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RESEARCH ARTICLE

Mental health during wildfires in Southcentral Alaska: An assessment of community-derived mental health categories, interventions, and implementation considerations

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Data Availability Statement: The dataset used in this study is comprised of transcripts of interviews and focus groups that may contain potentially identifying or sensitive information about participants. A limited dataset may be available with a request to the Johns Hopkins Bloomberg School of Public Health (jhsph.irboffice@jhu.edu) and University of Alaska Anchorage (uaa_irb_coord@alaska.edu) Institutional Review Boards.

Abstract

Previous studies have linked wildfires to a range of adverse mental health outcomes, but there has been limited research on the mental health impacts of wildfire in Alaska, an area undergoing rapid environmental change. We used a multi-level qualitative approach to identify mental health and psychosocial problems, coping, existing support, and gaps in support among communities who were affected by the Swan Lake and McKinley fires in Alaska in 2019. We recruited 39 community members from Anchorage and the Kenai Peninsula to participate in free list interviews, a community ranking workshop, and in-depth interviews, and we recruited 12 professional key informants including wildland firefighters, mental health providers, community advocates, policy makers, and public health professionals to participate in in-depth interviews and a discussion-based workshop. There were several locally-defined categories of mental health issues identified in relation to wildfires in south-central Alaska in 2019. Key informants who work in the region identified a package of communications-related interventions as being the most impactful and actionable support for wildfire-related mental health concerns. Additional highly rated mental health supports centered around leadership acknowledging the connection between wildfire and mental health, connecting community members to formal or informal systems of mental health care, enhancing the emergency shelter system, and providing crises debriefing during wildfire evacuations. The results of this study can be utilized to facilitate implementation of prevention and response activities to support mental health resilience during wildfires in Alaska and other wildfire-affected regions.

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Introduction

Acute climate change related hazards, such as wildfires, are increasing in frequency and intensity [1,2] and have been linked to a range of adverse physical and mental health outcomes [3–6]. Wildfires in particular have been associated with psychological distress, elevated levels of mental health symptoms, and increased rates of post-traumatic stress disorder, depression, and anxiety [3]. Grief, mourning, and distress have also been reported in relation to the destruction caused by wildfires to places and landscapes [3]. Some of these adverse impacts on mental health and well-being in the aftermath of wildfires are enduring, with reports of impacts 10 and 20 years after the event [3,7,8]. In-depth case studies of people's experiences during and after wildfire events and evacuations provide rich detail regarding the breadth of factors contributing to mental distress as well as coping strategies people have employed. For example, in Northwest Territories, Canada, a prolonged and intense wildfire season contributed to feelings of isolation, decreases in physical activity and time spent outdoors, and negative impacts on emotional well-being and food security due to fewer opportunities to participate in traditional harvesting activities [9]. Evacuation from wildfire-affected regions can compound these issues by adding additional logistical challenges of providing temporary housing and healthcare for displaced populations. Indigenous Elders in rural Ontario, Canada have described language and cultural barriers negatively affecting their experience during evacuations [9,10]. After returning from wildfire evacuations, residents report additional stressors such as having to throw out freezers full of wild and store-bought meat that spoiled during a power outage or concern about costs incurred for clothing and food during evacuations [11]. Several studies have also identified mechanisms that people have used to cope with these traumatic wildfire events such as connecting with others through shared experiences [12], community initiatives to create indoor opportunities to socialize and do physical activity [9], strong social support for particularly vulnerable residents such as Elders [10], and advocacy for improved planning and preparedness activities that incorporate community members [9].

Many of these experiences in the Canadian Arctic are relevant in Alaska, where rapid environmental change has contributed to an intensifying trend in wildfires over the past several decades. The Alaskan wildfire season is getting longer due to a shortened snow season and increasing summer temperatures [13]. In addition, the frequency of large wildfires is increasing [14–16]. In Southcentral Alaska, spruce bark beetles have contributed to hundreds of thousands of acres of dead and downed spruce trees, which contribute to hazardous fire conditions in highly populated areas of the state [13,17,18]. Alaskan fire agencies have noted that underground fires smoldering in the duff layer of the soil, just below the vegetated surface, are more likely to resurface following large fire years, contributing to reburning of previously fire-affected areas [13].

In 2019, a prolonged drought and high winds contributed to extreme fire activity in Southcentral Alaska [19]. On the Kenai Peninsula, the Swan Lake Fire was triggered by a lightning strike on 5 June 2019 and grew to over 167,000 acres in the next four months under extreme summer conditions [20]. Although the fire began inside the Kenai National Wildlife Refuge, it eventually spread to the highway, forcing road closures and evacuation warnings for nearby communities [21]. North of the peninsula, the McKinley Lake Fire started on 17 August 2019 due to sparks from a downed power line and drought-stricken vegetation [19]. In addition to the destruction and transportation delays caused by the wildfires, communities near the Swan Lake and McKinley fires dealt with dense smoke for much of the summer [22]. In Anchorage, an urban community situated between the two fires, the three month (June-August) average concentration of fine particulate matter (particulate matter 2.5 μm or less, or PM2.5) was 159.6 percent higher than the previous 10-year summer period [19]. Although previous studies in

Alaska have demonstrated the association between wildfire smoke and increased visits to the emergency department for cardiorespiratory complaints [23], none have examined the impact of wildfires and smoke on mental health.

The aims of this qualitative study were twofold: First, to identify and describe the mental health problems experienced by communities in southcentral Alaska related to wildfire. Second, to explore interventions to support wildfire related mental health in these communities, identify highly ranked supports based on perceived impact and actionability, and to elucidate barriers and facilitators to the implementation of those supports.

Materials and methods

Study site and population

This study used qualitative and rapid ethnographic methods to explore mental health and well-being in the context of the 2019 wildfire season in Anchorage and the Kenai Peninsula in Alaska (Fig 1). A multilevel qualitative methodology including free-list interviews, ranking workshops, in-depth interviews with pile sorts, and key-informant interviews was carried out

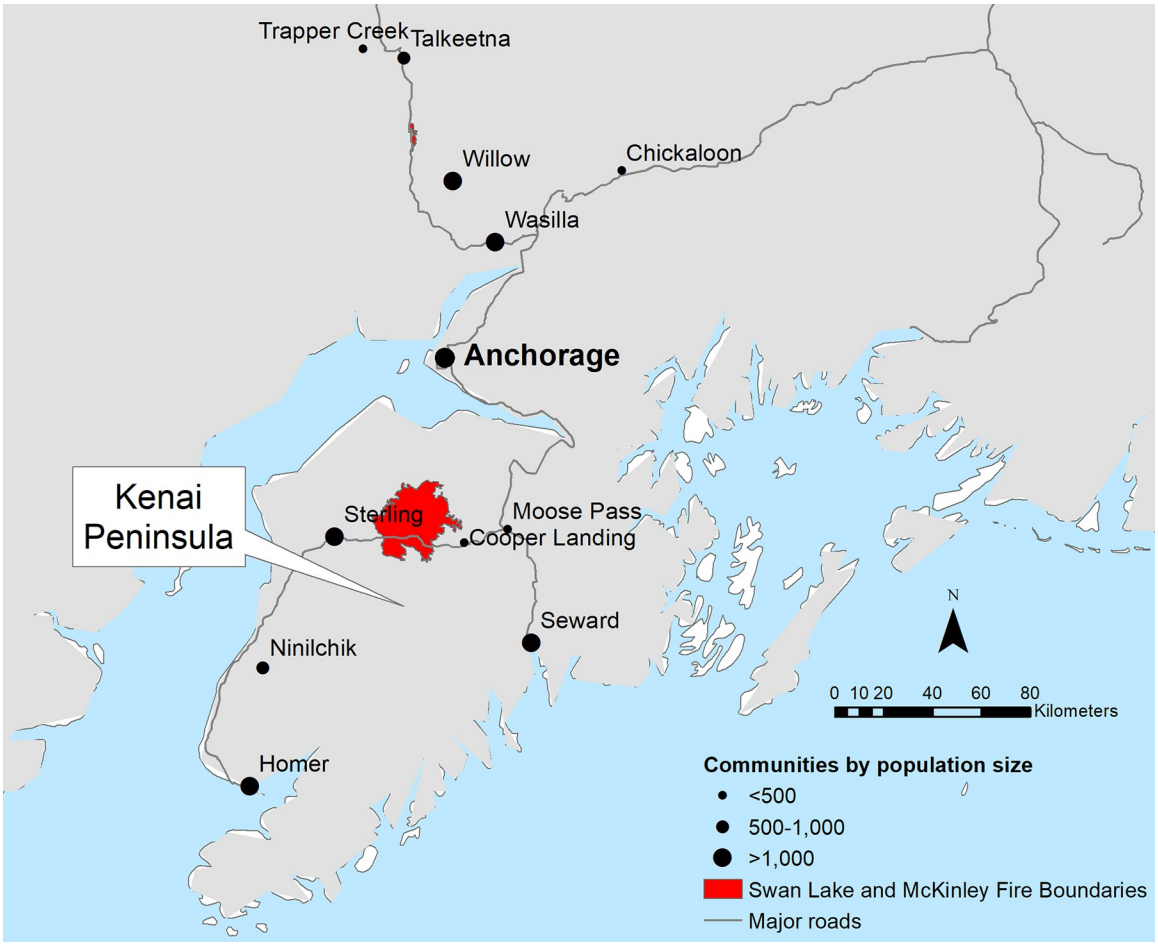

Fig 1. Map of communities in southcentral Alaska including the study regions of Anchorage and the Kenai Peninsula. Boundaries of major fires in the region in 2019 are shown in red. Base map from the Alaska Division of Community and Regional Affairs (DCRA) and is available for research purposes in the Community Database Online: https://dcra-cdo-dcced.opendata.arcgis.com/datasets/DCCED::alaska-borough-and-census-area-boundaries/explore.

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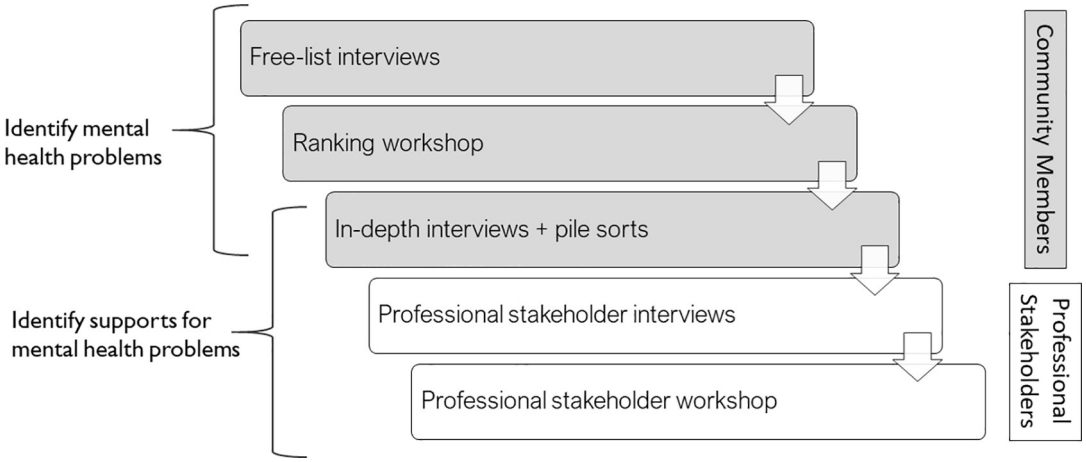

Fig 2. Multilevel qualitative methodological framework used to engage community members and professional stakeholders in conversations about the mental health impacts of wildfires and potential interventions and supports in southcentral Alaska.

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online via Zoom between August 2020 and February 2021 (Fig 2). Ethical approval was received from the University of Alaska Anchorage Institutional Review Board and the McGill Faculty of Medicine and Health Sciences Research Ethics Board. The Johns Hopkins Bloomberg School of Public Health deemed the project exempt. Verbal informed consent was obtained from all participants prior to study activities.

Purposive sampling [24] was used to identify both community members and key informants. Community members were individuals over the age of eighteen residing or working in Anchorage or along the Kenai Peninsula during the 2019 wildfire season. Key informants included wildland firefighters, mental health providers, community advocates, policy makers, and public health professionals serving these areas.

We recruited community members for free-list interviews, a community workshop, and in-depth interviews by posting our project flyer on approximately 150 Alaska-based Facebook groups. These groups included neighborhood and tribal council groups as well as community events and news groups in Anchorage and the Kenai Peninsula. We also disseminated study information through local newspapers (e.g., Senior Voice Alaska), local clubs, and the Kenai Chamber of Commerce in order to reach specific demographic groups (e.g., seniors, business owners). Key informants were recruited for provider workshops through direct email and phone invitations. We contacted approximately 175 professionals at organizations in Anchorage and the Kenai Peninsula through our initial contact list and subsequent snowball sampling. Interested community members and providers were invited to complete a recruitment survey on REDCap [25] where they selected the study activity(s) they were interested in participating in and provided basic demographic information. All data collection activities described below were conducted online via Zoom to facilitate community conversations during the COVID-19 pandemic when in-person gathering was not possible. All study team members involved in data collection were trained in qualitative data collection techniques including free-listing exercises, interviewing techniques, and focus group moderation.

Identifying wildfire related impacts to mental health and well-being

Free-list interviews. Free-list interviews [26] were conducted to obtain a list of mental health and psychosocial problems experienced by community members during and in the

aftermath of the 2019 wildfire season. During free-list interviews, participants were first asked the following question: "What are the problems of people in this area that are related to the 2019 wildfires?". Once a list of problems had been generated, a second question was asked for each problem identified to create a comprehensive list of problems and ways of coping with each problem: "What are the main ways that people in this area coped or are coping with this problem?". The average length of free-list interviews was an average of 30–45 minutes. Listed problems, their descriptions and coping mechanisms were recorded verbatim via notetaking. Each of these questions were formatted and delivered specifically to solicit lists from participants.

The entire study team participated in several analysis sessions to group and merge items and create categories through discussion. Like items were grouped under a banner item and eventually merged together (i.e. "smoke" and "air quality" were grouped and then merged into a single "air quality" problem). Subsequently problems were categorized under higher level themes. An example of such a higher-level theme included problems pertaining to thoughts, feelings, and/or behaviors (i.e. problems related to mental health and well-being).

Ranking workshop with community members. Once a consolidated list of community-defined mental health-related problems that occurred during and after the wildfires had been generated, the list was presented to community members during a subsequent ranking workshop. In addition to ranking mental health related problems, the workshop provided an opportunity to check free-list interview results with community members. Community members were asked to select 10 items from the list that they felt were the top 10 most important problems faced by Alaskans during the recent wildfire via online polling. The votes were tallied and the 10 problems that received the most votes were then displayed for all participants to see. The group of community members then collaboratively ranked the ten problems from least important to most important with the support of a facilitator whose role it was to confirm agreement of a given rank and encourage discussion in cases of disagreement. Importance was determined by community members' own opinions and definitions of importance. Notes were taken during the workshop recording the points of discussion into an electronic document by a member of the study team. Given that the data was analyzed by community members during the workshop in the form of generating a top 10 list and ranking of same, additional analysis of workshop data was limited to review of the recorded workshop notes when developing content for the subsequent study activities.

Identifying supports for mental health and well-being in the context of wildfires

In-depth community member interviews with pile sorts. In order to gain a deeper perspective on the mental health problems identified during free list interviews, in-depth interviews (IDIs) with community members who participated in the ranking workshop were designed to 1) carry out a pile sorting exercise of the mental health problems in order to merge these items into distinct categories of mental health impacts with clear conceptual boundaries and 2) begin to solicit information regarding gaps in support for mental health problems. These interviews offered a second opportunity to verify free-list interview and ranking workshop results with community members. Additionally, the problem labeled as "High stress" was also explored with community members. This problem emerged as one of the top 10 problems during the ranking workshop but given that it is often used broadly in various contexts, we wanted to learn more about its specific meaning in the context of wildfires and mental health.

IDIs lasted between 60–107 minutes with an average of 60 minutes. Participants were first asked to reflect on the ranking workshop discussion surrounding the problem of "High Stress",

as highlighted above. Participants were then provided with the list of the 17 wildfire and mental health related problems and engaged in a pile sorting exercise. During the exercise, participants were instructed to sort the problems into groups according to perceived similarities between the items, then to name those groups according to their shared property. Participants were told that they could not create one large group which included all items, nor could they create no groups. No additional conditions were imposed on the exercise. Pile sorting was done either via the online tool at OptimalWorkshop.com, or via a shared PowerPoint slide, according to the technological access of the participant (the PowerPoint slide was used in one case where the participant was unable to use the online tool). Participants were given 8 minutes to complete the exercise. Participants were then asked to talk in further detail about each of the groups they created in the exercise, including why they had grouped these items together, and were probed to identify existing and future mental health and psychosocial supports to address each of the groupings identified.

IDIs were recorded in Zoom and audio files were subsequently processed through the voice recognition and automated transcription software Otter.ai to produce transcripts. A study team member checked the Otter.ai transcripts against the audio file to ensure accuracy and removed any identifying information from the transcripts. Final transcripts were uploaded into NVivo [27] for qualitative analysis.

Pile sort data was uploaded into ANTHROPAC software [28] to create an aggregate similarity matrix. This matrix was then imported into UCINet [29] where multidimensional scaling (MDS) was used to analyze the data. The MDS technique utilizes aggregated proximity matrices to create a two-dimensional map, which groups together items based on their co-occurrence in piles across the participants. Both metric and non-metric MDS results were obtained and showed similar results. MDS was run iteratively with increasing dimensions (2–10 dimensions) in order to identify a model with stress indicating an acceptable goodness-of-fit ($\leq$0.05) [30,31].

Transcripts of the interviews were analyzed inductively via descriptive line-by-line coding allowing for simultaneous coding [32]. It should be noted that the objective of this qualitative analysis was not to deductively organize the interview data according to the findings of the MDS results, but to perform an inductive analysis of the text, permitting concepts and themes to emerge directly from the interview data. Second cycle analysis further organized these codes into larger themes. During a second-cycle analysis session including the entire study team, these codes and themes were analyzed side-by-side with MDS pile sort results in order to arrive at a final list of mental health/psychosocial problems with clear definitional boundaries.

Key informant interviews with professional stakeholders. Key informants were professionals operating in the study area who could provide insight into the 2019 wildfire events and response, including mental health providers, wildland firefighters, local government officials, public health officials, community advocates and other stakeholders. We began key-informant interviews by sharing the mental health problems and supports that were generated by study activities with community members via a brief 10-minute presentation. Key informants were invited to provide feedback on the list of supports and to offer other ideas for supports, as well as their own perspectives on these mental health problems and their causes. Interviews were held on Zoom and audio recorded. Transcripts were created by Otter,ai software and checked for accuracy, identifying information was removed, and transcripts were transferred to NVivo for analysis. Support ideas and their descriptions were extracted from transcripts and compiled for use in the final ranking workshop with professional stakeholders. Transcripts were coded thematically [33] to identify inductive codes and to extract detail on potential supports for the mental health problems identified by the community, and any challenges that may be faced during the implementation of such supports.

Ranking workshop with professional stakeholders. All professional stakeholders who participated in a key informant interview were invited to participate in a final ranking workshop to identify supports perceived to be the most impactful and actionable. This workshop provided an opportunity to verify key informant interview results with professional stakeholders. The participants included behavioral health providers, public health practitioners, wildfire first responders, policy makers, and community advocates among other professional stakeholders. The one-hour workshop began with a brief presentation that summarized the categories of wildfire-related mental health concerns identified through the analysis of the community free-list interviews, workshop, and in-depth interviews. The professional stakeholders were then presented with a list of the supports developed through the community and professional stakeholder interviews. Professional stakeholders were asked to select five support ideas for each of the six categories of mental health problems that they felt were most impactful and actionable via an online poll. The two most frequently selected supports for each mental health problem were aggregated into one list and participants collaboratively ranked this list based on perceived impact and feasibility. Workshop participants then participated in a discussion of implementation of these supports including any challenges with public acceptability, which organizations would likely implement each support, and what kind of resources would be needed. The workshop ended with a summary of the discussion and additional discussion of potential strategies for dissemination of the research results.

Results

The majority of community members who participated in free-list interviews, a ranking workshop, and/or in-depth interviews were women between 25 and 54 years of age (Table 1). Over

Table 1. Demographic characteristics of participants in all components of the wildfire and mental health study in Southcentral Alaska*.

Demographics	Free-list Interview (n = 39)	Community Ranking Workshop (n = 8)	In-depth Interviews (n = 10)	Key-informant Interviews (n = 12)	Provider Ranking Workshop (n = 7)
Age					
18–24	2 (5%)	0 (0)	0 (0)	0 (0)	0 (0)
25–54	26 (67%)	4 (50%)	5 (50%)	9 (75%)	4 (57%)
55–64	8 (21%)	1 (13%)	3 (30%)	2 (17%)	2 (29%)
65+	3 (7%)	1 (13%)	0 (0)	0 (0)	0 (0)
Gender					
Man	15 (35%)	2 (25%)	3 (30%)	6 (50%)	3 (43%)
Woman	28 (65%)	6 (75%)	7 (70%)	6 (50%)	4 (57%)
Residence					
Anchorage (urban)	14 (33%)	4 (50%)	5 (50%)	4 (33%)	2 (29%)
Kenai Peninsula (rural)	25 (60%)	4 (50%)	5 (50%)	5 (42%)	2 (29%)
Southcentral Region	3 (7%)	--	--	2 (25%)	3 (43%)
Profession					
Mental Health Provider	--	--	--	4 (33%)	2 (29%)
Wildland Firefighter	--	--	--	4 (33%)	3 (43%)
Policy/Advocacy	--	--	--	4 (33%)	2 (29%)
Total	**39**	**8**	**10**	**12**	**7**

*Age was missing for some participants for each of the activities: Free-list (3), Community workshop (2), In-depth Interviews (2), Key-informant Interviews (1), Provider Workshop (1).

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half of community members who participated in free list interviews were residing in the Kenai Peninsula. Among community members who participated the ranking workshop and in-depth interviews, half were residing in the Kenai Peninsula and half were residing in Anchorage. More than half of professional stakeholders who participated in key informant interviews and the ranking workshop were women between 25 and 54 years of age. The majority of professional stakeholders who participated in the key informant interviews were working in the Kenai Peninsula whereas the majority of those who participated in the ranking workshop were working in the Southcentral Region. Even numbers of mental health providers, wildland firefighters, and professionals working in policy or advocacy participated in the key informant interviews. Among those participating in the ranking workshop, there were more wildland firefighters than mental health providers or professionals working in policy or advocacy.

Wildfire-related mental health problems identified by community members

Free-list interviews resulted in a total of 79 unique community-identified problems related to mental health. These problems included both predictors (e.g. air quality, financial troubles) and symptoms (e.g., anxiousness, sadness) of mental health problems. These problems were organized into 36 categories perceived to be related to mental health based on participant descriptions (S1 Table). For example, after exploring the descriptions of each problem, the problem "being sad" identified by one participant and the problem "changes to the land" were combined into a new category called, "Being sad because of changes to the land", given that in their more detailed descriptions these problems were explaining the same underlying concern. These categories were used during the ranking workshop with community members. At this workshop, 8 of the top 10 problems were *causes* of mental distress rather specific mental health problems (Table 2). The number one cause of mental health problems was identified as being an overarching lack of communication from authorities, including government, wildfire management, and health officials regarding the status of the wildfire and how to manage its associated risks. The remaining problems were related to an overarching sense of insecurity and uncertainty related to finances, potential property loss, food security, struggles coping with poor air quality and record-breaking heat, and the mental health impact of the wildfire on community members' ability to move freely between communities or to recreate outside.

Two of the top 10 problems related to wildfires were mental health problems. The first was a general sense of fear and anxiety for loved ones living near the fire. The second was the personal state of distress described by community members as "high stress." Information from

Table 2. Top 10 community-identify problems related to wildfire in southcentral Alaska identified through a group ranking process.

Rank	Problem
1	Lack of communication from authorities
2	Financial issues: Not knowing if your livelihood was going to be there from one day to the next
3	Fear of losing property
4	Poor air quality
5	Travel and transportation issues
6	Fear and anxiety for friends and family that live in affected areas
7	Food security: impacts on ability to fish, forage, and hunt
8	High stress
9	Not being able to recreate outdoors
10	Record-breaking heat

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community members in-depth interviews and pile sorting was key in defining the boundaries and expanding the description of specific mental health issues beyond this broad category of "high stress."

In pile sorts, 17 problems from the freelist interviews that related explicitly and directly to *manifestations* of mental health problems rather than the *causes* of such problems were used. The MDS analysis of pile sorting results returned a solution of four dimensions with a stress of 0.043. These results provided an indication that conceptual clustering was occurring. For instance, "unknowing from hour to hour", "low-grade consistent stress", "fear for friends and family", "fearful that the fires would continue", "lingering anxiety", "fear", and this general term of "high stress" situated themselves as potentially interlinked. Similarly, "sad for the land", "mental impact on children", and "destroyed the town mentally" were seen as closely related by community members. Problems which appeared to stand alone included "alcohol and drugs", "fear for self", and "claustrophobia".

Combining these MDS results with the analysis of the qualitative data from the in-depth interviews where the pile-sorting occurred, we uncovered six distinct categories of mental health problems experienced in wildfire-affected communities. Interviewees described Cluster 1 as being linked to two separate mental health problems: "Apprehension of the unknown" and "Prolonged stress", wherein "Prolonged stress" was a condition that stemmed from the long term affects of apprehension of the unknown. Interviewees most commonly labeled Cluster 2, "Grief." Three other mental health concerns were indicated in the MDS results ("Feeling trapped", "Substance use", and "Life and property") but were more richly elucidated and described through the qualitative analysis of the IDIs. One mental health concern, "Returning ghosts", was identified in the in depth interviews but not through the pile sort exercise.

Four mental health problems included in the pile sort exercise ("Being a burden", "Mental health in general", "Trouble sleeping", and "Weighing risks") did not emerge as unique mental health problems when discussed in interviewing, though were seen to relate in tangential ways to several of the mental health concerns. For example, the weighing of risks was a cognitive activity related to and reciprocally affected by multiple mental health concerns, such as apprehension of the unknown, prolonged stress, and fear of the loss of life and property. Trouble sleeping, worries about being a burden to others, and mental health in general were similarly related to multiple concerns and hence did not bear out in the final results.

Apprehension of the unknown. Apprehension of the unknown was the most discussed mental health concern among participants and was related to a number of different unknown or unknowable aspects related to wildfire events and their impacts on communities.

> The first thing is just kind of sorting out the unknowables that are. . . they're often a concern to people. It's just like, what, you know, what about the future? What will the domino effect of this be? Because it deals with unknowing or not knowing things, and then thinking about, what's this going to mean for life? (IDI, Male, Seward)

Other words beyond "apprehension" were used to describe this mental concern. One participant (IDI, Female, Homer) described it as "That foreboding sense of where's your next breath going to come from? Where are you gonna go?" Another participant described it as anxiety and explicitly tied this anxiety to the perceived lack of communication and information regarding the wildfire and its impacts.

> People didn't know what was going on, and it was just this idea of the unknown, of not really knowing what was coming, or what was next, what was happening. Again, I think it

> comes back to the information piece, or education piece. . . I don't think people would have anxiety if they knew it was going on. I don't think people would have to question if they should go outside or if they should breathe the air if they knew it was going on. (IDI, Female, Anchorage)

Participants described apprehension as related to not knowing about risks or future events, both related to the unfolding of the wildfire event itself and the impact of poor air quality and smoke. Concerns around air quality were seen as particularly significant for those with physical health concerns, such as asthma or those who were pregnant. One participant noting (IDI, Female, Anchorage) "At times I couldn't tell if it was actually healthy or not to go outside into the air, and there was not really an adequate way to judge that."

For some this led to feelings of a loss of control, feelings of lost normalcy, fear, feeling pushed beyond their comfort level, hopelessness, irritability, or becoming brooding, quiet and withdrawn. For some participants there was a strong sense of isolation related to this concern and a feeling that they had been abandoned by authorities and officials whose duty they felt it was to communicate this information to them. One participant shared that health providers were not proactively communicating risks to patients (IDI, Female, Anchorage). Another participant (IDI, Female, Cooper Landing) described how the community experienced stress when firefighters were pulled out of the area saying, "oh yeah, it was. . . we felt abandoned." Participants described the lack of media coverage of the wildfire, the emergence of misinformation on social media platforms, and being told to listen to public radio in areas where public radio had been cut. Other participants noted that while public meetings to provide information on the wildfire were welcome, these meetings often became heated in instances where, in the words of one participant (IDI, Male, Seward) "there was a lot of government double talk, and there were also people not hearing what they wanted to hear."

Some felt as though local leaders were not taking the wildfire seriously, and there were also suspicions on the part of community members as to why this information was not being provided. There were concerns that information was being purposefully withheld, and some participants said that they did not trust that authorities had the best interests of the public at heart when making wildfire management decisions.

> I think we needed a little more health information. . . and it was like, they didn't want to give us that information, because you know, they didn't want us to panic or they didn't want everybody to leave in a mass herd or something, I don't know. . . they were liable. I mean, it was their fault. They let this grow because that was what was good for the forest. And it's like that was frustrating. It might be good for the forest. But what about the people? (IDI, Female, Cooper Landing)

Participants said they coped with the effects of apprehension of the unknown in several ways, including staying busy as a form of distraction or attempting to take things one day at a time. Others used more action-oriented coping strategies, including attending meetings, attempting to educate themselves and advocate for themselves, preparing their property for wildfire, or developing solutions in their own homes, such as homemade air purifiers. Checking in with others and bonding with fellow community members was also seen by some to help ease the effects of apprehension.

Prolonged wildfire stress. We also observed a differentiation by participants between the short-term apprehension and anxiety caused by wildfire and the long term mental health effects of prolonged wildfire seasons. In contrast to acute apprehension describe above, participants also described long-term stress as a separate issue. For example, one participant (IDI,

Female, Homer) said, "it felt like it was never ending." Another said (IDI, Female, Soldotna) "I feel like it just went on the entire summer basically." And yet another participant shared (IDI, Male, Anchorage) "Your body doesn't know whether to be ready to jump, or go and lay down and take a nap."

> Imagine the worst day to be a human. . . there have been awful days, but they're usually one day. And if you get through that one day, you know it, it very quickly goes back to a baseline. But starting around like World War One when we first started to talk about shell shock and that kind of stuff, people were in these situations for months. The Kenai Peninsula wasn't the Battle of the Marne, but it was people keyed up all the time for months and months. . . on your guard for months. People's systems aren't designed for that. It's like we're supposed to have waves. . . where there's moments of extreme urgency, and then there's moments of peace and destressing, but when you don't have the information, or when you can see your business evaporating in front of you. . . are you supposed to relax during that? I felt like people would kind of go from annoyed to combative to resigned almost. (IDI, Male, Seward)

Another participant related this explicitly to the experience of that wildfire season:

> Well, I mean, that's what stress does. . . these little bits pile up. Nobody ever got divorced over somebody burning the toast. . . so I think duration is a big deal. Like, okay, so you had to send your kid with asthma to live with your sister in Seattle and your husband didn't manage to get much money coming in from the business you just started, and the person down the street is starting to spew [political] stuff and then. . . you just freak out, you know when the air quality is bad. I mean, it's just. . . there's a culmination effect. (IDI, Female, Anchorage)

Similar to one participant who described the manifestation of prolonged stress as being a point of resignation, other participants described this to be the point at which people gave up hope. "It had to be something in the eyes. You just kind of lose that spark, that's the only way I can describe it. You know, that glimmer in the eyes that just [goes out]" (IDI, Female, Cooper Landing). Reaching a point where people did not go anywhere or do anything, feeling overwhelmed, and feeling tired were also recognized signs and symptoms of this concern. Unlike apprehension of the unknown, there were no strategies reported by participants for how communities coped with the effects of prolonged wildfire stress.

Grief. Wildfire-related grief was related to multiple factors as demonstrated by the clustering of mental health problems in the pile sort data (Fig 1). These factors all centered around loss, whether due to loss of lands ravaged by the wildfire, loss of property, or loss of normal activities that were sidelined because of the wildfire.

> Like not having school for a month. That's sad, especially if you're a little kid who like likes to be around your social group and your friends. And it was actually the first month of school, which is kind of crazy. Like, they didn't even get to start school. . . Just the loss of like your normalcy. . . and then being sad about the landscape changes. I know a lot of people who feel just like an underlying sadness about driving the highway now, because it doesn't look like it did anymore, you know? It looks totally different. And it's one of the most beautiful highways in the world, and when you drive through it now, it's just barren. (IDI, Female, Soldotna)

In some, the loss of the landscape was seen as a continuation of the natural losses due to climate change.

> We've been experiencing climate change for decades. Since you've been here, you've watched it, you've watched the loss of our glaciers in Kachemak Bay. I can tell you I can start to list the species of fish and birds and animals that were available that have gone, you know, they're not available, like belugas do not come into Kachemak Bay because their populations endangered. (IDI, Female, Homer)

For many participants this grief was related to the loss of memories, artifacts of their connection to their own histories and to the land. One participant shared "So many people have the first moose horns in the cabin. The first trout their kid [caught]. . . and it's [mounted] above the fireplace in the cabin. And you lose those memories" (IDI, Male, Anchorage). In continuing to describe the experience of grief among community members, another participant (IDI, Female, Soldotna) described the following moment:

> A couple of my friends went to hike this trail, and it's a trail that they love, and they're a couple and they have a special connection to this trail. . . it's important to them. And one of them had grown up in that area and has been hiking that trail his whole life. And they went on this trail for the first time since the fire and, I don't know, wanted to talk about it later, when we were all hanging out. And was just like, it was really sad to see all of these trees that I had grown up around and they were really tall and beautiful and now they're gone. But one of the things that was interesting, that he said it was like it was like all destroyed but then at the very, very end [of the trail] some of it wasn't, and they were like thank goodness, like a little bit of it is still there. (IDI, Female, Soldotna)

This experience of wildfire-related grief was connected to deep feelings of loss, feelings of devastation, sadness, crying, and wondering if what was lost would ever return. As indicated in the quote above, participants described that reaching out to people who would listen to their experiences of loss was an important coping mechanism. As another important part of the process to cope with the loss of land, some Alaskans in this area reflected on their deep connection to the land, emphasizing that what was lost would indeed return through the natural cycles of loss and regrowth. This coping strategy focused on the positive natural events that would inevitably follow the wildfire, such as the blossoming of the fireweed across the landscape, or the abundance of morel mushrooms that would be ripe for picking.

> Remember when you were a kid, and you'd go through a section of the Sterling flats, and there's a moose preserve, Wildlife Preserve there, yeah, little scrubby trees, and your parents told you about the fire in the 50s that completely wiped out that area and how it came back. And then there was great moose hunting for decades. And so I guess there's a cyclical nature to life here that we're more attached to. . . it's like, nature is a day to day part of life [in Alaska]. (IDI, Female, Anchorage)

Feeling trapped. Participants also described a feeling of being "trapped" or "closed in." Several participants described this feeling in relation to the dense smoke caused by the wildfire. Concerns around the safety of breathing in the smoke led many to stay indoors during a time of year when most Alaskans are maximizing their outdoor activities. One participant noting "You were literally stuck inside, you couldn't open your windows" (IDI, Female, Homer) and

another sharing "In the summer of 2019 one of the biggest things I remember was feeling like I couldn't ever leave my house, and not knowing if I should" (IDI, Female, Anchorage).

While being restrained to indoor activities left many trapped in their homes, feeling trapped extended also to include the lack of visibility caused by the smoke, as well as concerns about being able to escape the area if the wildfire spread due to only one road connecting a particular region to the rest of Alaska. Participants reported feeling anxiety regarding what would happened were they to lose access to this single highway of escape.

> I felt trapped and I think I heard other people who voiced that also because the highway would be closed going out of town one direction. . . I remember going through this mental plan of if the fire actually came down to the road, how would we get out? . . . and then just that closeness. I mean, that was part of it. That feeling of not being able to escape. And then the other part was just the smoke being so close and so dense that you couldn't see. I mean, it's a really, it was like a really thick fog. That was days and days long. I couldn't see. (IDI, Female, Cooper Landing)

Life & property. Participants widely discussed the notion that Alaskans lived close to nature and felt very connected to the ebb and flow of seasons and to the wildlife, and grappled with the many risks associated with that closeness to nature. As one participant put it "All those adventures that we have with Mother Nature" (IDI, Male, Anchorage). While risk was a part of everyday life, there was a distinction between minimal risks and those imminent threats that Alaskans felt warranted action. This included direct threats against one's own life, the lives of those in their care, or direct threats against property.

> A weird Alaskan way of describing something is "life and property". You can shoot a bear on your property if it's in defense or life or property. So you can kill another animal, if it's in defense of life and property. That is a very Alaskan distinction of what's important. (IDI, Female, Anchorage)

Others noted that as Alaskans shared their experiences of the wildfire via social media, the worry spread.

> I remember somebody posting a video [on social media] of them driving through the road in the evening time when the fire had jumped the road out of nowhere. And, you know, it was like flames on both sides of the road. And it was. . . and they were like. . . legit. . . I mean, it was like, legitimately fearing for life. And I was like, holy crap, you know, I didn't realize it was that bad. . . Just hearing those people on there thinking that they were just gonna burn alive was definitely, uh terrifying. (IDI, Female, Seward)

Notably, participants highlighted the importance of pets and livestock in the lives of many Alaskans. As participants grappled with the direct threats of wildfire this included also the lives and wellbeing of their animals. Once participant noted the direct implications of wildfire-related stress on livestock, "My pigs are stressed out, I'm stressed out. Pigs aren't eating, they're not going to fatten up and I'm not going to make any money for Christmas" (IDI, Male, Anchorage). This participant added, "Or if its just your pet, those become your children" and summarized "So you know you've got a stressed out animal and stressed out owner and stressed out kids, you know, little piggy one, two and three are stressed out and you don't know what they're gonna do with them. And when daddy says hop in the car, 'What about my pet pigs that I've been feeding all summer long?'". Another unique consideration included the

teams of working sled dogs kept by Alaskan dog mushers, whose safety was also threatened. Participants who felt this direct threat to life and property said they showed this through signs of anger, fear, and a loss of control of emotions. This anger in particular was noted by participants to often be aimed towards wildfire and other authorities.

Returning ghosts. Many participants noted that while the wildfire season of 2019 was a particularly stressful time, Alaskans have experienced many disaster events in their lifetimes. One participant sharing, "I think that it's something that mental health people need to take into consideration that fires, floods, earthquakes, tsunamis, all of these things have affected us. We've lost people to them" (IDI, Male, Anchorage). The frequency of disasters caused by natural hazards led to vivid recollections of past disaster events and lingering anxieties about these events occurring again in the future. In some cases the recollections of these events were triggered by activities associated with past events. A participant (IDI, Male, Anchorage) described experiencing a particularly strong earthquake while being in the shower one day, and now being unable to shower without feeling anxiety about having another earthquake. Another participant described this feeling as being haunted by the "ghosts" of past disasters (IDI, Male, Anchorage). "[For] some people it doesn't matter what you do, you know. . . the ghost will be coming back anyway. This tied once again to Alaskans' closeness with nature and a real feeling that they were always at its mercy, one participant stating clearly that you must always "be prepared for Mother Nature, she could be a bitch" (IDI2, Male, Anchorage).

Participants largely felt that the way to cope with adversity caused by these repeated disasters caused by natural hazards was to be flexible, while others noted that these repeated disaster events were causing migration out of the state when people were unable to cope. One participant shared "Because over so many years, we get tired of being concerned and tired of watching the news. And it's easier just to move someplace safe" (IDI, Male, Anchorage).

This was linked to a sense of not only ongoing threat of natural disasters, but also a likely increase in their frequency. One participant noting "You're just like one step away from disaster" and adding, "There's definitely going to be another wildfire season" (IDI, Female, Seward). Another participant made the connection to climate change.

> It's inevitable that we'll have fires like this again, some day, just with the changing climate, and personally I would feel a little bit more at ease if the local leaders took it a little bit more seriously. . . addressed it as a climate problem. We had high winds, drought, and super high temperatures, and all of those things are, you know, out of anyone's control, but it's like, we know that it's gonna be like that more often. (IDI, Female, Soldotna).

Substance use. In the context of this study, substance use was seen as a negative coping mechanism to wildfire-related stress. For some participants this connection was witnessed starkly, (IDI, Male, Seward) "Oh, yeah. Drinking went way up. There was a lot more alcohol use that I saw." However, this same participant noted that alcohol use in particular was normalized in Alaskan society, "I mean you know, Alaska is a pretty hard drinking state anyway. So the fact that it was noticeable, you are just 'Oh wow, ok.'" Another participant shared "People get release, [they] release their worries. . . and ultimately, we have alcohol [and other negative behaviors]" (IDI, Male, Anchorage).

Substance use was also viewed to be exacerbated due to the constraints on normal summer recreational activities. For example, one participant said that alcohol or drug use increased because people were "just sort of sitting around" (IDI, Female, Seward). Another participant noted that this increase may have been the case mostly for those with a history of substance use (IDI, Female, Anchorage).

Interventions to support wildfire-related mental health

Community members and professional stakeholders identified 102 potential supports to address wildfire-related mental health concerns (S2 Table). The ranking workshop with professional stakeholders identified 11 of these supports as the most actionable and impactful options for the local context based on the experience and expertise of participants (Table 3).

Professional stakeholders at the workshop identified what they called a "package" of communications activities as the jointly top-rated support for mental health during wildfires in Alaska. This package included ensuring early communication and communication strategies that permitted equitable access to wildfire-related information. Components of this package also supported the use of strong community-based and participatory approaches to wildfire preparation and management. By involving communities in both evacuation planning and preparedness and prevention programs these were seen as natural routes to educating the public and empowering them with the knowledge and action plans they would need in the event of wildfire.

Notably, after the package of communication-related interventions, the second most highly ranked support was simply the acknowledgement of the impact of wildfires on mental health. It was believed that local government and wildfire leadership could play a role in normalizing the discourse around wildfire-related mental health by including it in their briefings. Other inventions included preparedness activities such as enhancing the emergency shelter system or creating a series of videos preparing homeowners for what to expect during wildfire. A number of the proposed interventions directly targeted efforts to recognize and support mental health during wildfire events, such as mental health debriefing at evacuation sites, supporting mental

Table 3. Most actionable and impactful interventions to support wildfire-related mental health as identified and ranked by key informants serving southcentral Alaska including wildfire and behavioral professional health responders.

Rank	Support	Description	Problem Addressed
1	Equitable access to information	Ensure that information regarding health risks and wildfire management is accessible to everyone, including those without internet connections or facing other informational barriers such as those requiring translation.	Apprehension of the Unknown
	Early communication	Enhance strategies to improve early communication prior to the arrival of public information officers employed by firefighting teams, possibly through the use of local leadership.	Apprehension of the Unknown
	Community involvement and support in evacuation planning	Involve community members in creating, organizing and communicating wildfire evacuation plans including evacuation locations, routes, shelters and plans for the welfare of pets and livestock.	Feeling Trapped
	Community-based preparedness and prevention programs	Events organized at the community-level for group activities related to clearing land or holding organized safe burns.	Returning Ghosts
2	Acknowledge connection between wildfire and stress	Mainstream everyday talk regarding the mental health impacts of wildfire. Including discussions by community leaders both during and in the aftermath of wildfire.	Prolonged Stress
3	Enhance emergency shelter system	Increase the availability of shelters as well as their accessibility and appropriateness for Alaskans.	Life & Property
4	Campaigns/programs connecting citizens to local mental healthcare systems	Identifying local systems of mental health support and facilitating access to these services via communication or other referral systems.	Returning Ghosts
5	Mutual support groups	Establishing either formal or informal support groups, including community conversations or other events where people can come together and grieve collectively.	Grief
6	Grief counseling	Mobilize and connect the public to both professional and nonprofessional (ex. faith leaders) offering grief counseling either through passive messaging or active outreach.	Grief
7	Mental health debriefing at evacuation sites	Organizing mental health professionals to provide immediate trauma-informed care and debriefing services at evacuation sites.	Life & Property
8	Video series on wildfire for homeowners	Create a video series outlining what homeowners should expect when a wildfire threatens their property, including the sequence of events and what firefighters do.	Prolonged Stress

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health referral to services, and developing support groups to facilitate community conversations around mental health after wildfires.

Implementation considerations for wildfire related mental health supports

Challenges in implementation of supports were largely seen to connect to two overarching issues: the ability to engage with communities and the difficulties of ensuring equity. Obstacles in ensuring the appropriate reach of supports and the acceptability of interventions in the context of Alaska are outlined below. Other challenges included those related to bureaucracy surrounding the implementation of supports, the need for strengthening the mental and behavioral healthcare systems in the state, and a lack of preparedness of communities and individuals.

Challenges engaging communities. It was noted by several professional stakeholders that mental health stigma, including stigma related to mental health service use, was prevalent in Alaska and would create challenges to implementing certain types of interventions. One participant stated, "Yeah, I think of my like, flannel shirt wearing father not going to see a mental health therapist. He will go work out his issues in the workshop. . . I think it's important to it has to be more than therapy [that is provided]" (KII, Female, Health Programs Manager). Another participant shared that in Alaska "mental health is something that you deal with very quietly, and you don't talk about it publicly. Like that's something that you deal with behind closed doors, and we don't talk about that publicly because that's shameful. And that's that stigma that we need to get rid of" (KII, Female, Mental Health Advocate).

Getting some Alaskans to engage with wildfire response efforts in general and the specific interventions noted in this study in particular was also seen to be potentially challenging. One participant stated "You are always going to have end-of-the-roaders" (KII, Male, Fire Manager). Another (KII, Female, Policymaker) added that people who live remotely in Alaska sometimes do so for a reason. In the view of one participant (KII, Male, Fire Manager) these individuals sometimes moved to Alaska to "get away" from mainstream society. While another participant (KII, Female, Mental Health Advocate) noted that these individuals were likely not to believe in concepts such as climate change, and another (KII, Male, Mental Health Provider) noting that they may possess anti-government sentiments that would make outreach challenging. The behavior of this population of remote Alaskans was seen as distinct from behavior associated with traditional village life in Alaska, which, while also remote, was not connected to the Western notion of Alaskan isolation. One participant (KII, Male, Fire Crew Superintendent) shared that wildfire incident managers would need briefings when coming in to respond to wildfires in Alaska about these unique challenges, and that no such framework was currently in place to support this training.

Among the population of people who choose to live an isolated lifestyle, individual rights were seen as primary over community involvement and distrust in authorities could lead to armed encounters. A participant stated, "It's a hard one. . . I've been on fires where people just, you show up and you're in a government vehicle, and they have guns ready" (KII, Male, Wildland Firefighter). Another participant added "in this pandemic [there] has been a lot of discussions around choice and freedom and independence. And we have to learn some lessons from this because people, a big portion of people want to make their own decisions. So how do we manage that with risk and public safety" (KII, Female, Health Program Manager).

Accessibility and equity. Several professional stakeholders noted various challenges in regard to ensuring that interventions were equitable and accessible to all populations within Alaska, including individuals with disabilities, non-English speakers, and those living remotely with limited infrastructure access. One participant (KII, Female, Policy Maker) shared that

many in Alaska live in remote areas without internet access and cell phone coverage. While door-to-door outreach may be possible in some instances, for other communication activities such as town halls, many would not be able or willing to access these events. One participant (KII, Female, Mental Health Advocate) noted that while fiber optics had been laid in some remote villages, there was still a lack of access to internet in some regions. For some who did have internet access at home, these were dial up networks, which would be slow to load complex websites. There was also a recognition from a participant (KII, Male, Mental Health Provider) that many Alaskans chose to live "off road," and perhaps chose this lifestyle in order to be disconnected from interaction with others, posing a different kind of challenge for communication.

In light of this challenge, participants shared that strengthening social networks and targeted outreach to those living remotely would be essential in ensuring equitable access to information and support.

> We've got a real close friend who is, I'm just gonna call him a hermit. And he, he isolates, he doesn't have his phone, he's got a landline. But he listens to the radio. . . I don't think he has a TV. But TV reception where he is is bad anyway. And so it's like, 'Did you get the word?' (KII, Male, Mental Health Provider)

Social support and community transience. Several professional stakeholders discussed how many Alaskans came from other areas and had no family in the state. This highlighted the importance of creating community and connectedness in efforts to provide wildfire-related support.

> So many Alaskans are not from here. On a day to day basis, you appreciate living in this beautiful place, [but] my whole family is elsewhere. . . I enjoy living here, but when something bad happens. . . it's easier to feel I think disconnected, because then your most natural support network of family. . . isn't nearby. I think we have 40,000, people come and go from Alaska every year. . . so the population turns over pretty frequently [in this small U.S. state]. It just means that you don't always have 'Oh my family's lived here for the last 50 years.' And, you know, so not only do I have my own personal resources, but the resources of my family that have built up over 50 years, so there's, you know, your brother's friends, your parents friends. . . maybe you just feel like you have more points of connection to people in times of need. (KII, Female, Policymaker).

Bureaucracy and multisectoral collaboration. The large number of actors involved in wildfire response was seen by some professional stakeholders to create dense bureaucracies that were sometimes difficult to navigate effectively. In the words of one participant "I have to talk to my boss, and my boss has to talk to his boss. So there's a lot of bureaucracy in between, and then if we want to coordinate with the [state] troopers, it has to go through that level also. So there's a lot of in between levels where it could be improved, but it's going to take a lot to get there" (KII, Male, Wildland Firefighter).

Although local governments were seen as potentially playing a vital role in enacting and promoting mental health supports, it was noted by one participant (KII, Female, Policymaker) that local governments in Alaska often did not have health powers, meaning the ability to pass and enforce health-related laws. Furthermore, while local municipalities could potentially support programs and facilitate implementing them they often "do not have the trained staff to really implement something like that."

Turnover in government leadership was also seen to be a challenge. In the words of one participant "changing governments add to a lack of consistency [in response]" (KII, Male, Mental Health Provider). Another noting "You can have turnover every year in municipalities in Alaska. . . The mayor is a two year term. So you [can have a] new mayor every two years potentially" (KII, Female, Policymaker). It was largely seen among professional stakeholders as important to create supports that did not hinge on particular leadership. One participant explained "You build plans that last longer than government and update them" (KII, Male, Fire Management). Political division was also seen to play a role.

> I'm not surprised in some [to hear about] the feelings of helplessness and hopelessness. Because there's been so much political division and inability to get things done. . . people are feeling really stressed because the government is dysfunctional locally and state and nationally. . . to get through it, you need a high functioning government. (KII, Female, Policymaker).

While involving community members themselves in wildfire response was seen to be beneficial, red tape in contracting and hiring locals was described as sometimes challenging.

> And these guys, the landowners, there were dozer operators and timber fallers. Men of the land, and when the fire started, they went to work, they went to work to stop the fire in conjunction with the responders. So they had been battling this fire in their backyard, for a month, and then the fire came into their yard, and it changed everything for them, And um it was really, really tough uh to, to deal with, it was probably one of the tougher things I've dealt with as a responder as you get to work with these guys. I say, you know, hey, you're doing a good job. And we're here to support you. We're here to pay you as well, which is always tough in the system and, you know, getting through all the red tape and getting them signed up as contractors is, is a tough deal. And their patience runs thinner as their stamina decreases over time, and then all of a sudden, their homes are burning. And it's. . . it was so rough. You know, there's a lot of a lot of tears in there in that camp. (KII, Male, Wildland Firefighter).

Others informants mentioned that it was essential to overcome challenges not just in building effective collaborations between federal and state agencies, but also between other sectors.

> So what we're striving to do in our region is really create a culture of "No Wrong Door". So by having relationships between agencies, an understanding of "who's who", who provides what and what supports they can offer. If someone shows up, and they're not able to be supported by that particular agency, in that particular moment, there's a warm handoff . . . I know who can [help you] and let me connect you with this person of this agency. So really having that connected, comprehensive, multi-discipline, network that is able to meet the needs of whomever walks through whatever door. (KII, Female, Policy Advocate).

How to promote early action. While ensuring that communities are involved in the preparation and provision of supports was identified as critical to implementation, one challenge noted was that communities are most likely to engage in efforts only after a disaster event.

> Especially with wildfires, people don't think about these things until it's too late. Very young in my fire career, I was told that no matter what the structure looks like, it's someone's home, so you treat it like it's your home. But. . . we can't do in 15 minutes what someone hasn't done in 15 years. [The fire] that hit [the town of] Big Lake in 1996, if I'm right that actually was the

> main motivator in creating [several programs]. Now they are probably the best prepared community in this state, you know the best in nation. (KII, Male, Wildland Firefighter).

Engagement of communities with wildfire preparedness was seen as essential, but soliciting early participation was seen to be challenging. In the words of one informant (KII, Male, Wildland Fire Crew Superintendent) "Outside supports come and go with incidents. Effective change comes from responders, mental health leaders, within their own communities."

Limited capacity of mental health systems in the state. There was a need identified for overarching health systems strengthening efforts in Alaska to enhance the mental and behavioral health care systems.

> We need to connect people back to systems of care that are already available, and we need to address massive issues we have within our mental health care system, in this state in particular. . . and so that means having more mental health care professionals and training mental health care professionals in addressing trauma from natural disasters. It also means though, addressing a lot of the issues we have with paying for mental health care, and that is still a huge issue for folks. (KII, Female, Psychologist)

This led to discussions about the ability of the state's mental health workforce to engage in mental health supports during wildfires and suggested the necessity for extending the scope of other agencies to provide mental health support more directly. One participant shared "I think there's not enough in our area, behavioral health care providers. I'm a strong supporter of the forestry service to actually do something about it directly" (KII, Male, Mental Health Provider). However, for wildfire agencies already managing a multitude of wildfire-related activities, the extent to which this would be feasible, and the extent to which a budget could be allocated for such efforts, was uncertain.

Discussion

This study described several locally-defined categories of mental health issues related to wildfires in southcentral Alaska in 2019. These included 1) apprehension due to the unknown risks and uncertainties related to wildfire that was exacerbated by a perceived lack of communication from authorities, 2) resignation and feelings of being overwhelmed after periods of prolonged wildfire-related stress, 3) grief due to the loss of natural landscapes, property, normalcy and their associated memories, 4) feelings of being trapped due to dense smoke and limited options for and understanding of evacuation, 5) immediate and intense fear and distress related to the imminent threat of loss of life or property, 6) lingering, intrusive memories and anxiety due to the common recurrence of disasters caused by natural hazards. Additionally, substance use was identified as a negative coping mechanism. Professional stakeholders who work in the region identified a package of communications-related interventions as being the most impactful and actionable support for wildfire-related mental health problems. Additional highly rated supports centered around leadership acknowledging the connection between wildfire and mental health, connecting community members to formal or informal systems of mental health care (including existing or new services, support groups, and grief counseling), enhancing the emergency shelter system, and providing crisis debriefing during wildfire evacuations.

The overarching term "stress" was often used to describe the state experienced by community members in this study during wildfire. Stress has been shown to be a more "normalizing label", in contrast to the use of specific mental disorder classifications (30). While some

participants did use specific terms commonly used to describe mental disorders and their symptoms (i.e. anxiety, claustrophobia), the use of more normalizing and general terminology could perhaps indicate mental health literacy as a potential focus for future study. Evidence has shown that mental health literacy, including knowledge about mental disorders and their treatments, can increase help-seeking behavior and the early identification and disclosure of symptoms (31). Mental health stigma, identified as prevalent in Alaska by participants, may also contribute to the use of normalizing and general terminology. Participants' observation that stigma against mental disorder may affect an individuals' willingness to disclose symptoms and seek care is well-supported by the literature. Stigma has been found to be one of the top barriers to mental health help-seeking (32), and can potentially be positively impacted by improved mental health literacy (33–35).

Aspects of most of the mental health problems identified in the present study, such as apprehension of the unknown, prolonged wildfire stress, grief, feeling trapped, and substance use have also been described in other populations affected by wildfire (6). For example, in a study conducted after the 2014 wildfire season in the Northwest Territories of Canada, participants described fear, stress, uncertainty, and isolation as a result of "not knowing what lies around the corner" in terms of wildfire risk and prolonged smoke exposure (36). Participants in this study also reported the inability to engage in regular activities on the land which adversely impacted well-being. They also described how gradual environmental recovery after wildfire was intrinsically related to their own recovery, offering hope and positively impacting well-being. In another study conducted after the "Black Saturday" bushfires in Victoria, Australia participants reported profound loss and grief related to personal losses and the destruction of the natural environment (37).

This study identified substance use as a negative coping mechanism in the context of wildfire. The role of substance use as a wildfire related mental health outcome and as a contributor to other wildfire related mental health outcomes is nuanced. A recent review on wildfires and mental health identified no studies that examined substance use as a primary outcome, however the review identified several studies describing an association between mental health problems and substance use where those living with mental disorders after wildfire were significantly more likely to use alcohol or drugs (6). In the review, substance use was described as both a potential coping mechanism for dealing with other mental health problems, and as an exacerbating factor of existing mental health problems. A retrospective study one year after the 2016 wildfires in Fort McMurray (Alberta, Canada) found that one third of the 1,510 evacuees sampled had clinically significant psychological symptoms with 7.9% prevalence of a substance use disorder [34]. Others have documented substance use as a coping mechanism following an the COVID-19 pandemic [35], and other disasters caused by natural hazards, such as hurricanes [36], and earthquakes [37].

A central finding in this study was that many of the mental health related issues during the wildfires were connected to apprehension around the uncertainty of events and a perceived lack of communication by authorities. Others have found that distrust of public officials can both exacerbate the mental health consequences of traumatic experiences such as disasters caused by natural hazards, technological disasters, or environmental contamination and can also be eroded post-disaster, leading to long-term impacts on health [38,39]. Perceived disorganization and poor communication have been identified as key contributors to stress during wildfire evacuation events among Indigenous [12] and non-Indigenous [9] communities in Canada affected by major wildfire events. Notably, wildfire and public health professionals involved in this study collectively identified a set of interventions targeting early, equitable, and community-based communication and preparedness efforts as the most actionable and impactful support options. Public communication has been identified as a key component of developing

community disaster resilience [40], and several studies of communication interventions during and after disasters suggest that outreach efforts can be an effective strategy to increase preparedness for disasters and to connect community members to mental health services [41]. A longitudinal analysis among residents in bushfire affected communities in Victoria, Australia found that a moderate amount of participation in community organizations builds social capital that can improve mental health outcomes post-disaster [42], suggesting that including residents in a voluntary community-preparedness program may build resilience to future wildfire events. Eriksen and Prior [43] highlight the importance of both physical and mental preparedness for wildfire events. The suggestion by the professional stakeholders in our study to develop of a short video series so that homeowners know what to expect during a wildfire could contribute to the three aspects of mental preparedness identified by Eriksen and Prior [43]: 1) ability to maintain emotional control, 2) understanding psychological strain and the realities during the wildfire, and 3) being prepared and ready to implement your preparedness plan.

While the mental health issues identified by community members and many of the supports that were highly ranked by the healthcare providers and wildfire responders can be generalized to other communities who have experienced wildfires, the detailed examples provided in interviews and workshops captured the local context and provide a strong foundation for tailoring interventions to Alaskan communities. It was clear from our conversations that tensions were high during the wildfire event, but despite this, the large number of supports and interventions identified by community members, providers, wildfire responders and other stakeholders provide an indication that many people involved in the 2019 wildfire season are eager to move forward and discuss strategies to prevent mental health impacts from future wildfire events. As difficult conversations in Alaska and other wildfire-affected communities about recovery and preparedness continue, we encourage the use of storytelling and narrative to broach topics that are difficult to describe or those that elicit emotional reactions. While storytelling has been used extensively to learn about people's lived experience and as part of interventions to cope with mental health issues [44], our experience facilitating conversations with diverse groups of stakeholders in Alaska supports the use of these techniques to promote constructive dialogue on difficult topics, such as supporting mental health during disasters like wildfires. Others have observed that sharing stories about a wildfire experience was perceived as a step towards coping and healing among community members, even a year after the event [12]. Additionally, cross-training of first responders and firefighters in mental health first aid and conversely, of behavioral health providers in the breadth of experiences and mental health impacts people may face during wildfires as described here, may help create a more cohesive and integrated spectrum of mental health supports during and after wildfire events.

A strength of this study is that data on mental health was collected based on the community's own perceptions of the boundaries and nature of mental distress, rather diagnostic categories. This provides strong insights and narratives into how psychological distress is perceived and experienced within wildfire affected communities in Alaska and provides an indication that elevated symptoms of disorders such as anxiety disorders, post-traumatic stress disorder, and depressive disorders may be present, warranting further study. Furthermore, it provides a lexicon for how these Alaskan communities may engage in discourse regarding mental health. A primary limitation of this study is related to the recruitment of participants through a sampling strategy that involved community outreach through social media and newspapers. Although our enrollment questionnaire to determine eligibility (based on age and residential location) was effective at excluding people outside of the wildfire-affected regions, our recruitment procedures only identified participants who were interested in talking to researchers about their experiences during the 2019 wildfire season. It is possible that the people interested in participating in the study were those who had intense experiences related to

the wildfires. Additionally, despite our efforts to target a variety of social media groups in order to reach a diverse pool of participants, our final sample of community members was disproportionately female. While male participants were present in the study sample, future studies should explore to what extent differences exist in psychological responses to wildfire based on gender, and whether the effectiveness of supports varies by gender. Children and adolescents also did not participate in this study and future work to understand their perspectives on wildfire related mental health directly is critical. For example, a study focused on Canadian middle and high school students found that diagnostic scores related to depression, suicidal thinking, and tobacco use were higher for students living in a region that had been affected by a large wildfire 18 moths earlier compared to a control community [45]. The data for this study were collected one year after the wildfires, which may have affected participant recall. Future studies would benefit from insights gathered either during or directly in the wake of the wildfire. Given that data collection occurred during the COVID-19 pandemic, perceptions and recollections may have been influenced by COVID-19-related stressors. While future studies could take care to disentangle wildfire-related distress from that related to other large scale emergencies, it is important to note that such complex disaster contexts are not uncommon, and researchers should evaluate the necessity of disentangling such psychological complexity, particularly in the context of developing actionable community support mechanisms.

Conclusions

As the frequency of large wildfire events and other climate change-related disasters increases, supporting the mental health of community members, as well as professional and volunteer service providers and responders, must be a key component of adaptation and preparedness plans. Specific elements to consider include the nuance and breadth of mental health responses that can occur during and after wildfires as well as the characteristics of the local context and population that may influence the reach and acceptance of interventions.

Supporting information

S1 Table. Categorical problems perceived to be related to mental distress during wildfires in southcentral Alaska based on community members descriptions during free-list interviews.
(DOCX)

S2 Table. Potential supports associated with each community-derived mental health problem identified by key informants (including wildfire and behavior health professionals) and community members.
(DOCX)

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