At the Intersection: Protecting Public Health from Smoke While Addressing the U.S. Wildfire Crisis

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Climate change, historical practices of fire suppression, and an increase in the growth of the wildland–urban interface are driving forces behind the increased occurrence of large, catastrophic fires in the United States (1, 2). Although fire itself can lead to extensive damage and detrimental ecological effects, the smoke emitted has substantial adverse impacts on public health. Wildfire smoke consists of a complex mixture, including fine particles ($PM_{2.5}$; particles with an aerodynamic diameter generally $\leqslant$2.5 μm), which has been shown to impact large geographic domains and contribute to thousands of estimated deaths and illnesses annually (2, 3). As a result, public health agencies at the local, state, and national levels have developed strategies to reduce exposure to smoke and to address wide-ranging health concerns associated with such exposures. These strategies help prepare and educate individuals and communities before, during, and after smoke episodes and are instituted by well-documented programs (e.g., smoke-ready programs, the Interagency Wildland Fire Air Quality Response Program (IWFAQRP) [https://www.wildlandfiresmoke.net/]), with the overarching goal of raising awareness on a suite of public health approaches and preventative measures (4).

Prescribed fire is defined as "any fire intentionally ignited by management actions in accordance with applicable laws, policies, and regulations to meet specific land or resource management objectives" (5). U.S. land management agencies have adopted prescribed fire as a principal strategy to reduce the adverse impacts of both fire and smoke, and they are expected to burn sizeable acreage within the United States over the next 10 years (6). Substantial scientific and historical evidence shows prescribed fire can result in ecological benefits and can potentially reduce the size, intensity, and smoke emitted from a future wildfire; however, prescribed fires also emit smoke, leading to both air quality and public health impacts (4). Therefore, the public health challenge is balancing prescribed fire need with ensuring access and equity in the ability of individuals and communities to take actions that reduce smoke exposure (7). The planned nature of prescribed fires presents an opportunity for land management and public health agencies to communicate the occurrence of prescribed fires in advance and help prepare communities to take preventative actions for reducing smoke exposures; however, such preparedness initiatives are rarely undertaken.

Mitigating air quality and health impacts from prescribed-fire smoke on nearby communities starts with smoke management practices that reduce the amount of smoke emitted. Although some studies indicate that prescribed fires can emit less smoke than wildfires per acre burned, they may be more likely to impact rural areas and socially vulnerable populations, resulting in greater challenges for risk communication (4, 8). In addition, the increased frequency and scale of prescribed fire needed to reduce wildfire risk, especially under a changing climate, may reduce opportunities to burn under optimal meteorological conditions, potentially leading to greater air quality and health impacts than those historically attributed to prescribed-fire emissions (9). Therefore, it is important to consider the health implications of repeated prescribed fire smoke exposures, which may be less extreme than wildfire smoke but more frequent, considering the extensive scientific evidence demonstrating that there is no $PM_{2.5}$ exposure threshold below which health effects are not observed (10). As a result, prescribed-fire smoke exposure is not without risk, especially for sensitive (also often referred to as "at-risk") populations.

When assessing the potential public health impacts from prescribed-fire smoke, it is important to factor in solutions that can minimize such impacts. The public health impacts of smoke exposure depend on smoke concentration, duration of exposure, size of the population exposed, the ability of people to reduce exposure, and the percentage of the population at risk of smoke-related health effects (11). Conceptually, minimizing impacts can be explored by estimating potential reductions in smoke exposure that a community could experience because of public health messaging and corresponding actions taken (4). Overall smoke exposure reduction is determined by the likelihood and/or ability to take a particular protective

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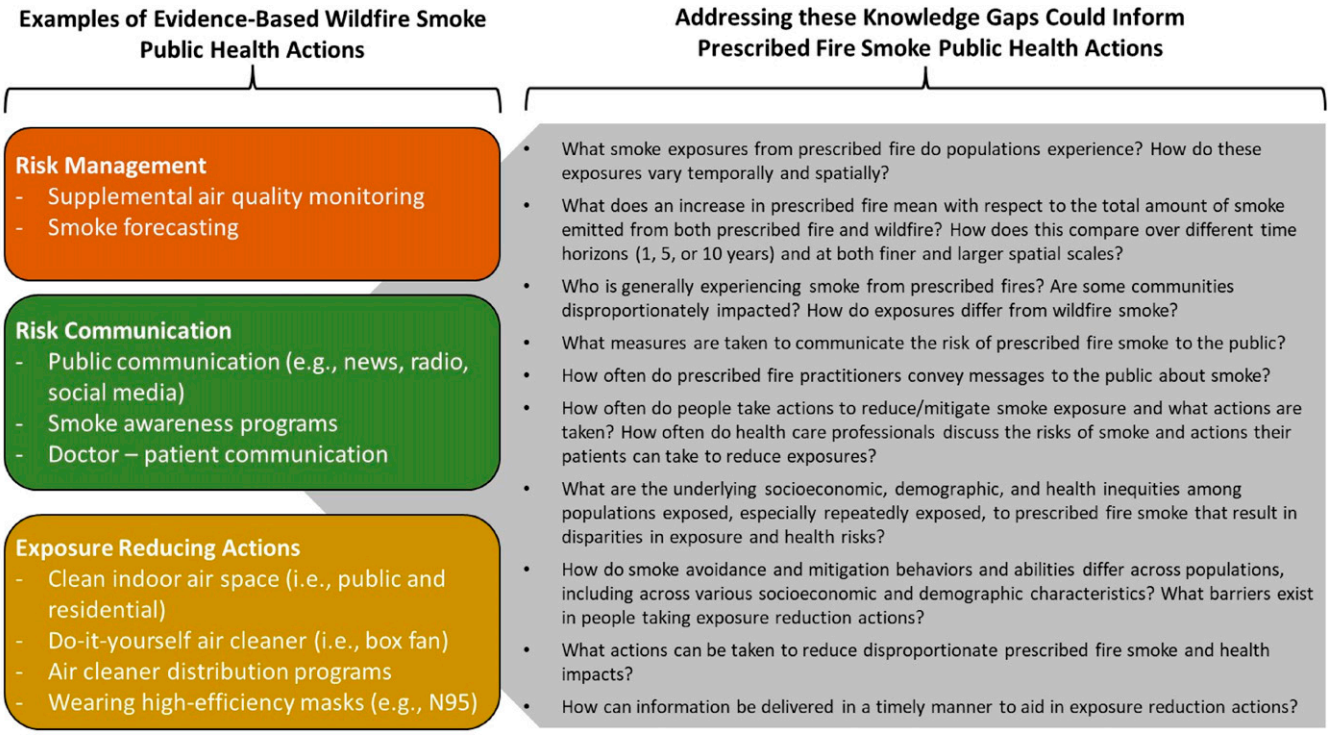

Figure 1. Current approaches to protect public health from wildfire smoke and opportunities to expand to address prescribed-fire smoke.

action combined with the effectiveness of the action. There are multiple factors that influence both elements, but two major ones are the awareness of the need (risk perception) and the ability (including financial, time, or opportunity costs) to take exposure reduction actions (12). Community demographics and socioeconomic characteristics likely affect both factors and influence the ability or willingness of individuals to take necessary actions (13).

Often, efforts to mitigate exposure to wildfire smoke are reactionary, but current wildfire smoke programs exist that could be expanded to build holistic community preparedness programs that include both wildfire and prescribed-fire smoke. The IWFAQRP one such example that has expanded efforts to also focus on prescribed-fire smoke by sending air resource advisors to some recent prescribed fires. Additional aspects of such efforts could include educating healthcare professionals on the risks of smoke to their patients and improving discussions between physicians and patients about the importance of taking steps to reduce smoke exposure, especially for at-risk patients, and fostering partnerships between prescribed-fire practitioners and local public health agencies to ensure communities are aware and prepared for prescribed-fire smoke (10, 14).

The expansion of prescribed fire will increase smoke in the air and likely impact air quality during seasons of minimal wildfire activity. Although the planned nature of prescribed fire presents numerous opportunities to prepare communities for smoke, knowledge gaps exist that, if addressed, could extend scientific and clinical knowledge to advance risk management, risk communication, and exposure reduction actions (Figure 1). Ultimately, this could facilitate increased access and expanded use of smoke exposure reduction actions, ensuring equity in the ability of communities and among individuals to reduce smoke exposure. Examples include increasing our understanding of exposure and health risk differences between prescribed-fire and wildfire smoke, identifying effective approaches to public health messaging for prescribed-fire smoke, increasing awareness of when and where prescribed fires occur and potential health risks of smoke, enumerating personal- and community-level measures and best practices to avoid prescribed-fire smoke exposure, and identifying actions public health agencies and healthcare providers take to prepare communities and individuals for smoke.

As we continue to embark on an all-of-government approach to address the wildfire crisis, it is important to reiterate that the public health impacts of smoke are broad and extend geographically well beyond the fires themselves (15). The increased use of prescribed fire to reduce wildfire risk requires us to take proactive steps rooted in current public health preparedness, response, and recovery efforts around wildfire smoke. Coordination between prescribed-fire practitioners, public health agencies, and healthcare providers will allow us to prepare communities, including individuals at greatest risk, to reduce smoke exposure and protect public health. ■

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