Public Health Planning for Wildfire Smoke

A multi-jurisdictional qualitative inquiry into current public health planning for wildfire smoke events; the capacity to respond and perceptions of wildfire smoke as a public health priority.

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Contents

Executive Summary

Population level wildfire smoke exposure is complex. It is difficult to measure and prevent. Reducing the adverse physical and mental health effects related to smoke exposure requires insight into social, economic, political and health-related factors within communities. In an attempt to understand some of the challenges of planning for wildfire smoke events, this report outlines the findings from a series of 22 interviews with public health practitioners and collaborators with varying experience responding to such events. It includes a diversity of perspectives from four Canadian provinces, one territory, and two U.S. States.

In regions such as British Columbia, the Northwest Territories, Alberta, Oregon, and California repeated wildfire smoke events have brought about collaborative planning and knowledge sharing opportunities that have begun to build trust among various, sometimes non-traditional partners. Planning in these regions has included:

- assessments of community infrastructure that might be suitable for clean air spaces;
- modifications to healthcare facilities' heating, ventilation and air conditioning (HVAC) systems;
- acquisition, distribution and deployment of residential and commercial air scrubbers;
- the development of innovative communication strategies; and
- early exploration of strategies to support community resilience.

The consensus among public health practitioners who participated in this project is that wildfires pose a significant threat to public health and safety and are expected to continue or worsen under climate change. Despite high levels of awareness and concern, planning for interventions that would reduce population level exposure to wildfire smoke is still in the very early stages of development in most jurisdictions and not well funded, if at all.

Introduction

This project is an extension of the *Public Health Responses to Wildfire Smoke Events Report* published in 2018.[1] The first report focused on past experiences of wildfire smoke events in four Canadian jurisdictions, highlighting novel and promising public health practices. This extension of the 2018 project is focused on current public health planning for future events. It explores the roles of public health agencies and their collaborators in planning for extreme air quality events due to wildfires and the capacity requirements that they are beginning to identify through their experiences.

A record 1.2 million hectares of land burned in British Columbia in 2017,[2] resulting in the evacuation of 65 000 people and the declaration of a provincial state of emergency.[3] The 2018 wildfire season saw nearly 2.3 million hectares of land burned across Canada[4] with over 1.3 million hectares burned in British Columbia, surpassing the previous record in 2017. This prompted a three-week state of emergency from August 15 to Sept 7,[5] with many thousands of residents under evacuation orders and alerts. California, experienced three of the State's largest recorded wildfires, which consumed 370 000 hectares of land, caused 94 deaths, and destroyed over 20 000 homes and buildings.[6]

The impacts of these horrific events are still being investigated and it will likely be many years before we fully understand their significance to the communities directly and indirectly affected.[7] While not as immediately threatening as the fire itself, smoke from wildfires can travel long distances, impacting communities thousands of kilometers away. In 2017 the Lower Fraser Valley Airshed recorded longer lasting, more intense wildfire smoke than ever before, exposing residents from Hope to Horseshoe Bay to high levels of pollutants.[8] In 2018, 2,117 fires prompted a total of 66 evacuation orders in BC[9] and kept some areas in southern and central BC under Smoky Skies Bulletins for over 40 days.[10]

Wildfire smoke contains primary pollutants, such as nitrogen oxides (NOx), carbon monoxide (CO), and volatile organic compounds (VOC) as well as secondary pollutants such as fine particulate matter ($PM_{2.5}$ and PM_{10}) and ground level ozone (O_3).[11] Current knowledge of the health impacts of wildfire smoke is largely attributed to the effects of particulate matter finer than 2.5µm, commonly referred to as $PM_{2.5}$.[12] Effects include; exacerbations of asthma and chronic obstructive pulmonary disorder (COPD), general respiratory morbidity, possible increases in respiratory infections, cardiovascular morbidity, potential increases in adverse birth outcomes, and increases in all-cause mortality.[12]

Volatile Organic Compounds produced by wildfires include formaldehyde, acetone, benzene, toluene, and furan.[13,14] Benzene and formaldehyde are known carcinogens and furan is considered a possible carcinogen.[15] Estimating population exposure to these compounds, however, is challenging as their atmospheric concentration can vary considerably depending on fuel source, geographic features, climate, weather, and distance from the fire.[16] Individual exposure can be further affected by factors such as work, lifestyle, and housing.[14]

Public health responses to wildfire smoke are managed in British Columbia by regional medical health officers (MHO) if they are localized and possibly the Provincial Health Officer (PHO) if they are more widespread and affect several jurisdictions. The MHO or PHO can request support from the Wildfire Smoke Response Coordination Group (WSRCG) to assess the risk of exposure and recommend health interventions during an event.[17] The WSRCG includes representatives from the Ministry of Health, BC Centre for Disease Control, regional health authorities, BC Emergency Health Services, First Nations Health Authority, Ministry of Environment, Emergency Management BC, and the Public Health Agency of Canada. During a wildfire smoke event, the broader public health system may need to be included in a co-ordinated response. In BC this could include four key categories of public health professionals; **consultants and specialist** (epidemiologists, technical experts, nurse practitioners, environmental health scientists, and evaluators), **frontline providers** (public health nurses, public health/environmental health officers, and health promoters), **managers and supervisors** (public health administrators and population health directors), and **medical health officers.**[18] Public health practitioners from across these categories have been included in this project to reflect the diversity of public health experiences, skills, and perspectives required to address an issue as complex as exposure to wildfire smoke. To fully appreciate the scope and complexity of a cross-sectoral response, public health collaborators such as First Nations, municipalities, housing providers, the Ministry of Education, local recreation commissions, and social service providers, among others, would need to be included in an assessment of planning and preparedness. Such an assessment is beyond the scope of this review and findings from the interviews included in this exploratory inquiry represent only a small cross section of those involved.

Methodology

A purposive sample of participants were invited to take part in this study based on their role in planning for wildfire smoke events and the jurisdiction they work in. The initial *Public Health Responses to Wildfire Smoke Events Report* focused on jurisdictions that reflected a diversity of ecozones, healthcare delivery models, and historical wildfire events within Canada.

As the focus of this extension is to better understand planning and capacity requirements to respond to future events, we sought to also include the experiences of jurisdictions outside Canada that had extensive experience with wildfire responses, such as Oregon and California; their experiences are similar to those expected for Western Canada under climate change. Though the health systems of Canada and the United States have many differences, much of the public health knowledge and expertise required to effectively respond to wildfire smoke events is relevant to both. Three additional Canadian provinces were included in this extension project and three regional health authorities in British Columbia that were not included in the first project are represented here. Figure 1 illustrates the distribution of jurisdictions included in both projects and Table 1 describes the roles and locations of participants in this extension project.

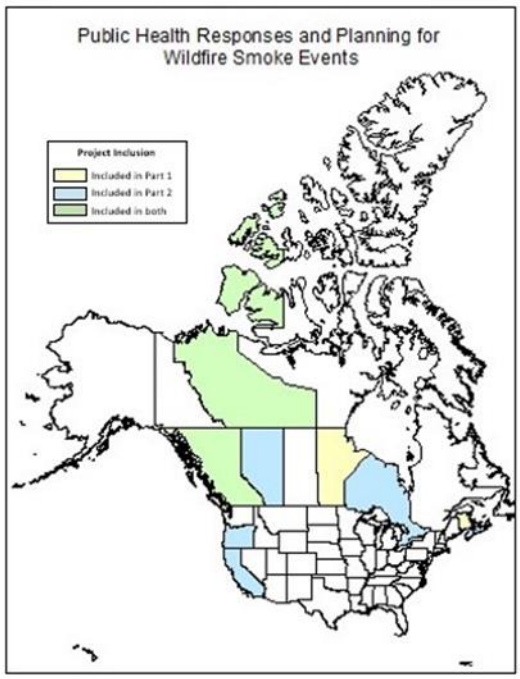

Figure 1: Jurisdictions included in Part 1 and Part 2 of the Public Health Planning and Responses to Wildfire Smoke projects

This sample is not intended to be representative of the entire Canadian public health system, that of the United States, or of any province, territory or state. It is an intentional sample with geographical, ecological, and positional variation of participants. Reported activities were not verified or documented in any way other than participants' accounts.

Twenty-two semi-structured interviews were conducted between December 2018 and April 2019. Participants represent many of the same roles as were included in the first project; medical health officers, emergency and health emergency managers and environmental health officers, as they are the key players in responding to and planning for wildfire and smoke events. Recently created roles that focus on public health planning for climate change were also included in this extension project. Increases in the frequency and severity of wildfire events are considered by most health authorities to be related to the effects of climate change and so planning for such events is likely to be considered part of these new roles. Technical advisors in air quality and environmental health were included as they are often integral to communication planning and work closely with public health agencies during wildfire smoke events.

Transcribed interviews were analysed using open coding to generate salient themes and recurrent practices. Thematic content analysis was then conducted using NVivo12 to identify the most relevant

experiences in public health planning and describe the current state of knowledge among practitioners across sectors and jurisdictions.

Select quotes are included in this report that are representative of thoughts and opinions shared by several participants. Quotes are not attributed to individual speakers in order to maintain the confidentiality of their responses, though participants' roles are identified in order to contextualize their comments.

	British Columbia	Alberta	Northwest Territories	Nova Scotia	Oregon	California	Ontario	**Total**
Medical Health Officers	7	0	0	0	0	1	1	**9**
Emergency Managers/Health Emergency Managers/ Environmental Health Officers	3	2	1	1	0	0	1	**8**
Technical advisors Air quality/Climate change/ Environmental health	4	0	0	0	1	0	0	**5**
Total	**14**	**2**	**1**	**1**	**1**	**1**	**2**	**22**

Table 1: Roles and Jurisdictions of Participants in the Public Health Planning for Wildfire Smoke project

Findings

The following sections discuss 15 themes that emerged recurrently throughout the 22 interviews. The summaries that follow are based solely on participant responses during interviews.

Changing perceptions

Respondents from the western regions of Canada, Oregon and California, all reported that wildfires, such as the ones in 2017 and 2018, are expected to be the new normal and no longer considered one off or unusual events. Respondents referred to 'advisory season' and 'wildfire season' in anticipation of fire and smoke events. The last four years were seen as turning points in people's understanding of the threat caused by wildfires and wildfire smoke.

Though smoke from wildfires was not considered to be as high a priority as preparing for immediate threats from the fires themselves, several respondents reported hearing an increased interest and level of concern from communities about the health effects of wildfire smoke. Most also acknowledged the need for long term planning to better respond to smoke events; however, planning is still in the early stages in most jurisdictions. There was a consensus among respondents that advanced planning and preparedness were necessary as reactionary responses during an event were not very effective.

Those who had been affected numerous times recognized the need to go beyond advisories and communication strategies to investigating and implementing interventions, though these efforts are in the early stages of development.

Respondents from jurisdictions that had not been directly affected by wildfires reported an increased awareness about the potential risk of wildfire and wildfire smoke among the agencies and communities they work with. Learning about the experiences of communities that have been affected by fires year after year has brought the issue to the attention of planners who may not have experienced or had to respond to one themselves. Media coverage of the events of 2017 and 2018 also brought increased attention to the issue, even in jurisdictions that were not directly affected.

"Before 2017, basically, you spend a few hours on it a year type of thing. So, it was off the side of your desk a little bit and now it's becoming a much bigger piece"

Health Emergency Manager

"We're going to see warmer and drier summers. We'll have more and more wildfires. So, this is the way we should be looking at managing ourselves in the future to deal with it"

Health Emergency Manager

"I think now folks are saying the extent and scale of these events is such that we can't just be ready to respond, we have to be prepared and essentially be proactive in how we're dealing with these things"

Environmental Health Officer

"I think the current realization, given the experiences that we continue to have, is that this is not something that is going to happen once in 20 years or something, so planning has started."

Medical Health Officer

Smoke events affecting larger urban areas raised broader public awareness and garnered the attention of decision makers who may not have been personally affected before. Public perceptions of the risks associated with exposure to wildfire smoke were reported to vary considerably though, both in rural and urban communities.

Several jurisdictions affected directly by fires reported that the recovery phase had been and continued to be longer than had been expected. Economic impacts such as loss of employment were affecting communities and the mental health impacts were greater than most had anticipated. Because the social, economic and health impacts might be quite different in every community, a one size fits all approach to planning was not considered very effective.

Climate change

Climate change was recognized by all respondents as an important public health issue, though organizational approaches to address it varied widely. While some jurisdictions have dedicated climate change specialists, some of whom were intentionally included in this project, others are unsure of how to integrate or adequately resource climate change adaptation planning.

> "I think we are struggling with defining a clear role for public health in the topic area of climate change" Medical Health Officer

Respondents noticed that events such as floods and wildfires, melting ice roads, food insecurity, and changing disease vector distributions have created increased interest from communities in addressing the health impacts of climate change. Those responding to media inquiries during the 2018 wildfire season in British Columbia and Alberta reported that most inquires asked about the connection between climate change and wildfires. Those professionals responding to such inquiries whose role was not directly associated with or defined as being related to climate change were extremely reluctant to answer them. Climate change was considered too complex, politically sensitive, and outside the scope of

their role for them to be able to answer such questions. Several respondents struggled with how to adequately respond to inquiries regarding climate change without losing sight of the immediate risks posed by wildfire smoke. They reported hearing media reports and community members conflating broader climate change mitigation strategies, such as reducing carbon emissions by driving less, with health protective adaptations during a wildfire event, such as creating an in-home clean air space.

Systems thinking

A consensus emerged, particularly among emergency managers, that immediate responses to wildfires need to be part of an all hazards approach to emergency management planning. An all hazards approach recognizes and integrates planning elements common to all hazard types and makes provisions for specific hazards only if required.[19]

Wildfire smoke events that do not immediately threaten life, infrastructure or property, do not fall under emergency management mandates. Such events were recognized by respondents as requiring a cross sectoral and collaborative approach that included various levels of government, government agencies and community engagement. Collaborative planning was perceived as an approach that could address the cascading potential effects of a wildfire such as the degradation of water supplies, worsening air quality, and contamination of local foods that may be beyond the scope of an all hazards emergency plan.

Respondents from California and Oregon referred to approaches such as "health in all policies" and all-of-government responses to emergency situations. Both Canadian and U.S. respondents spoke of two distinct and parallel processes; that of health being integrated into emergency response planning and climate change adaptation strategies and that of emergency response and climate change adaptation being integrated into health system planning. Planning for climate change adaptation was recognized as requiring holistic approaches that include all of society as well as ecologically informed perspectives.

Collaboration within the health sector

Respondents who had been involved in repeated wildfire events reported an increased level of confidence because of

"You know who to call and I think everyone was a little bit more comfortable with reaching out, knew who to reach out to, and that was strengthened which is good"

Health Emergency Manager

"As much as we suffer from the shortage of necessary resources, we do have the sense 'okay, we're all in this together' and I think the fires have broken down the silos that existed before"

Medical Health Officer

"So much of it is relationship building, and I think that maybe partners are beginning to understand the value that public health preparedness brings"

Climate Change and Health Planner

" You can't live within your silo and expect a good outcome"

Medical Health Officer

connections they had made with other agencies involved in planning and responding to events. Concerted efforts to collaborate and share information and resources have built relationships that respondents felt they could rely on for support and expert advice. While some experiences of early efforts to work with other agencies had not always gone smoothly at first, the experience of working together had built trust and understanding.

Wildfire smoke working groups have been developed in several jurisdictions both regionally and provincially/territorially. These groups include a diversity of cross-sectoral members including; medical health officers, emergency managers, nurses, environmental health officers, health scientists, air quality specialists, representatives from the oil, gas and resources sectors, ministries of environment, energy and mines, as well as local and municipal governments. There was consensus among respondents that these working groups were extremely effective for sharing resources, developing consistent messaging and accessing the information necessary to make decisions at a regional and local level. They encouraged collaboration and created connection points that could be leveraged during an emergency event.

Respondents recognized that there were still improvements needed in communication, both with the public as well as within and across health systems. Consistent messaging to the public was identified by many respondents as an area of ongoing development and improvement. The dissemination of information to physicians, pharmacists, residential care settings, and other healthcare providers was inconsistent across jurisdictions with some having an established protocol in place and others using ad hoc and informal distribution channels.

Collaboration across sectors

Emergency management and disaster response planning requires coordination and collaboration across sectors, levels of government, as well as with voluntary and professional agencies. In nine provinces and all three territories, local authorities such as municipalities, First Nations, and regional districts are responsible for having an emergency management plan; however, the scope and specificity of such plans vary widely.[20] When threatened directly by a wildfire, local authorities can coordinate with provincial/territorial and possibly federal agencies to respond; protecting life, property and vital infrastructure. The appropriate response to and responsibility for an extreme smoke event that does not immediately threaten life or property, is not as clear.

Respondents reported that public health planning would likely be a new and foreign concept to most local and municipal planners. In their experience, local emergency planners had not made the connection between environmental hazards and health. Community and municipal planners were most often connected to regional or provincial emergency management agencies, but not directly connected to health or public health agencies. Long term planning was also not a common feature at local or regional levels.

Planning for wildfire events at the local level most often consisted of mitigation strategies such as Firesmart programs,[21] where communities were in close proximity to forested areas. Longer term community planning is generally more focused on land use and incorporating health was a relatively new idea in most jurisdictions. Land use planning based on air quality standards currently considers industrial and transportation infrastructure but has no mechanism to incorporate wildfire smoke events in planning decisions. Several jurisdictions also spoke about campfire bans that were increasingly prevalent in local, state, and provincial parks. There were challenges with enforcement, however, in more rural jurisdictions where people often camped outside of official parks and campsites and continued to have open fires despite campfire bans.

Several jurisdictions have initiatives that promote healthy built environments by increasing awareness of environmental health hazards, and convening local partners to plan for and respond to community-based health concerns.[22-24] Respondents reported working collaboratively with community-based organizations such as airshed councils,[25,26] school boards and municipal governments to incorporate health concerns into planning. Working with community organizations helped respondents learn how to create more effective communication strategies regarding wildfire smoke.

Working directly with municipalities and housing corporations was reported at various stages of development. Several respondents reported positive interactions with local governments and social housing providers who had shown an interest in how to create healthier indoor environments during wildfire smoke events; however, none had yet reached the stage of formal implementation. The development of resources such as the National Research Councils' Housing Research Summaries[27] were seen as helpful for communicating across sectors with urban planners and housing providers. The need to communicate with partners and collaborators outside the health sector was seen by respondents as extremely important for the implementation of strategies to prevent exposure to wildfire smoke.

Municipalities have been reluctant in some jurisdictions to take on the responsibility of providing cleaner air spaces as they do not feel they have the funding to do so. Information from public health officials on the importance of creating accessible community clean air spaces was met with resistance when funding sources for such initiatives were not clear or assumed to come from smaller municipal governments. Larger municipalities were better prepared to work with public health departments and are piloting municipally sanctioned clean air spaces.[28]

"Unless someone comes with money and wants to invest something, they have no interest in ideas, in ideas without money."

Medical Health Officer

Collaborating with local governments and social housing developers has been a challenge for many respondents. Evidence for the effectiveness of interventions such as specialized HVAC systems that can effectively filter $PM_{2.5}$ particles and building envelope modifications are not yet available, making it difficult to make the case for their installation.

"The research evidence is often in the health world, but the building world is very different. They rely on different evidence and I don't think we have that evidence to provide them."

Environmental Health Specialist

Mental health

The mental health impacts associated with wildfire and smoke events were an important consideration for almost all respondents. Public health and community-based clinical practitioners reported being surprised by the scale and volume of the negative mental health impacts; seeing increases in emergency calls from seniors suffering from severe anxiety and community resources being overwhelmed by demand for their services.

Several respondents recognized that mood and anxiety disorders already represent a significant challenge for public health and the healthcare sector more broadly. Respondents reported a lack of preparation among community agencies and physicians to respond to the sometimes overwhelming demand and also recognized that service providers were often also community members who may have themselves been struggling to cope with the impacts of a wildfire event on themselves and their families.

Though evidence regarding the mental health impacts of wildfires and wildfire smoke is increasing in the literature, community debrief sessions and direct community responses have made the need for immediate and ongoing mental health supports apparent. In addition to psychological first aid,[29], which is available to communities during emergencies in several jurisdictions, community wellness managers have been funded to support communities following significant wildfire events in British Columbia. Their role is to build resilience by facilitating dialogue and the development of self management skills as well as connecting community members to existing resources.

Social infrastructure and resilience

Building community resilience was recognized by respondents as an important part of planning for future wildfire events, particularly by communities that had been repeatedly affected. Incorporating mental health supports into the early stages of a response was seen as an important part of supporting

community resilience and more effective than only considering mental health as part of the recovery phase.

The importance of a strong and supportive social infrastructure was raised by several respondents. One jurisdiction is working on developing a network of community champions who would act as points of contact during an emergency. Champions are those who have a good understanding of their community, particularly those at greater risk during a severe smoke or fire event.

Those working directly with Indigenous communities commented on the strong connections within communities and how effective those connections were for mobilizing a rapid and equitable response. Some Indigenous communities were adopting a resiliency focused approach to emergency management planning as opposed to a more traditional, highly structured incident command model.

Indigenous communities

Respondents reported that many of the Indigenous communities they had worked with identified the need to prepare for wildfire events. Planning included mitigating fire hazards close to community infrastructure, developing emergency response plans, and debriefing following events.

Planners working with Indigenous communities were looking for ways to incorporate traditional ecological knowledge into wildfire prevention and mitigation, recognizing that Indigenous community members held profound knowledge of the ecosystems they were a part of.

Respondents recognized the mental health implications for Indigenous evacuees, and the need for cultural safety training in communities receiving evacuees. They also recognized the importance of culturally significant land and water resources and the impacts on communities when they lost access to them because of wildfires.

"People that you would consider to be your tough guys, macho, first responder, fire fighter; man are they ever on board with making sure that when they experience a terrible event, they have debriefs. They make sure that everybody goes home feeling a heck of a lot better than when they left that terrible scene."

Community Wellness Manager

" We know that those fires are not just impacting those we serve but also our own providers "

Medical Health Officer

"It was impressive, [Indigenous communities] response during the 2017 wildfires. But what was really impressive is they all had a debrief afterwards; 'how can we improve this?' So, when 2018 rolled around, way better prepared, on top of what I already thought was an impressive response compared to other communities"

Community Wellness Manager

"I think it comes down to experience, and our [Indigenous] community members, they know their community"

Emergency Manager

Data

A challenge raised by many respondents was that of making planning decisions with little published evidence on the health effects of wildfire smoke or the effectiveness of emerging interventions. Because public health strives to be an evidence-informed practice, many practitioners were struggling with justifying interventions such as clean air spaces without an evidence base to support them. Most respondents felt that even if interventions such as modifying HVAC systems and installing air scrubbers to improve indoor air quality did not have an established body of evidence to support them, taking such actions were preferable to taking no action at all; they are 'better than nothing'.

"So that's an important thing to overcome, is how to make very rapid decisions in the absence of a full dataset"

Medical Health Officer

Several jurisdictions are beginning to gather health data more systematically during smoke events, both to better understand the health impacts of wildfire smoke and to inform planning in their jurisdiction. Some are using established public health surveillance systems that were originally intended to monitor outbreaks of infectious diseases that can be queried to find increases in respiratory and cardiovascular events. Feedback systems are being developed that can use surveillance data to provide healthcare providers and community members with real time alerts during a smoke event.

" So, it's not actually an easy thing to do, just in terms of accessibility, access to data, what type of data we have, and making those linkages. But we're certainly putting more attention on the surveillance aspect, so we can understand the health impacts of the poor air quality"

Medical Health Officer

The collection of more air quality data was identified as important for correlating health system data and health outcomes to concentrations of pollutants. Some respondents cautioned against an overreliance on monitoring data in decision making, however, as it is not yet well understood how particulate concentrations correlate with health outcomes; particularly for relatively short exposures. The lack of longitudinal data for people exposed repeatedly to wildfire smoke was also identified as a challenge when advocating for community clean air spaces and improved building standards.

Health Canada's Air Quality Health Index (AQHI) was developed by the federal government as a tool to provide air quality and health information in such a way that the public and

government agencies could understand air quality risks and implement protective behaviours.[30] The index was developed primarily for urban environments where O_3 and NO_x concentrations are of primary concern but is not seen as ideal for use during a wildfire event when $PM_{2.5}$ concentrations are seen as the most significant pollutant. Alert systems are being developed based on real time monitoring data and include health indexes that adapt to exceedances of single pollutants, such as $PM_{2.5.}$

Respondents saw the systematic collection of real time health and air quality data and the creation of alert and feedback systems as important to inform planning. Current planning in most jurisdictions is based on historical data and patchy evidence of health outcomes, which respondents found challenging to work with as a basis for decision making. Collecting and analysing data on the mental health impacts of wildfires and wildfire smoke was seen by many as an important and particularly difficult challenge.

Occupational health

Protection of workers in camps, particularly in northern regions, was raised as a challenging issue. While employees of camps such as cooks and administrators are often covered by occupational health and safety regulations, contracted and temporary workers usually are not. Workers tended to work outside for extended periods of time, often during the height of the wildfire season and could be exposed to significant amounts of wildfire smoke. Jurisdictions with a significant number of work camps are working collaboratively with the resource development sector to track and identify where camps are located in case they need to be notified of a developing emergency and to plan for the protection of workers.

Capacity

Respondents reported a growing recognition that health authorities will require capacity to manage wildfire events and climate change related issues. Jurisdictions that had not been affected by repeated smoke events recognized that they did not have a lot of capacity to respond to one, nor a depth of knowledge about the health effects of wildfire smoke. Very few jurisdictions reported having designated positions or resources for climate change related work. Most were seeking federal funding for project-

based initiatives or integrating climate change adaptation into existing positions. Regional health authorities currently have very little capacity to generate, access, and synthesize evidence or create tools and resources required to respond to wildfire smoke.

Respondents noticed communities becoming concerned about the health impacts of smoke when it was present; putting increased pressure on public health departments to respond during these events. Environmental Health Officers were often the only available resource to communities. However, they did not always have the capacity to respond given an already heavy workload. Environmental health is not seen to have a very high profile in most health authorities and is not thought to be well understood by other departments.

The role of public health during an emergency response was still unclear to most respondents. Most saw the role of public health in planning; acting as conveners, facilitators of dialogue, bringing a health perspective to emergency management, as well as raising equity and mental health issues. During an emergency, most agreed that public health was best suited to play a supportive role within emergency management structures, providing psychological first aid, monitoring food and water safety issues at evacuee centres, and providing air and water quality information when requested and assessing health and safety concerns when rescinding evacuation orders.

"Partnerships can take you a long way. When you lack the people power, there's still a lot that can be done in partnership with other agencies and community-based organizations"

Climate Change and Health Planner

"Pretty much all of us in the region have a pretty equal chance of receiving a certain exposure, but the thing which is not at all equal is the ability to then cope with that exposure"

Air Quality Specialist

"When you're telling people that the situation is that the smoke is very harmful to your health and they should be going to these cleaner air shelters, it is less than declaring a state of emergency, but it is an emergency because you're trying to do extraordinary steps to protect the public health"

Emergency Manager

Interventions

Assessments

Planning for wildfire smoke events was considered by most to be part of climate change adaptation planning, which is in the early stages in most of the regions included in this project. Vulnerability assessments were seen as an important first step in effective planning. Guidance on the implementation of such assessment has been developed in some regions such as Ontario[27] and California.[28]

Different approaches suggested for assessment included: integrating health into community wildfire risk assessments; state, provincial and regional social and health vulnerability

assessments; stress testing community infrastructure; and asset mapping to understand how existing community resources might be utilized during an emergency or a smoke event. A few jurisdictions had begun the process of mapping community infrastructure and assessing its suitability to function as a clean air space.

Communication

Effective communication during a wildfire smoke event was considered an important public health role for all respondents. Those who had experienced several events recognized the need to have communication materials ready in advance of an event. Effective communications were those that were simple, easy to understand, and suggested actions people could take to protect themselves.

Traditionally air quality advisories were based on industrial and urban emissions such as O_3. Such advisories are generally short-lived and highly localized. Wildfire smoke presents distinct challenges when issuing air quality advisories as it can cover large areas, linger for long periods of time, and vary in intensity over time.

Respondents observed people becoming overwhelmed and distressed by long periods of smoke exposure; community members also became desensitized to advisory messages. Though public health departments did not report receiving many calls directly from the public about wildfire smoke, communications from health authorities were seen as trusted sources of information. Community leaders often preferred having communications that came directly from health authorities for this reason.

Media outlets, particularly television, were seen as effective ways to reach large numbers of people with advisories. There were times when media messages were not aligned with official air quality advisories however, creating some confusion. Because television weather forecasters do not have the same responsibility as health and environmental departments for the health and well being of communities, they were not always as cautious in their messaging. Respondents reported using a variety of

communication strategies including social media, newspaper, notices at bus and LRT stations, health clinics, and even sandwich boards on the street.

Clean air spaces

Jurisdictions that had some experience with the promotion and implementation of publicly accessible clean air spaces had moved away from referring to them as 'clean air shelters'. They found the word 'shelter' had negative connotations for many people who felt it inferred a place for those with high health and social service needs.

Creating clean air spaces was seen as the most effective intervention to reduce population level exposure to wildfire smoke. Clean air spaces took three basic forms; in home clean air spaces, community clean air spaces, and clean air environments at health facilities. Respondents from different jurisdictions had been involved in planning and implementing all three.

Providing clean air in healthcare facilities benefits both patients and employees and is within the purview of health authorities to implement. Jurisdictions with extensive wildfire smoke experience tried two different approaches: adapting existing HVAC systems and bringing in portable air scrubbers. Adapting an HVAC system required frequent replacement of air filters with MERV ratings between 12 and 14 and careful monitoring of the system's static pressure. It was seen to be inexpensive and highly effective, with staff reporting that they felt more comfortable at work. When facilities were quite old, this was not seen as a viable option and portable, industrial air scrubbers were brought in to clean the air.

"Very, very rarely are we evacuating the hospital or a health centre. It's more likely that we're inundated with smoke and we're looking at cleaner air shelter kind of scenario. So if we went around and evaluated every community and said 'this is the best location to put it, and here's what's required to do it' and then we chase down the funding to actually make the changes, we'd be so much further ahead"

Emergency Manager

In home clean air spaces were seen as the most practical and appealing option by most people. Most jurisdictions did not supply domestic air scrubbers directly to the public but did provide guidance on their use. True HEPA filters were recommended for domestic use, though respondents did recognize that they may not be affordable for all community members. One jurisdiction provided instructions on how to construct an air scrubber using a box fan and standard air filter with a MERV rating of 13 or more, which was much more affordable and accessible to low income households. Though it was not likely as

effective as a true HEPA filter, during an extreme smoke event, it was considered to be better than nothing at all. One jurisdiction did supply vulnerable community members with domestic HEPA filters and is now considering how to track and maintain those units.

The development of community clean air spaces is at various stages in different jurisdictions. Some have begun the process of assessing community infrastructure to identify appropriate sites. Schools were identified by many communities as the most appropriate building as they are generally equipped with emergency power supplies and large communal spaces. Some communities identified a community structure, often a school, as a site that could serve in *many* emergency scenarios. Schools usually have multiple doors allowing for the isolation of a single room or space that would not be inundated with smoke each time a door is opened. Many schools, particularly in the north, however, do not have air conditioning, which could be problematic during a hot, dry wildfire episode.

To date, implementing a community clean air space has only been done with portable air scrubbers in the jurisdictions included in this study. Some jurisdictions had purchased several portable units that could be deployed to communities as needed. The perception was that they provided some improvement in air quality, though no indoor air quality monitoring has been done to date.

Though there is some interest in larger, urban communities to develop accessible community clean air spaces, attempts thus far have been ad hoc, uncoordinated and largely independent of health authorities. Attempts to engage local governments in small, rural communities to develop such spaces have met with some resistance, with local governments reluctant to take responsibility or pay for them. Though there seems to be agreement that community clean air spaces could serve an important function in protecting people's health during a wildfire smoke event, there remains disagreement about who should fund them.

The City of Vancouver's Climate Emergency Response, released in April 2019, includes a plan to pilot up to five clean air rooms within existing public cooling centres using portable HEPA filters.[28] The pilot sites will operate during poor air quality events and be evaluated for their level of use, challenges, and lessons learned during their implementation.

Masks

Several respondents identified the need for additional guidance on the use of N-95 masks during a smoke event. To date, public health agencies have generally advised against the use of masks because of the risk of wearing an ill-fitting mask that would not offer the protection it was believed to. Public health practitioners are finding it increasingly difficult not to address the topic further, however, when communities are affected by wildfire smoke for long periods of time and advice to stay inside to avoid exposure becomes impractical or is not providing any significant level of protection.

Discussion

The consensus among public health practitioners who participated in this project is that wildfires pose a significant threat to public health and safety and are expected to continue or worsen under climate change. Awareness among public health practitioners of the health impacts of wildfire smoke is very high in regions that have experienced repeated severe wildfire events. This understanding is also increasing rapidly among practitioners in areas that have not been directly or severely impacted by a wildfire as well as among the general public. Despite high levels of awareness and concern, planning for interventions that would reduce population level exposure to wildfire smoke is still in the very early stages of development in most jurisdictions and is not well funded, if at all.

Until recently, public health agencies and their partners have relied almost entirely on communication strategies to alert the public to the hazards of wildfire smoke. In regions that have been repeatedly impacted it is becoming increasingly apparent that providing highly generalized health messaging such as avoiding exertion outdoors and staying inside, is not enough. When communities are exposed to prolonged periods of poor air quality due to wildfires, practitioners identified the need to provide the public with practical, actionable advice that allows people to continue with their regular daily activities as much as possible. Guidance on the creation of residential and public clean air spaces, the use of N95 masks, personal planning and preparedness in advance of an event were identified as the most immediate and practical interventions that require further development by public health departments and agencies.

Local and municipal governments were identified as important collaborators in emergency response planning, though there is still little agreement on how to work together and distribute the costs of developing public clean air spaces in most jurisdictions. Guidance on the assessment, modification, and use of public buildings as clean air spaces has not yet been developed and may help to facilitate their planning and implementation. Such guidance would need to be developed collaboratively with partners such as municipalities, businesses, builders, housing agencies, school boards and recreation commissions in order to understand the contributions they could bring and the limitations they may face in developing such infrastructure.

The mental health impacts of prolonged and repeated wildfire smoke exposure remain poorly understood and are of very high concern to many practitioners, particularly those who have experienced several events and seen their effects on community mental wellness. Community level mental health supports were seen as fragmented, inconsistent, and not well prepared for an increase in demand for their services. Though mental health supports are increasingly integrated into emergency response planning, practitioners recognized that such supports were required for longer and by more people than first anticipated. Working with communities to build resilient social infrastructure and personal mental wellness strategies was identified as important as well as professional clinical educational opportunities.

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