Outliers Matter in Environmental Justice: Unique Exposure Pathways and Disproportionate Exposures in Low-Income, Minority, Native American, and Other Populations

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The human health risk assessment paradigm includes consideration of individuals at the 95th or even 99th percentile of risk, but does not adequately account for those with unique exposures or pathways or those with extremely high exposures (> 99th percentile). In this paper we: (1) review exposure pathways normally examined by risk assessors in the exposure assessment phase calling attention to outliers; (2) provide a framework for identifying unique pathways; (3) identify and discuss populations with high end exposures and unique exposure pathways (such as children, Native Americans, urban poor) whose risks from combined exposures (chemical, physical, psychosocial) are likely underestimated by current risk assessment practices; and (4) examine how these contribute to health disparities. It is critical to identify and assess these exposures and pathways because they lead to poor environmental health, particularly if the burdens fall disproportionately on low-income populations, urban communities, minorities, and Native Americans. Attending to the identification of risk factors for these environmental justice communities will lead to improving risk assessment, improving public health, and decreasing environmental inequities in our health care system.

We present a conceptual model for risk assessors to consider when gathering information that could lead to unusual, unique, and excessive exposures that builds on the exposure matrix of inhalation, dermal, ingestion, and injection. We discuss unusual exposure scenarios that should be considered when conducting risk assessments for a neighborhood, community, or other population (whether defined by ethnicity, income level, or other factor). Exposure pathways for inhalation include exposure from factories, volatile household pesticides, sweat baths for American Indians, cultural uses of mercury, and volatile contaminants from showers. Dermal exposures include cosmetics or medicines, showering or swimming, and contaminants on clothes. Unusual ingestion scenarios include self-caught fish or shellfish, wildlife, or bird eggs; wild herbs, berries, and roots; high one-meal exposures; and soil ingested by children or adults. Injection includes intentional injection of plant or animal extracts, and tattoos. Some of the above are included in risk assessments, but without addressing the uncommon high exposures.

Given the matrix of exposure routes and pathways, there are several groups that are particularly vulnerable and are apt to have unusual, unique, or excessive exposures, including children, Native Americans, subsistence or game/sport fishers, rural populations (including farm workers and migrant workers), and the urban poor. Often, individuals and communities fall into several of these categories. While children, rural residents, or urban residents are not necessarily exposed to unusual or unique exposure pathways, they can be so exposed when their economic or minority status leaves them vulnerable.

We conclude that there is scientific evidence that unique exposure pathways and unusual behaviors can significantly add to the hazardous exposures for various populations. Most of these pathways fall outside the conventional methods of exposure assessment and evaluation of risk as practiced by EPA. The impact of these unusual pathways is greater in minority and low-income populations, which also experience

multiple stressors. A concerted effort needs to be made to capture these data and translate this information into guidelines for risk assessors. Decision-makers need to be aware of what questions to ask about the exposures and risks. A conceptual model for these exposures is presented in this paper as a matrix of routes and pathways of exposure. We discuss several ways in which exposure assessment and risk assessment can be expanded to enhance protection of these outlier populations.