



Breathing Inequality: The Unseen Burden of Wildfire Air Pollution in Vulnerable Nations

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ABSTRACT

Wildfires are no longer seasonal threats; they are now persistent, transboundary health hazards. As landscape fire-sourced (LFS) air pollution intensifies across the globe, the scale of human exposure is both staggering and uneven. While recent global estimates suggest that over 1.5 million deaths annually may be attributed to wildfire-related air pollution (Xu et al., 2024). The actual burden likely extends far beyond mortality figures. This Perspective argues that the world must expand its lens to include the chronic, cumulative, and inequitable health impacts of LFS exposure, particularly in under-monitored and climate-vulnerable regions.

KEYWORDS: Wildfires, Air pollution, Burden, Breathing, Nations, Threat

INTRODUCTION

Studies have shown associations between long-term $PM_{2.5}$ exposure and neurodevelopmental deficits in children (Wang et al., 2021), impaired cognitive aging (Ailshire & Crimmins, 2014), adverse pregnancy outcomes (Zhu et al., 2015), and increased all-cause dementia risks (Shaffer et al., 2021). These impacts are often not included in Global Burden of Disease estimates, but they might significantly affect DALYs in vulnerable populations. Furthermore, the geographical generalization of exposure estimates may dilute the urgency for localized action. LFS events intersect with a host of environmental stressors, such as desertification, industrial emissions, and poor waste management, exacerbating respiratory and cardiovascular burdens in regions already struggling with fragile health infrastructure

In many low- and middle-income countries (LMICs), wildfire smoke is part of a wider atmospheric attack. Communities across North Africa and the Middle East face compounding exposures from smoke, desert dust, industrial emissions, and open waste burning (Shepherd et al., 2016). In these regions, basic environmental monitoring is sparse or nonexistent. Residents inhale high concentrations of fine particulate matter ($PM_{2.5}$) without knowing the risks, while governments lack the data needed to mount timely interventions (Kouachi et al., 2024). The long-term consequences of this exposure are alarming but largely undocumented. Growing evidence links $PM_{2.5}$ to impaired neurodevelopment in children, cognitive decline in older adults, and adverse pregnancy outcomes (World Health Organization, 2024; "World Health Organization Air Pollution," 2024). Yet, such non-acute health outcomes remain absent from most global burden of disease models. The result is a systematic underestimation of LFS pollution's true impact, particularly on communities least equipped to respond.

Even when wildfires make international headlines, the health repercussions in LMICs often go unreported. The 2023 wildfires in Algeria and Tunisia, for example, devastated large swaths of forest and displaced entire communities. However, systematic health follow-ups

were minimal, and no public air quality alerts were issued. In these contexts, exposure to wildfire smoke is both acute and invisible, present in emergency wards and respiratory clinics, but absent from national health registries.

Inequality does not end at exposure; it deepens during recovery. In high-income countries, those affected by wildfires can turn to insurance schemes and government compensation. In contrast, in most LMICs, there is no safety net. Local farmers, displaced families, and forest-dependent workers face financial devastation without access to relief funds or credit support. Health systems, already stretched thin, are left to manage the fallout with limited resources and no environmental health surveillance tools.

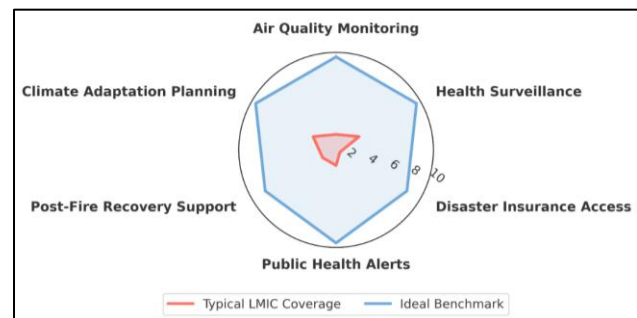


Figure 1. Policy gaps in wildlife preparedness and health response.

To bridge this gap, three shifts are needed. First, surveillance must go local. Hyperlocal air monitoring systems, mobile sensors, and satellite overlays can enable real-time exposure mapping, even in data-poor regions. These technologies should be integrated into primary care to support syndromic surveillance of smoke-related illnesses. Second, financial protection must become part of the public health agenda. Wildfire-prone regions need access to climate-adaptive insurance schemes that include post-disaster health impacts (Baker et al., 2024). Without such mechanisms, affected populations will remain trapped in

cycles of loss, exposure, and vulnerability. Third, global policy must recognize that LFS air pollution is not just an environmental issue; it is a climate justice issue. Forest degradation, land mismanagement, and delayed adaptation efforts all converge to produce unequal health risks. Global climate finance must prioritize the resilience of those most exposed and least responsible.

We urge the international health community to widen its scope. Chronic

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exposure, unequal recovery, and health invisibility must be brought to the center of wildfire discourse. Epidemiological evidence, though critical, is not enough. The path forward lies in equitable surveillance, inclusive financial protection, and climate-conscious policy. Without these, the world will continue to underestimate the invisible toll of wildfires, one that is already costing lives, futures, and livelihoods across the Global South.

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Ethics approval

Not applicable.

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