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Public health communication strategies during wildfire events: Lessons for the United States from a global perspective

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Abstract

Wildfires are an escalating environmental and public health threat in the United States, driven by climate change, prolonged droughts, and urban expansion into wildfire-prone areas. These events produce severe health hazards through smoke exposure, with impacts ranging from respiratory illnesses and cardiovascular complications to mental health challenges. Public health communication is a crucial tool for mitigating these risks, shaping protective behaviors, and promoting community resilience. This research article surveys public health communication strategies employed during wildfire events globally and evaluates their relevance to the U.S. context. Lessons from countries such as Australia and Canada reveal innovative approaches to engaging diverse populations, leveraging technology, and addressing inequities in information access. The discussion highlights persistent challenges in the United States, including disparities in communication reach, the spread of misinformation, and variable levels of public trust. Recommendations emphasize the need for multi-channel, culturally tailored, and community-centered strategies to strengthen U.S. public health communication capacity in the face of worsening wildfire crises.

Keywords: Wildfires; Climate Change; Risk Perception; Communication; Smoke Exposure; Public Health Communication; Community Resilience; Misinformation

1. Introduction: Setting the Stage for Public Health Communication in Wildfire Events

As of July 23, 2025, a total of 70 large fires are burning nationwide [1]. The United States has been vulnerable to the effects of wildfires despite efforts to prevent and contain them. While wildfires are not a new phenomenon, their frequency, intensity, and destructive power have escalated in recent years. Recent research indicates that the annual number of large wildfires nearly doubled from 1984 to 1999, to 2005, to 2018 [2]. Several factors contribute to this increase, including climate change, prolonged droughts, and the rapid expansion of urban development into historically fire-prone areas [3]. Across the United States in 2021, nearly 59,000 wildfires burned more than 7.1 million acres. The number of wildfires and acres burned were equivalent to the 10-year average, but there was considerable variation by region. The Western U.S. was particularly impacted by more frequent fires, some of which grew to an enormous size. The Eastern U.S. also saw an increase in more intense fire activity, while other areas of the U.S. that usually account for a large percentage of the nation's burned acreage, such as Alaska, saw fewer fires and significantly fewer acres burned [4]. In total, the Interior Department obligated over $1.2 billion for wildland fire management activities in the 2021 fiscal year [4]. These fires not only cause extensive physical damage, destroying homes and infrastructure, but they also create a cascade of public health risks that can affect individuals far beyond the immediate vicinity of the fire.

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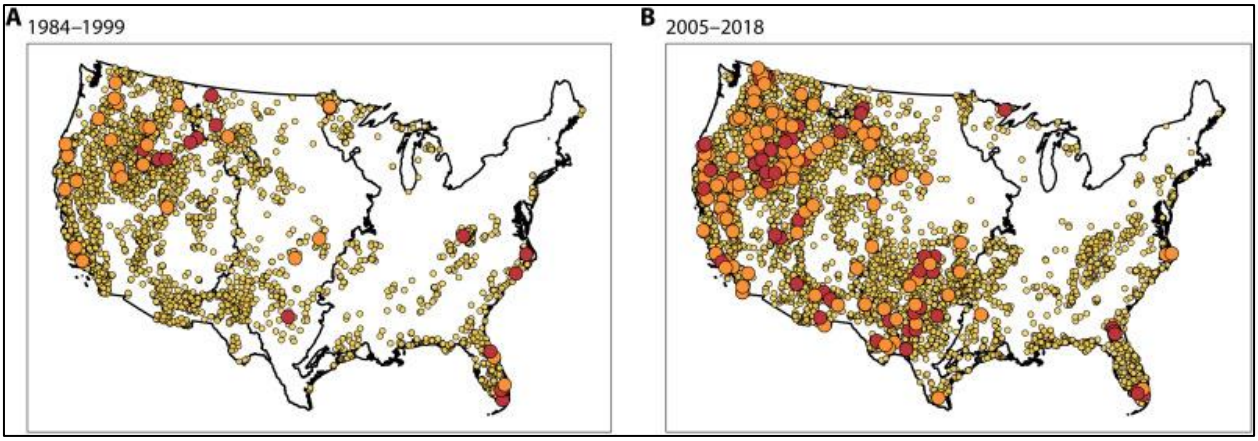

Figure 1 Spatial distribution of fires in the U.S [2]

Fires in the West (leftmost region), Great Plains (central region), and East (rightmost region) in (A) 1984–1999 and (B) 2005–2018. Nonextreme fires are shown with small dots, and extreme fires are represented with larger orange (area burned >99th percentile in 1984–1999) or red bubbles (area burned >99th percentile in 2005–2018).

One of the most significant health hazards associated with wildfires is the smoke they produce. Wildfire smoke contains a complex mixture of gases, including carbon monoxide, nitrogen oxides, and volatile organic compounds, as well as fine particulate matter ($PM_{2.5}$), which can be inhaled deep into the lungs. These particles are small enough to enter the bloodstream, causing both immediate and long-term health effects. Short-term exposure can trigger respiratory symptoms such as coughing, wheezing, and shortness of breath, whereas long-term exposure has been linked to an increased risk of chronic respiratory diseases, cardiovascular diseases, and even untimely death. Beyond these physical health impacts, wildfires also contribute significantly to mental health challenges. The displacement of people, property loss, and the uncertainty surrounding wildfire's progress can lead to increased stress, anxiety, depression, and post-traumatic stress disorder. The psychological effects of wildfires are often underappreciated, yet they can be as debilitating as the physical health risks. In fact, studies have shown that the mental health burden of wildfire survivors can persist long after the fires have been extinguished, affecting individuals' overall quality of life and their ability to recover from the trauma as a result of witnessing such a horrific event. This trauma can persist acutely to even many years after the incident in adult and pediatric populations [5].

As wildfires continue to grow in both frequency and severity, the need for effective public health communication becomes even more urgent. Clear, timely, and actionable communication is essential to helping individuals and communities protect themselves from the health risks associated with wildfire smoke. Effective public health communication can help guide behaviors that reduce exposure, such as staying indoors during periods of poor air quality, using air filtration systems, wearing N95 masks, and, in extreme cases, evacuating areas at risk of direct fire damage, as well as to avert unnecessary deaths as wildfires increase in frequency and intensity [6]. Although wildfire smoke risk communication research has also increased in the past decade, best practice guidance is limited, and most health communications do not adhere to health literacy principles: readability, accessibility, and actionability [7].

This manuscript will explore how the U.S. can learn from global experiences, particularly from countries like Australia and Canada, which have long dealt with the health challenges posed by wildfires. By examining the strengths and weaknesses of these nations' public health communication strategies, we can identify key lessons that could improve the U.S. response to wildfire crises.

2. Purpose and Scope

Wildfires have arisen as one of the most pressing environmental and public health challenges in the United States, with their frequency and severity swiftly increasing due to climate change, protracted droughts, and expanding urban areas encroaching upon regions that are prone to wildfire. These disastrous events not only cause significant physical damage but also pose severe health risks to individuals exposed to smoke and other hazardous emissions. Wildfire smoke, filled with particulate matter ($PM_{2.5}$), can travel great distances, impact large populations, and cause a range of respiratory, cardiovascular, and mental health complications. Public health communication plays a critical role in mitigating these risks by informing the public about the potential hazards of wildfire smoke and promoting behaviors that can reduce exposure, such as staying indoors, wearing protective masks, and using air filtration systems. However, despite

advances in technology and communication infrastructure in the United States, many barriers remain in reaching people effectively. These challenges include misinformation, preventable differences in access to communication channels, and public skepticism in health authorities.

The purpose of this manuscript is to explore the public health communication strategies employed globally during wildfire events, with a focus on identifying key lessons that can be applied to the U.S. context. By analyzing case studies from countries such as Australia and Canada, both of which frequently experience wildfires, this review aims to assess the applicability of these strategies in the United States, where wildfire risk is expected to continue rising in the coming decades. Furthermore, this manuscript will discuss the persistent challenges that hinder effective communication in the U.S. and propose recommendations to strengthen public health communication efforts, ultimately helping to improve preparedness and response during wildfire crises.

This exploration of public health communication during wildfire events encompasses several key concepts. First, it will investigate the health impacts of wildfire smoke, highlighting the physical, mental, and emotional toll it takes on individuals and communities. It will then delve into the communication strategies that are used by various public health organizations worldwide to manage these risks and protect the health of the public. Following this, the manuscript will assess the current state of public health communication in the United States, identifying weaknesses and challenges that challenge its effectiveness. Global best practices and case studies from Australia and Canada will be discussed, providing insights into how these nations have leveraged technology, community engagement, and culturally sensitive messaging to improve communication outcomes during wildfire events. Finally, recommendations will be made to enhance U.S. public health communication, with an emphasis on accessibility, inclusivity, and trust-building in the face of increasing wildfire risks.

3. Health Impacts of Wildfire Smoke: A Public Health Imperative

The health impacts of wildfire smoke are extensive and severe, affecting both the respiratory and cardiovascular systems, as well as mental health. The mechanism of wildfires is that the vegetation in wildlands, composed of trees, bushes, grasses, and peat, acts as the fuel which burns to produce smoke [8]. Wildfire smoke contains a range of harmful pollutants, including fine particulate matter ($PM_{2.5}$), carbon monoxide, ozone, and volatile organic compounds, all of which have significant dangerous effects on human health. Wildfire smoke also contains at least 20 types of air pollutants documented by the US Environmental Protection agency, such as formaldehyde, benzene, and hydrogen cyanide [9,10]. $PM_{2.5}$ is one of the most concerning pollutants due to its small size, which allows it to penetrate deeply into the lungs and enter the bloodstream, exacerbating existing health conditions and causing new health problems [11,12]. Also, it can cause asthma, respiratory inflammation, jeopardize lung functions and even promote cancer [13]. Acute wildfire smoke exposure can cause respiratory issues like coughing, shortness of breath, and throat irritation. People with pre-existing conditions such as asthma or COPD may experience severe flare-ups, resulting in emergency visits and hospitalization [14]. The long-term health effects of wildfire smoke are also considerable. For example, prolonged exposure to fine particulate matter has been associated with a greater risk of lung cancer, heart disease, and early death [15]. Research investigated how long-term exposure to PM2.5 affects overall and specific causes of death in a huge group of nearly 19 million Medicare beneficiaries. With 4.2 million deaths recorded, this is the largest group studied so far and it showed positive and statistically significant associations between $PM_{2.5}$ exposures and respiratory disease-related mortality in a US population [15]. These enduring health impacts are particularly concerning as the frequency and severity of wildfires continue to increase.

In addition to harming physical health, wildfires are escalating a mental health crisis. The psychological effects can be severe, especially for individuals who experience property loss, displacement, or direct trauma from the fire. Studies show that wildfire-affected people are at increased risk of anxiety, depression, and PTSD. These mental health challenges often go on long after the fires are over and event with persistent wildfires, requiring ongoing psychological treatment and support [16,17]. Vulnerable populations such as children, the elderly, and low-income communities experience much of the health impact. Children are especially prone to respiratory issues caused by wildfire smoke, which can worsen conditions like asthma and affect development [18]. Older adults, especially with pre-existing health issues and undergoing health interventions such as dialysis, face higher risks of severe health problems [19]. Low-income communities, particularly in rural or underserved urban areas, often lack resources to shield themselves from wildfire smoke, worsening health disparities [20].

Given the seriousness of these health impacts, it is essential for public health messaging to deliver accurate, timely, and actionable information to those affected. This involves informing the public about the health risks linked to wildfire smoke, giving advice on how to minimize exposure, and offering mental health support to individuals impacted by the trauma.

4. Public Health Communication as a Response Tool

Public health communication plays a key role in minimizing health risks during wildfires. Its main aim is to inform people about the dangers of smoke exposure and promote protective actions to reduce these risks. Well-designed communication strategies assist individuals in deciding whether they should stay indoors, use air filters, wear masks, or evacuate as needed. In fact, effective wildfire risk communication is crucial for spreading awareness, informing about fire hazards, and offering safety advice for future wildfire responses. This helps increase public awareness and enhances understanding of risks [21].

In the United States, agencies such as the Centers for Disease Control and Prevention (CDC), the Environmental Protection Agency (EPA), and various state health departments play key roles in issuing health advisories during wildfire incidents. These advisories typically deliver updates on air quality, guidance on minimizing smoke exposure, and details about evacuation orders. Local health agencies, fire departments, and emergency management teams also regularly participate in disseminating health-related information.

The development of digital communication platforms, including websites, mobile applications, and social media, has transformed the way public health messages are disseminated. As an example, AirNow.gov, run by the EPA, provides live air quality information, allowing people to track local conditions and determine when it is safe to go outdoors [22]. Also, the CDC provides real-time data on air quality, evacuation plans, and safety advice, making it simpler for individuals to stay informed during wildfires [23].

Social media platforms like Twitter and Facebook have become critical tools for public health agencies to reach large audiences quickly. In the U.S for example, more than 80% of US state health departments have social media accounts (Facebook and Twitter accounts, and YouTube channels) that they operate [24]. These platforms allow for rapid dissemination of information and help to counter misinformation that may spread through unofficial channels.

However, despite the advantages of digital platforms, significant barriers still exist in making sure all populations get the information they need. Not everyone has access to the internet or smartphones, especially in rural and underserved areas. Moreover, not everyone is technologically literate, which can limit their ability to access health advisories or understand complex information [24]. Rural populations are often hard to reach via traditional communication channels, and air quality monitoring data to support messaging may be limited or unavailable [25]. Also, materials that people cannot relate with or cannot be implemented by a specific group can be discouraging and lead to their detachment from health communications [26]. When people are likely to lose money from outdoor employment, it can discourage them from staying indoors [27]. Additionally, some forms of communication may involve the possibility of temporary relocation, which can cause psychological stress, particularly for vulnerable groups, and may deter them from moving [28].

5. Challenges in U.S. Public Health Wildfire Communication

5.1. Inconsistent Messaging Across Agencies

One of the primary challenges identified in the U.S. is the lack of coordination between different government agencies responsible for disseminating wildfire-related information. According to Olsen et al. (2014) [29], the U.S. faces substantial barriers in ensuring consistent messaging across federal, state, and local agencies. Inconsistent or conflicting guidance can confuse the public during emergencies, particularly when residents receive contradictory information about evacuation routes, shelter locations, or protective measures. This challenge is particularly critical because wildfire events often affect multiple jurisdictions, and effective communication requires agencies to coordinate their messaging to avoid confusion and maintain public trust [29].

5.2. Risk Perception and Audience Segmentation

In the U.S., research highlights prominent differences in how diverse individuals perceive wildfire smoke risks [30]. For example, young adults often do not consider the health dangers of wildfire smoke as seriously as older adults or those with pre-existing conditions like asthma. This variation in risk perception can lead to unpredictable adherence to safety measures, such as wearing masks or staying indoors, particularly in communities where wildfires are infrequent or less intense.

5.3. Trust Issues and Information Sources

Trust plays a vital role in effective risk communication. Research points out that during wildfires in the U.S., there was a significant lack of trust in digital platforms and official sources [30]. As digital media, including social media, apps, and websites, have become essential communication tools, public skepticism about the accuracy of information from these sources can hinder risk mitigation efforts. People might ignore warnings or safety advice if they distrust the source or question the reliability of digital platforms.

5.4. Information Overload and Complexity

The large amount of information shared with the public during wildfires often causes confusion and delays in response. The U.S. struggles with delivering too much information too quickly, which can overwhelm people's understanding [31]. This issue is critical during rapid wildfire developments when residents must quickly follow straightforward, actionable guidance. Using technical language, detailed evacuation plans, and complicated safety instructions can hinder timely action.

5.5. Approaches to Wildfire Communication from Other Countries That the U.S. Can Adopt

Current wildfire smoke risk communication at a broad scale is typically conveyed through multiple channels, including electronic and print news media, social media, social networks, the internet, mobile apps, road signs, hotlines, fact sheets, school programs, and public presentations [32]. Various countries around the world have developed innovative public health communication strategies to tackle the health risks of wildfire smoke. Notably, Australia and Canada, with their extensive wildfire management experience, have established communication methods that effectively protect public health.

5.6. Targeted Communication Based on Risk Perception

In Italy, Spano et al. (2021) found that people with direct wildfire experience had greater knowledge about wildfires and smoke exposure than those without such experience [33]. This indicates that customized communication, which considers individuals' experiences and risk perceptions, can improve understanding. The U.S. could implement this approach by targeting regions prone to wildfires and designing information campaigns that address the public's specific exposure levels and personal experiences.

5.7. Hybrid Approaches to Risk Communication

A Western Australia study by Cao et al. (2016) showed that combining maps with text messages significantly boosted public understanding and perception of risks [34]. Maps displaying fire locations and nearby shelters, coupled with text alerts offering actionable guidance, facilitated effective communication during wildfires. The U.S. could adopt this method by improving public messaging with real-time maps and precise location-based text alerts, especially in regions prone to wildfires.

5.8. Technology and Community Engagement

Australia's Fire Stories film case study demonstrated how multimedia, particularly films featuring real wildfire footage, increased protective actions among viewers [35]. Through relatable narratives, the campaign enhanced awareness and concern about wildfire hazards. Likewise, the U.S. could broaden its communication efforts by incorporating emotional storytelling through multimedia channels, such as social media, local films, or videos, to build stronger community ties and encourage preventive measures.

5.9. Multi-Channel Communication with Localized Content

A systematic review across various countries highlights the need for clear, consistent, and localized messaging using both traditional media (TV, radio) and non-traditional sources (social media, websites). These combined channels help reach diverse audiences, from rural areas to cities. The U.S. can adopt this mixed-media strategy to deliver wildfire-related messages more effectively, ensuring consistency across platforms and emphasizing region-specific details [36]. In Canada, a study in the Northwest Territories demonstrated how community-based initiatives, like removing flammable materials and enhancing food security, can lower wildfire risk and smoke exposure [37]. These efforts empower residents to proactively protect themselves and their families. The U.S. might consider similar community-focused strategies that motivate residents to participate in prevention activities, fostering resilience and shared responsibility for managing wildfire risks.

5.10. Clear and Simple Messaging for Quick Recall

Studies from Tasmania and found that clear, straightforward communication led to improved recall and understanding, especially about smoke exposure. The research also demonstrated that digital messaging, when combined with public health guidelines, yielded high recall rates [31]. The U.S. can apply this strategy by simplifying emergency communications and emphasizing clear, actionable instructions, such as staying indoors and wearing masks, particularly in regions heavily affected by wildfire smoke.

5.11. Collaborative Communication for Consistency

Research from Victoria, Australia, highlights the importance of interagency collaboration for consistent messaging during wildfires. Thomas et al. (2021) noted that emergency risk communication professionals often feel pressure to provide accurate information quickly. The U.S. can adopt a similar strategy by enhancing coordination among federal, state, and local agencies to ensure clear and timely communication during wildfires. Additionally, sharing resources can help reach larger audiences more effectively [38].

6. Strengthening U.S. Public Health Wildfire Communication: The Path Forward

Addressing these challenges requires a more inclusive, coordinated, and community-oriented approach to public health messaging. First, broadening communication efforts is crucial to ensure that all populations, regardless of location, income, or access to technology, receive timely and accurate information. Traditional media, such as radio and television, should remain vital components of communication strategies, particularly for rural or underserved communities that may lack access to digital technology. Establishing a unified communication protocol across all government levels can enhance clarity. A centralized system for sharing wildfire warnings, alerts, and safety instructions may reduce conflicting information. Additionally, regular training for communication personnel at all levels is crucial to ensure messages remain consistent and clear.

The U.S. could adopt more customized communication strategies that cater to varying perceptions of risk. By dividing the population into high-risk and low-risk segments and designing specific messages for each group, wildfire communication can be more impactful. Moreover, public health campaigns might incorporate stories and testimonials from affected people to boost engagement and make the health risks more relatable. Again, the U.S. could build public trust by ensuring that communication about wildfire risks comes from credible and established sources, such as local emergency services, health organizations, or trusted community leaders. Consistent and transparent communication across multiple platforms, paired with accurate and evidence-based content, can help improve public trust. Additionally, leveraging local influencers and community figures to spread information can help ensure that the messaging is accepted and trusted by local populations. Emergency messages should be simplified to include only the most critical and actionable steps. Clear, concise messages that focus on immediate actions (such as evacuation instructions or health protection measures) should be prioritized. Emergency communications should be designed to be easily digestible by people of all ages and literacy levels, using simple language and visuals (e.g., infographics, maps).

Wildfire spread rapidly, making it essential to deliver timely, real-time information. During wildfire events in the U.S., delays in communication can occur, preventing public safety messages from reaching people quickly enough. This delay may stop residents from acting promptly, such as evacuating or seeking shelter, potentially leading to injury or loss of life. In rural or remote areas, such delays are even more dangerous, as residents might not receive urgent warnings in time. To address this, the U.S. could develop systems for real-time updates through various channels, such as emergency broadcast systems, social media, mobile apps, and local alert systems. These should send immediate notifications upon detecting an emergency and offer clear, actionable steps for individuals to follow during wildfires. With the recent surge in artificial intelligence, it can enhance wildfire communication by delivering early warnings via real-time analysis of satellite and weather data, allowing for quicker alerts to communities at risk. It customizes health messages according to location, health conditions, and language, ensuring vulnerable groups get clear instructions. AI can also track social media for misinformation, assist in emergency response planning, and assess the effectiveness of communication efforts to improve future strategies [39]. By increasing public awareness and communication about wildfires, public health is safeguarded.

7. Conclusion

This scholarly examination emphasizes the significance of prompt, accessible, and culturally sensitive public health communication during wildfire incidents. Drawing from international experiences, it delineates effective strategies such as multi-platform messaging, interagency coordination, and targeted outreach to vulnerable populations. By

incorporating these lessons, the United States can improve its communication frameworks to more effectively safeguard public health during wildfire emergencies. This research provides practical insights to inform policy formulation and implementation, thereby ultimately fostering more resilient communities amidst the increasing frequency of climate-related disasters.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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