, but not limited to: genetic or developmental factors, race, gender, lifestage, lifestyle (e.g., smoking status and nutrition) or preexisting disease; as well as population-level factors that can increase an individual's exposure to an air pollutant (e.g., PM) such as socioeconomic status [SES], which encompasses reduced access to health care, low educational attainment, residential location, and other factors."

In commenting on this definition, the CASAC letter on the second draft PM ISA stated:

"CASAC concurs with EPA's definition of "susceptible subpopulations" as those that have a greater likelihood of experiencing health effects related to PM exposure; and we find that the ISA offers a careful characterization of the factors that may contribute to increased susceptibility to PM-induced health effects."

On rereading the definition from the PM ISA, I am less convinced as to its adequacy and it is not expressed with sufficient clarity. I also see mingling of concepts and pathways in the clause related to "population-level factors." The definition has been changed in its wording in the ozone ISA, largely by identifying susceptibility as reflecting "Individual- and population-level factors..."

In our discussion on Wednesday, I suggest that we consider the following:

1. Is such a broadly construed definition of susceptibility useful?

2. How does the definition relate to the intent of the CAA and considerations of susceptibility in the REA and the Policy Analysis?
3. Does the definition need to be rewritten to be conceptually sharper?