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Differential Vulnerability and Susceptibility: Expanding the Scope of Risk Assessment

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Objectives: The central paradigm for U.S. Environmental Protection Agency standard-setting is risk assessment. This paradigm has served public health well for decades. However, gaps have emerged in the fabric of this framework, causing some authors to begin to challenge certain underlying assumptions. With two goals in mind, we examine six related assumptions. First, our overall aim is to extend the risk assessment approach by examining, both conceptually and methodologically, how differential vulnerability and susceptibility across population groups can be better integrated into the risk assessment process. Second, we illustrate these issues, focusing on two specific examples: lead and air pollution.

Relevance: Addressing inequities in health risks and health outcomes will require an extension of the risk assessment paradigm. Currently, methods and approaches are available for considering differential risk and vulnerability, but have not yet found their way into widespread usage. Our proposed extension is intended to increase the precision and effectiveness of risk assessment generally, and to provide additional policy tools to help target resources to achieve greater equity in the health status of populations.

Summary of Findings: We identify and discuss six assumptions implicit in standard risk-assessment models. For convenience, we label these: (1) risk independence, (2) risk averaging, (3) risk uniformity, (4) risk non-transferability, (5) risk synchrony, and (6) risk accumulation and chaining. The literature on lead and air pollution is reviewed to illustrate how these assumptions might be modified to take account of differential risk and vulnerability. Our main finding is that differential risk and vulnerability is a critically important but neglected area within risk assessment. However, a wide range of methodological and conceptual tools now is available for addressing these gaps.

Recommendations: If continued progress is to be made in explicating these complex phenomena, future studies of toxicant exposure-risk relationships must invest the resources necessary to measure contextual and individual-level factors that might modify these relationships. In most cases we do not know which subgroups are the most vulnerable or, if we do, subgroups are defined very broadly. We advocate defining vulnerable subgroups with greater specificity. We urge investigators to gather additional data necessary to identify factors that modify vulnerability. To characterize more fully the bases of inter-individual differences in vulnerability, we recommend several methodological approaches that go beyond simple interaction terms to consider multilevel and cross-level structures. In essence, we argue for moving beyond the reliance on standard uncertainty factors and working to explicitly unpack the "black box" that represents variability in vulnerability.