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Invited Perspective: Assessing the Contaminant Exposure Risks of Urban Gardening: Call for Updated Health Guidelines

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The lack of access to fresh produce in so-called "food swamps" (areas where there is an abundance of nonhealthy food options) and "food deserts" (areas where there is limited access to fresh produce) is a widely recognized health challenge. Urban farming has been blossoming over the recent years to address this problem. In many places, vacant lots are increasingly turned into growing spaces, and supply chain disruption during the COVID-19 pandemic has reenforced the importance of home gardening (Lal 2020). However, urban soils often contain elevated levels of heavy metals and metalloids (HMM) from various roadway, housing, and industrial sources, and exposure to some of these HMM can be harmful to human health. Recent research has further emphasized the strong connections between soil lead (Pb) concentrations and children's blood Pb levels (Mielke et al. 2019).

Many studies have found an increased risk of exposure to HMM among youth in low-income families in urban areas (Filippelli and Taylor 2018; Filippelli and Laidlaw 2010; Pamuk et al. 1998) with estimated societal costs of billions of U.S. dollars for health care (Gould 2009; Hanna-Attisha et al. 2016; Landrigan et al. 2002; Schwartz 1994). Racial and class disparities in HMM exposure are substantial, with African Americans and lower-income and disenfranchized communities bearing the greater exposure burden (Distler and Saikawa 2020; Morrison et al. 2013; Muller et al. 2018; Raymond and Brown 2016). This burden is partly because black and brown communities and lower income population typically abut less-valuable properties, which often have higher densities of legacy emissions sources, and soils in these areas can be a major sink of HMM in the environment (Khan et al. 2008; Wuana and Okieimen 2011). It is thus no surprise that exposure to HMM from urban gardening in these areas can be an environmental justice issue (Clark et al. 2006).

The use of garden-grown food increases the consumption of fruits and vegetables (Alaimo et al. 2008; Barnidge et al. 2013; Litt et al. 2011; McCormack et al. 2010; Rustin et al. 2015) and also saves money for many families by reducing the need to buy produce at grocery stores (Rustin et al. 2015; Winne 2008). However, exposure to HMM through urban gardens and farms can potentially pose serious health risks, and the extent of exposure still remains largely unknown (Luo et al. 2012).

In their new study, Lupolt et al. (2021) measured concentrations of six nonessential (As, Ba, Cd, Cr, Pb, Ni) and three essential (Cu, Mn, Zn) HMMs in soil, irrigation water, and 13 types of urban-grown produce to answer multiple community-driven questions (Lupolt et al. 2021). The researchers used these measurements, taken at 104 urban agriculture sites in Baltimore, Maryland, to assess the safety of urban agriculture itself and of consuming urban-grown produce. Lupolt et al. (2021) also assessed differences in HMM concentrations and potential health risks between the two farming techniques (conventional vs. organic) at two different locales (urban vs. peri-urban). This study is not the first to test HMM concentrations in soil, irrigation water, or produce; for example, Taylor et al. (2021) recently conducted a comprehensive urban garden soil–food analysis of more than 3,600 households in Australia. However, this study is unique in that it assessed the soil–produce link across a broad spectrum of gardening types and locations using composite "trowel-depth" soil samples that better reflect the potential risk to urban gardeners.

HMM concentrations were highest in soils, followed by produce and irrigation water. Although an array of soil safety guidelines exists for some HMM elements—notably for Pb—there are no regulatory levels for produce in the United States. Lupolt et al. used the World Health Organization's *Codex Alimentarius* (Food and Agriculture Organization 1995), which establishes regulatory levels for Cd and Pb in specific types or groupings of produce. The researchers found that produce concentrations for all HMM were consistent across all farming techniques and locales and concluded that urban agriculture was generally safe with respect to HMM exposures for urban growers and consumers of fresh produce in Baltimore.

The main contribution of this paper is its suggestion that more nuanced application of public health guidelines may be needed for urban agriculture. The authors emphasize that there are limited public health guidelines for HMM in soil, irrigation water, and produce. Importantly, most of the guidelines are only for select HMMs and usually apply solely to clean-up and remediation activities. Indeed, many of these soil-based guidelines are woefully out of date. For example, the U.S. Environmental Protection Agency (U.S. EPA) soil Pb guideline was developed decades ago, based on blood Pb screening standards set by the U.S. Centers for Disease Control and Protection before that agency concluded that there is no safe level of Pb. The U.S. Court of Appeals Ninth Circuit has ordered the U.S. EPA to reconsider the regional screening level of Pb, and many countries already have soil standards significantly lower than that of the United States. There is a need for clear, enforceable standards that encourage easy preventative measures to be placed at urban farms and gardens.

Similarly, more comprehensive public health guidelines specific to urban farms and gardens are urgently needed. Lupolt et al. (2021) correctly point out that existing soil guidelines are not helpful for determining the safety of produce grown in urban soils. These guidelines exist independently from those for other

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exposure pathways, such as dietary intake. In other words, there needs to be a site-specific assessment guideline that illustrates means for interested communities to conduct the cumulative and multipollutant exposures from multiple pathways to determine human health risks. The effects of different HMMs on human health as a whole can be determined only by engaging the community in the exposure assessment.

There is still a long road ahead for multipollutant exposure assessment, and additional research is necessary to create more applicable and nuanced public health guidelines toward this goal of ensuring healthy urban farms and gardens. Such guidelines, tailored to specific locations and populations, would also allow community empowerment and move us toward a more just and equitable society. Considering that those most affected by soil HMMs are usually in environmental justice communities that are already overburdened with other sources of exposures, it makes sense to start with these neighborhoods.

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