Policy Interventions for Managing the Risk of Wildfire Smoke for Vulnerable Populations

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The Institute for Policy Research and Engagement (IPRE) is a research center affiliated with the School of Planning, Public Policy, and Management at the University of Oregon. The IPRE is an interdisciplinary organization that assists Oregon communities by providing planning and technical assistance to help solve local issues and improve the quality of life for Oregon residents. The role of IPRE is to link the skills, expertise, and innovation of higher education with the transportation, economic development, and environmental needs of communities and regions in the State of Oregon, thereby providing service to Oregon and learning opportunities to the students involved.

About the Oregon Policy Lab

The University of Oregon's School of Planning, Public Policy and Management and the government of Lane County started a partnership in 2018 to provide applied learning experiences for students, applied research settings for faculty and staff, and technical assistance to the Lane County government.

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Purpose of this Report

If recent years are any indication, the presence and risks of wildfire smoke will become more common in Lane County in future years, not less. The effects of climate change will continue to exacerbate the risk of these fires' size and intensity. This memo sets out to outline the range of known policy interventions that might be taken by Lane County and other governments to protect vulnerable populations when wildfire and their smoke affect our area.

Known Health Risks from Forest Fire and Wildfire Smoke

It is known that the smoke from wildfires sets off and exacerbates a range of health problems, most acutely "adverse respiratory outcomes" — particularly related to asthma and COPD [1], though heart disease and cardiac arrest have also been linked to smoke [2,3]. Fine particulate matter or PM2.5 (PM = particulate matter) has been linked to increased mortality and morbidity [1,2]. The risk of PM2.5 is not uniform, as the chemical composition of smoke from wildfires may differ from that of PM2.5 typically found in urban areas [1]. Particulate matter from wildfire smoke is also very small (diameters between 0.4 and 0.7 micrometers), which makes it more dangerous since it can more easily reach the lungs and affect the heart [4]. Carbon monoxide is also a concern and is highest when these fires are smoldering. Climate change is expected to increase the frequency and severity of exposure to PM2.5 in fire-prone areas, thus this is not a problem that will be going away [2].

Health effects of smoke

There are several health effects of exposure to particulate matter, including eye and respiratory tract irritation, bronchitis, worsened asthma and heart failure, and premature death [4]. Many of the studies on the health impacts of air pollution, however, occur in urban areas. There are also concerns about the impacts of short-term exposure to wildfire smoke on increasing the risk of cancer and other health conditions. However, short-term exposure to wildfire smoke has lower risks to the general population, as many risks are relative to accumulated lifetime exposure to carcinogens.

There is also variation in how and who is affected from exposure to wildfire smoke since it can depend on age and current health conditions. There are, however, more vulnerable populations, including children, who are more susceptible since their lungs are still developing. Studies show fetal health is affected by exposure of pregnant women to pollution. The elderly are also at greater risk because they are more likely to have a pre-existing lung or heart condition, as well as weaker physiological defense mechanisms to protect

themselves. Those with asthma, other respiratory diseases, and cardiovascular disease are high-risk because exposure to smoke from wildfires could worsen their conditions. Finally, people of low socioeconomic status may be more vulnerable due to poor access to protection from smoke, including air conditioners or other filtration systems.

Consequently, the populations that would likely need to be targeted for assistance during a wildfire event would include:

1. Elderly
2. Pregnant women
3. Young children
4. Individuals with pre-existing lung and heart condition
5. People of lower socioeconomic status
6. Unhoused or Homeless

Common Interventions to Improve Health Outcomes

Researchers and public health officials have identified typical interventions to respond to wildfire smoke incidents [2,5]. The ordering of the list below corresponds to a rough approximation to a combination of effectiveness of the intervention with its cost to the local government. This ordering is not meant to be definitive nor prescriptive in all situations—as some circumstances will require, for example, evacuation for public safety.

1. Public Information Campaigns (combined with other interventions)
2. Stay indoors
3. Existing filtration systems
4. Reduce physical activity
5. Reduce other indoor air pollution sources
6. Cleaner air shelters
7. Closures
8. Portable air cleaners (PACs)
9. Respirators
10. Evacuation

These interventions are intended to be done before or during the wildfire events. Each of these common interventions have their own drawbacks and advantages, particularly for vulnerable populations that are most susceptible to the effects of PM2.5 from wildfire smoke. Other policies may be required to prepare a community prior to the events.

Public Information Campaigns**:** The choice of the means by which emergency and public health managers choose to communicate with the public is also very important. The use of social media, for example, to get out the word of health

risks to vulnerable populations that do not use social media regularly—"elderly residents and lower than average internet connectivity"— would be highly ineffective[6]. Direct outreach to senior centers and medical facilities that serve the elderly or the delivery of fact sheets to daycare sites with at-risk children would be more effective at reaching those populations.

The research on communicating risk during wildfire smoke events needs to be very clear and unambiguous. Researchers have found that the simpler the message, the more likely these warnings will be heeded—"Messages that use simple language, such as 'stay indoors', are more commonly recalled, understood, and complied with"[6]. Overall, it is important to understand who the vulnerable populations in your community are and how they regularly get their information.

Stay indoors**:** Depending on the age and maintenance of the home, staying indoors could offer protection from wildfire smoke. Newer homes are typically more effective at keeping pollution out than older homes because they are more tightly closed, and air-conditioned homes are even more effective because they re-circulate indoor air. However, in homes with no air conditioning, air pollution levels closely mimic those found outdoors. When windows and doors are closed, however, indoor air pollution levels can represent less than half of outdoor pollution levels. One potential drawback of recommending people stay indoors is heat stress since wildfires season overlaps with summer and early fall. In which case, closing doors and windows may be more difficult in homes with no air conditioners. Also, heat stress can worsen health conditions for elderly individuals, who could suffer from heat exhaustion or strokes. If temperatures are high, it is recommended individuals without air conditioners stay with friends or family who have them, go to a cleaner air shelter, or leave the area. Regarding what to do during work, California has developed their own guidance on how to protect workers in indoor workplaces from wildfire smoke, including taking advantage of heating, ventilating and air-conditioning (HVAC) systems.

When *inside vehicles*, keep windows and vents closed and operate the air conditioner in "re-circulate" mode, if available, to reduce the number of particles in the car. However, cars heat up very quickly, so children and pets should *never* be left inside vehicles with windows closed by themselves. Be careful of carbon dioxide build-up in cars when vents and windows are closed and the air is re-circulating.

Existing filtration systems**:** Many buildings today, residential and commercial, are outfitted with HVAC systems. The benefits of staying indoor will vary widely and **"**largely depends on building construction and the infiltration of outdoor air"[2]. When modern HVAC systems fans are run "continuously with no upgrade in filter efficiency" they can reduce "the mean PM2.5 concentration by 24%"[7]. When the HVAC system fan is run continuously and is upgraded with a particulate filter, the concentration of PM2.5 is reduced by about half [7]. If the filter is in place in the HVAC system, but the fan is not run continuously, the mean PM2.5 particulate reduction is only about 11 percent[7]. Pleated medium- or high-efficiency particle filters are better at capturing smaller particulates from smoke and help decrease how much outdoor air pollution comes indoors. Filters should also be replaced

regularly and those with filter upgrades can set the system's circulating fan to operate continuously during wildfire smoke events. However, this is costly since it requires a large amount of energy. Newer air conditioners that have a "fresh air ventilation system" should turn off this feature during smoke events and contact their building to adjust the system during smoke events if they are unable to do so themselves. Also, homes and buildings with ventilation systems that purposely bring outdoor air inside should be turned off or adjusted during smoke events. Existing HVAC infrastructure can be used to create public or private 'clean air shelters' as a way to reduce the levels of PM2.5, so long as the HAVC systems are sufficiently efficient. "Taking advantage of existing induct filtration or air conditioning in large buildings is a practical approach, particularly when these systems use high efficiency filtration. However, some buildings may only be equipped to operate low efficiency filters that provide limited benefits with respect to exposure reduction"[2]. Consequently, the choice of clean air shelters is highly dependent on the HVAC system quality, efficiency, and mode of operation.

Reduce physical activity**:** Exercise can increase air intake by 10 to 20 times as much over resting level, and more people breathe through their mouths which bypasses the filtering ability of nasal passages. As a result, physical outdoor activity should be avoided.

Reduce other indoor air pollution sources**:** Avoid "smoking cigarettes, using gas, propane and wood-burning stoves and furnaces, spraying aerosol products, frying or broiling meat, burning candles and incense and vacuuming" because they all contribute to increasing particle levels inside the home (p. 19, ("Wildfire Smoke: A Guide for Public Health Officials," 2016).

Cleaner air shelters**:** Cleaner air shelters should be identified and evaluated prior to fire season. They can be used by residents to escape the smoke since staying indoors may not be feasible for some people, especially vulnerable populations.

Closures**:** By canceling events public and private entities can help reduce exposure risk, particularly those events that would strain the respiratory system (games and sporting events, for example). While indoor air can be as dirty as outdoor air, there are ways in which to clean indoor air not available outside.

Closures will depend on local conditions and it is worth considering if pollution levels inside homes will be similar to those in schools or businesses, especially if time spent outdoors or physical activity is easier for schools, than homes, to control. Certain groups could be targeted, including vulnerable populations, or specific outdoor activities.

Portable Air Cleaners (PACs)**:** PACs are generally seen as two types of portable air filters: 1) "high efficiency particulate air (HEPA) filters" or 2) "electrostatic precipitators"[2]. The use of PACs for wildfire smoke has been shown to reduce indoor PM2.5 concentrations by "63 to 88% lower PM2.5

concentrations in homes with PACs… while PACs for other pollutants saw reductions of 32–88%"[2].

PACs have been studied for general respiratory and allergen-related health, beyond wildfire smoke, with results that suggest they are highly efficient at cleaning air for these conditions. The PACs "are more energy efficient than central HVAC systems in removing particles because of their lower fan power per unit air flow and higher particle removal efficiency"[7]. PACs can be used to augment existing HVAC systems, particularly those that are low-efficiency in-duct systems. PACs can be useful in creating or improving the air quality in public/private clean air shelters during times of great need, thus creating opportunities to provide clean air benefits to larger populations.

At the household level, PACs have been shown to be an effective intervention for reducing PM2.5 exposure for vulnerable groups[8]. Individuals should purchase PACs before a smoke event to avoid them selling out and avoid going outside. Many portable units also have a Clean Air Delivery Rate (CADR), which accounts for efficiency and airflow. There are three CADR numbers for different pollutants. Higher numbers correspond to units more quickly filtering the air. The cost of PACs, however, may be too high for some vulnerable populations, and thus they may need to be subsidized or given out for free to be highly effective[2]. Room high-efficiency particulate air (HEPA) filter air cleaners and safe ESPs cost between $90 and $900. Units should provide filtered airflow for two to three times the room volume per hour. Larger central air cleaners are also available ($450-$1500) and can improve air quality for the entire home. One example of local public health agencies partnering with other institutions to disseminate this technology is the Missoula County Health Department who partnered with Climate Smart Missoula and distributed air filters to the elderly[9]. They also partnered with United Way and area schools to gather funds to distribute HEPA air filtration units to several schools when the fire season extended into the school year. Each classroom typically has two of these filters.

It should be noted that "the fraction of the population with [a hospital] admission attributable to wildfire smoke is small, thus, the costs of interventions in all homes far exceeds the economic benefits of reduced hospital admissions. However, the estimated economic value of the prevented deaths exceed or far exceed intervention costs for interventions that do not use portable air cleaners. For the interventions with portable air cleaner use, mortality-related economic benefits exceed intervention costs as long as the cost of the air cleaners, which have a multi-year life, are not attributed to the short wildfire period. Cost effectiveness is improved by intervening only in the homes of the elderly who experience most of the health effects of particles from wildfires"[7].

Other recommendations include electronic particle air cleaners or electrostatic precipitators (ESPs) which have been tested and shown not to produce excess ozone. These can be added by a technician. However, the U.S. EPA also suggests avoiding "ozone generators, personal air purifiers, 'super-oxygen' air purifiers, and 'pure air' generators" because they increase ozone gas, which manufacturers claim can remove mold, but they also worsen human health[4]. Also, while humidifiers will not reduce the number of particles or remove gases, they could reduce small amounts of pollutants, and could be helpful in dry

environments during a smoke event by keeping the mucous membranes moist which alleviates eye and airway irritation.

Respirators**:** The primary challenge with respirators is that in order to be effective they require specialized fitting and their "use is cumbersome"[2]. Some may also feel that they only need to wear respirators outside, when indoor air quality can match that of outdoor air quality if the buildings do not have adequate filtration systems[8]. When the respirators are not properly fitted they offer the illusion of protection, which may result in some individuals undertaking activities that are unhealthy—creating an outcome worse than not using the respirator. Often, people confuse masks with respirators. Surgical masks do not form a tight seal with the face, so they do not prevent individuals from breathing in particles from smoke. Nor will covering the mouth with a dry or wet cloth (e.g., bandana, handkerchief). N95 particulate filtering facepiece respirators with a higher level of protection are appropriate for the public. The following website has information on approved particulate filtering facepiece respirators: [http://www.cdc.gov/niosh/npptl/topics/respirators/disp_part/n95list1.html]

Respirators must fit well and provide an adequate seal[1] to filter small particles, this should be confirmed using a "fit test." However, disposable respirators (NIOSH-certified N95 or P100 particulate respirators) are easily accessible, and many people purchase and use them without them being properly fitted. As a result, health officials should provide guidance on how to select and use respirators, even if a proper fit test and training are unavailable. N95 is typically cheaper compared to the P100 and people should make sure to change them out when necessary. The following website provides guidance on how to correctly use disposable N95 and P100 respirators: https://airnow.gov/static/topics/images/epa-infographic-respirator.jpg

It should be noted that other more effective ways of reducing exposure to smoke should be used, and respirators can be used after having taken these other precautions first.

Evacuations: Evacuations, as an intervention, remove the individuals from the area affected by wildfire smoke. Evacuations are known to be "stressful, and may not protect populations from smoke in the absence of direct threat from fire," [2] when comparing evacuations to other interventions.

[1] There are no adequate seals for most children and men with beards

Conclusions

Both existing HVAC systems and/or PACs can be used to create in-home (private) clean air shelters. Clean air shelter "use may be part time (e.g., several hours per day) or full time (e.g., day and night) for the duration of the smoke event…to reduce exposure to wildfire smoke by creating a space with reduced smoky air from outdoors and little indoor air pollution"[5].

Public clean air shelters would be operated by governments to provide similar benefits for individuals within the community that do not have access to HVAC systems or PACs in their homes. The cost and effectiveness of existing infrastructure need to be tested ahead of time and designed with sufficient capacity to clean the air of the shelter. It may be that targeted interventions, for homes of the elderly for example, will be more cost-effective, since it is this group that is most likely to be hospitalized during a wildfire smoke event. This targeted approach was shown to reduce the "intervention costs by almost 80% while health benefits remain similar in magnitude" to providing PACs more broadly to the community[7].

The unhoused and homeless are particularly vulnerable during wildfire events. They often lack access to places that could provide relief from the smoke. Even those individuals that are otherwise healthy within this group, could over time begin to face a more chronic exposure to the ill effects of the smoke. There has been very little research in this area making specific policy recommendations for this population difficult. Clean air shelters may be one of the most straightforward actions a community could undertake during an event for this population. The Oregon Public Health Division recommends clean air shelters as a helpful remedy to ill health effects caused by wildfire smoke for individuals experiencing homelessness[10]. In northern California shelters and public buildings, like libraries, have been extending hours they are open during recent years to provide greater relief during smoke events[11,12]. Until further research is done it seems safe to say that indoor shelter space, whether it is for sleeping or for other purposes during the day (libraries, for example), offer the best way to address the needs of the homeless/unhoused during smoke or bad air quality events.

Creating clear communication guidelines for public agencies is also important. This means that clear thresholds of PM2.5 exposure for when events should be canceled are set up ahead of time, as a way to reduce the frustration at the time of the events. Communication channels for outreach during the time of event need to be identified ahead of time and tested to assure the agencies are able to reach the intended audiences during events.

Useful Resources and Guides from Other Governments

Example of other government's efforts to communicate to the public on risks and possible interventions during smoke events

US

City of Ashland, OR

Smoke and Your Health—general information for residents
http://www.ashland.or.us/Page.asp?NavID=17502

Smoke and Outdoor Events—decision making and planning around smoke
https://www.ashland.or.us/Page.asp?NavID=17505

Ashland Chamber of Commerce

Smoke Preparedness Workshop
http://www.ashlandchamber.com/Page.asp?NavID=1384

Deschutes County

Health Tips for Wildfire Smoke
https://www.deschutes.org/health/page/health-tips-wildfire-smoke

State of Oregon

Oregon Wildfire Response Protocol for Severe Smoke Episodes
https://www.oregon.gov/deq/FilterDocs/WFresponse.pdf

Oregon Office of Emergency Management

Communications Toolkit: Wildfires (includes tips/templates for press releases and social media use)
https://www.oregon.gov/OEM/Documents/WildfiresCommunicationsToolkit.pdf

Oregon Health Authority

Hazy, smoky air: Do you know what to do?
https://apps.state.or.us/Forms/Served/le8622.pdf

Oregon School Activities Association

Recommendations for Outdoor Sporting Events Based on Air Quality and Visibility
http://www.osaa.org/docs/health-safety/AirQualityIndexMemo.pdf

US Centers for Disease Control and Prevention

https://www.cdc.gov/features/wildfires/index.html

US Environmental Protection Agency

Wildfire Smoke: A Guide for Public Health Officials
https://www3.epa.gov/airnow/wildfire_may2016.pdf

Canada

British Columbia Centre for Disease Control

"Guidance for BC Public Health Decision Makers During Wildfire Smoke Events."
http://www.bccdc.ca/resource-gallery/Documents/Guidelines%20and%20Forms/Guidelines%20and%20Manuals/Health-Environment/WFSG_BC_guidance_2014_09_03trs.pdf

Yukon Health and Social Services

Yukon Wildfire Smoke Response Guidelines for Protecting Public Health. **Report includes a guide on creating a "clean air shelter" in your community**
http://www.hss.gov.yk.ca/pdf/wildfiresmokeresponseguidelines.pdf

Cleaner Air Shelter at Home (checklist and description)
http://www.hss.gov.yk.ca/pdf/createacleanerairshelter.pdf

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