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PERSPECTIVE

Responding to simultaneous crises: communications and social norms of mask behavior during wildfires and COVID-19

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1. Simultaneous crises

The ongoing COVID-19 pandemic and the potential for co-occurring wildfires pose health threats to people around the globe. Along with the direct impacts of wildfires, exposure to fine particulate matter (PM 2.5)—pollution composed of small inhalable particles with diameters of 2.5 micrometers or smaller—from wildfire smoke is a growing public health issue with potentially serious short-term and long-term consequences [1, 2]. In the United States, models suggest that by the end of the century, fire-related pollution could account for more than 50% of the annual average PM 2.5 concentration, and deaths attributable to fire-related PM 2.5 exposure could reach 44 000 per year [3]. Recent research indicates that increased long-term exposure to PM 2.5 may be linked to increases in the COVID-19 case fatality rate [4, 5]. Peak wildfire season is underway in the western U.S. [6], where in August 2020, nearly 12 000 lightning strikes hit the state of California, starting hundreds of fires and blanketing the region in thick smoke [7]. The simultaneous crises of smoke exposure and COVID-19 pose grave challenges for those already vulnerable to COVID-19 [4, 5], thus demanding action from agencies and experts charged with providing public health guidance.

According to public health experts, wearing a face mask can effectively mitigate wildfire smoke and COVID-19 exposure [8–10]. However, not all face masks are created equal. Only certain masks are effective during wildfires, while a range of face coverings may help prevent coronavirus transmission, although experts have called for additional research into mask effectiveness [8]. Currently the Environmental Protection Agency (EPA) and the U.S. Centers for Disease Control and Prevention (CDC) provide different face mask recommendations for protection against wildfire smoke and the

coronavirus, respectively. The EPA recommends that adults spending time outdoors during a wildfire wear a N95 or P100 particulate respirator, which have been shown to effectively filter the PM 2.5 from wildfire smoke, while surgical masks and alternative face coverings have not [10, 11]. To our knowledge, the EPA has yet to address the complexity of mask use decisions during wildfire season and the COVID-19 pandemic. In contrast, based on evidence that cloth face coverings provide a barrier to COVID-19 transmission [12–14], the CDC currently advises that people wear cloth face coverings in public and reserve scarce N95 masks for medical workers [9]. Additionally, the CDC does not recommend N95 masks with respirators, or exhalation valves, because although they may protect the wearer, expelled respiratory droplets may still transmit the coronavirus [15]. When addressing the overlap of wildfire season and COVID-19, the CDC notes that cloth face coverings offer limited protection against wildfire smoke, N95 masks may be scarce, and N95 masks without exhalation valves are preferred when wildfire smoke and COVID-19 are simultaneous threats [16, 17]. The CDC also acknowledges local resource constraints and suggests that public health officials should determine mask recommendations based on the local supply of N95 respirators, the severity of the wildfire smoke, and COVID-19 community transmission levels [16]. However, this guidance aimed at multiple contexts and localities may be confusing to the public and does not reconcile with EPA's longstanding recommendations on mask use during wildfire smoke events [10]. In light of these conflicting and changing recommendations from government agencies, and as wildfire season progresses, we expect that public confusion around face mask use will increase.

Government agencies and public health researchers should respond to the overlap of wildfire season and COVID-19. Drawing on validated models of health behaviors [18–20] and our research investigating mask behaviors during wildfires, we

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show how social norms are one possible pathway influencing protective behaviors in response to respiratory health threats (see figure 1). We recommend that 1) agencies and officials reconcile the current inconsistencies in mask use recommendations, 2) behavioral researchers study decision-making processes for overlapping health threats, and 3) public health communications leverage social norms, along with other behavioral science-based approaches, in mask-use messaging and guidance.
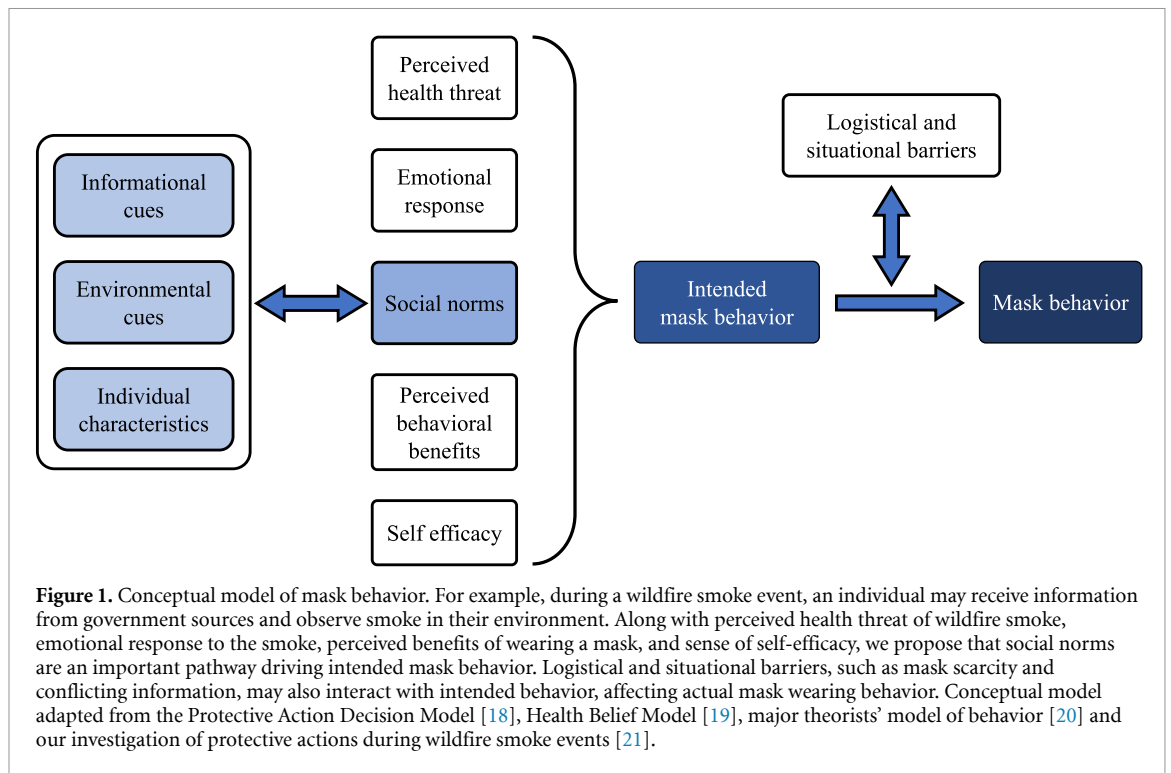
2. Mask behavior

Public officials, in the U.S. and abroad, will likely continue recommending the use of face masks in the coming months, as masks may provide protection against viral transmission in places where social distancing is difficult [8] and given expectations that COVID-19 may resurge periodically until an effective vaccine is developed [22]. However, we posit that the scarcity of N95 face masks may intensify as wildfire season in the U.S. progresses. Even before the pandemic, N95 face masks were in high demand during recent wildfires, like the Camp Fire in 2018—the deadliest and most destructive fire in California history, which sent smoke across hundreds of miles in Northern California, burning 153 336 acres, destroying 18 804 structures, and resulting in 85 deaths [23]. During the Camp Fire, the city of Sacramento alone distributed 267 000 N95 masks to the public [24].

The pathways and processes that motivate mask behavior are not fully understood. Few studies have examined mask use during wildfire smoke events [25, 26]. One study, conducted in the U.S., found that individuals with pre-existing health conditions (e.g. asthma) were more likely to wear a mask during a wildfire [25], whereas another U.S.-based study found that wearing a mask was positively associated with spending more time outdoors [26]. The latter finding echoes expert concerns that face masks may increase the wearer's sense of safety and self-efficacy, thus lowering compliance with other protective behaviors [8]. On the other hand, a study in Japan found that wearing a mask in public was associated with other hygienic, protective health behaviors [27]. In the public health literature on mask use during pandemics (i.e. SARS, H1N1), several studies have found that high perceived threat of illness and strong perceived benefits of masks are associated with greater adherence to mask-wearing [28, 29]. In the context of the COVID-19 pandemic, one recent online experimental study found that people perceived mask wearers as more likely to be ill, but also more trustworthy and socially desirable [30]. However, to our knowledge, no studies have examined mask-type decision-making in wildfire smoke or infectious disease settings, nor mask-wearing behaviors to protect against simultaneous hazards.

To address the gaps in our understanding of mask use during wildfires, in 2019 our team conducted a qualitative, theory-generating study drawing from 33 semi-structured interviews, investigating the lived experiences and decision-making processes of individuals exposed to wildfire smoke from the 2018 Camp Fire [21]. We found that *social norms*—shared belief systems within a social group that provide information on how to behave and manage relationships [31, 32]—were a salient driver of mask-use behavior. This affirms previous public health research suggesting that during novel events, when information is scarce and uncertain, social norms influence individual decision-making [32]. We anticipate that during the convergence of wildfire season and COVID-19, people will look to emerging social norms in their communities to decide when, where, and what types of masks to wear.

The current scarcity of N95 masks and the diversity of mask options prevents a singular *descriptive norm*—a standard of behavior based on what others do [31, 32]—from developing, which may lead to a patchwork of norms and behaviors in different locations. For example, some people will use face coverings such as surgical masks, hand-made masks, or clothing accessories that can be worn over the face. The impact of N95 mask scarcity on descriptive norms was apparent in several of our interviews on wildfire smoke. One participant said, 'I'd be out wearing a mask and nobody else was. So, I do not think most people take it very seriously' (F-3) [21]. This remark illustrates the inferences people may make about others' motivations and behaviors by observing mask wearing. Conflict and confusion can arise when descriptive norms are not robust.

Uneven adherence to mask wearing norms could also result in the perception of violating *injunctive norms*—the perception of what behaviors most people in a social group approve or disapprove of [31, 32]. This may result in social sanctioning based on social group, visible features of the wearer, the way a mask is worn, or mask type if one is worn at all. In our study, one participant noted, 'there was a mom and a daughter playing in the park across without masks. I was like, "do not do that!" That's when I started to hone in on who was not wearing masks'(S-11) [21]. In the context of simultaneous hazards, we ask: will social sanctions of individuals wearing scarce masks, such as N95s, increase if the wearer does not appear to be ill, vulnerable, or a medical worker, despite recommendations that N95 masks should be worn during wildfire smoke events? During the COVID-19 crisis, injunctive norms are rapidly evolving, drawing on public health communications, media coverage, and social interactions. Mask choices may also signal information about an individual's access to resources, fear of racial profiling, or political affiliation [33]. However,

Figure 1. Conceptual model of mask behavior. For example, during a wildfire smoke event, an individual may receive information from government sources and observe smoke in their environment. Along with perceived health threat of wildfire smoke, emotional response to the smoke, perceived benefits of wearing a mask, and sense of self-efficacy, we propose that social norms are an important pathway driving intended mask behavior. Logistical and situational barriers, such as mask scarcity and conflicting information, may also interact with intended behavior, affecting actual mask wearing behavior. Conceptual model adapted from the Protective Action Decision Model [18], Health Belief Model [19], major theorists' model of behavior [20] and our investigation of protective actions during wildfire smoke events [21].

behavioral science has shown that even individuals with resources and a desire to follow public health recommendations can be influenced by injunctive social norms, decreasing their adherence to a protective health behavior [32].

Finally, the act of giving and receiving face masks can represent social support, while also influencing *subjective norms*—the perception of expected behaviors by valued others (i.e. close friends and family) [32]. Many participants in our study said they gave or received masks during the Camp Fire. One person remembered, 'I did not have any masks. Someone at a work function I went to in the Bay brought a bunch of extra masks, so I eventually got one from her, which was really wonderful' (S-10), and another participant discussed how she bought a mask for her mother and worried about its efficacy [21]. During the Camp Fire, it appeared common for people to purchase masks for one another; and now, during the COVID-19 pandemic, people are gifting hand-made masks to family, friends, and hospital workers. If a valued other gives a face mask, there is a subjective norm that the recipient should wear it.

3. Recommendations

We outline three recommendations for government agencies in the U.S., as well as researchers and public health communicators globally.

1) U.S. government agencies, such as CDC and EPA, as well as state-level leaders, such as the California Air Resources Board and the California Department of Public Health, should reconcile incongruent face mask recommendations. Although our case study has limited generalizability, the majority of

participants (~38%) trusted government websites the most for information on wildfire smoke, pointing to the importance of these venues for vital information sharing [21]. We recommend a comprehensive communications effort clarifying the types of masks that are effective for both threats and which are threat-specific. We also suggest providing information about where to acquire masks; whether there is a scarcity of commercially-made N95 masks; and how to make, fit, and reuse masks. To reach vulnerable groups, communications should be translated into languages other than English and presented in culturally appropriate formats [34]. An infographic could be a useful tool to clarify mask-type differences and the protection they offer, by providing images with descriptions indicating which masks protect against smoke, the virus, or both. During wildfires, people wearing cloth face coverings may mistakenly believe they are protected from wildfire smoke, or those wearing N95 masks with respirators may mistakenly believe they are reducing potential transmission of COVID-19.

2) Researchers should investigate the social and psychological processes that influence mask use and seek to understand how masks interact with other protective health behaviors, such as hand-washing and social distancing. Mask wearing could increase the salience of other behaviors, thereby reinforcing them, or alternatively, provide such a sense of safety and efficacy that people relax precautionary behaviors [8]. A better understanding of how people weigh multiple risks during wildfire season and COVID-19 could also assist in crafting effective health messaging for other environmental and health threats that co-occur. Finally, wearing a mask during wildfire

season can only protect individual health, whereas wearing a mask during COVID-19 may also provide group benefits by preventing virus transmission from asymptomatic individuals [8, 9]. Thus, a valuable area of study involves how social norms related to mask behavior interact with individualistic versus collective motivations [35].

3) Public health communications should leverage the growing understanding of the social nature of mask use. Common ways to use social norms for behavior change involve providing information comparing a person's actions to others [32], positive feedback when actions are taken [36], or situated messaging, where information is disseminated in locations where protective behaviors are most relevant [31]. For example, during a wildfire, messages may be most useful in outdoor spaces, whereas during COVID-19 it may be more appropriate to target indoor areas, where it is difficult to socially distance. In addition to social norms, we acknowledge that there are many other approaches within the social and behavioral sciences that could help us understand what motivates mask use behavior, including but not limited to those that employ morality, values, attitudes, and risk perceptions [20]. In an ideal world, we would test the efficacy of these different approaches, but the urgency of the overlap of COVID-19 and wildfire season does not afford us that time. Therefore, we suggest conducting rapid testing of potential interventions using social norms along with other models.

To promote effective protective health behaviors during wildfire season and the COVID-19 crisis, mask use guidance should be clarified and streamlined by government agencies, and informed by behavioral research. Peak fire season in the western U.S. typically lasts until mid-November [6], thus requiring urgent attention to the convergence of these threats. However, the need to clarify mask-use recommendations, advance new knowledge on mask behaviors, and draw on behavioral science to shape public health messaging is not unique to the U.S. or the Northern Hemisphere's wildfire season, as the dual threat of wildfires and COVID-19 has implications around the globe.

Acknowledgments

Data availability statement

The data that support the findings of this study are available upon reasonable request from the authors.

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