Lived experience of a record wildfire season in the Northwest Territories, Canada

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Abstract

Objectives During the period of June–September 2014, the Northwest Territories (NWT) experienced its worst wildfire season on record, with prolonged smoke events and poor air quality. In the context of climate change, this study sought to qualitatively explore the lived experience of the 2014 wildfire season among four communities in the NWT.

Methods Our team conducted 30 semi-structured interviews in four communities (Yellowknife, N'Dilo, Detah, and Kakisa). Interviewees were purposively sampled to include a broad cross-section of backgrounds and experiences. Interviews were video recorded, and the audio portion of each interview was transcribed to facilitate analysis and theme generation.

Results Interviewees reported how their experiences of evacuation and isolation as well as feelings of fear, stress, and uncertainty contributed to acute and long-term negative impacts for their mental and emotional well-being. Prolonged smoke events were linked to extended time indoors and respiratory problems. Livelihood and land-based activities were disrupted for some interviewees, which had negative consequences for mental, emotional, and physical well-being. Individual and community stories of adaptation and resilience prior to and during the summer, including the opening of indoor recreational spaces, were shared; however, there was consensus about the need for improved risk communication and coordination at the community and territorial levels to address similar events in the future.

Conclusion Coordinated community-based education, communication, and adaptation initiatives that are inclusive of local knowledge, values, and context are needed to address the expressed needs of community members associated with prolonged smoke events and wildfire seasons.

Résumé

Objectifs La période de juin à septembre 2014 a été la pire saison des incendies jamais enregistrée aux Territoires du Nord-Ouest, avec des épisodes de fumée prolongés et une mauvaise qualité de l'air. Dans le contexte des changements climatiques, notre étude visait à explorer de façon qualitative l'expérience vécue durant la saison des incendies de 2014 dans quatre localités des Territoires.

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Méthode Notre équipe a mené 30 entretiens semi-directifs dans quatre localités (Yellowknife, N'Dilo, Detah et Kakisa). Nous avons intentionnellement composé notre échantillon de personnes aux antécédents et aux expériences très diverses. Les entretiens ont été enregistrés sur support vidéo, et la portion audio de chaque entretien a été transcrite pour en faciliter l'analyse et en dégager les grands thèmes.

Résultats Les personnes interrogées ont expliqué que leurs expériences d'évacuation et d'isolement et leurs sentiments de peur, de stress et d'incertitude ont eu des effets nuisibles aigus et prolongés sur leur bien-être mental et émotionnel. Les épisodes de fumée prolongés les ont amenées à passer beaucoup de temps à l'intérieur et ont été liés à des troubles respiratoires. Les activités terrestres et de subsistance de certaines des personnes interrogées ont été interrompues, ce qui a eu des conséquences négatives sur leur bien-être mental, émotionnel et physique. Des récits individuels et collectifs d'adaptation et de résilience avant et durant l'été, comme l'ouverture d'espaces récréatifs intérieurs, ont été partagées; un consensus s'est toutefois dégagé sur la nécessité d'améliorer la communication des risques et la coordination à l'échelle locale et territoriale pour faire face aux épisodes semblables à l'avenir.

Conclusion Des initiatives communautaires de sensibilisation, de communication et d'adaptation coordonnées intégrant les connaissances, les valeurs et le contexte locaux sont nécessaires pour répondre aux besoins exprimés par les résidents en lien avec les épisodes de fumée prolongés et la saison des incendies.

Keywords Wildfire smoke · Mental health · Physical health · Adaptation · Climate change · Subarctic

Mots-clés Fumée d'incendies forestiers · Santé mentale · Santé physique · Adaptation · Changement climatique · Subarctique

Introduction

Wildfires and wildfire smoke are pressing public health and environmental threats in Canada. In the context of climate change, shifts in temperatures, extended drought conditions, and high winds are projected to increase the incidence and intensity of wildfires throughout the country (Wang et al. 2015). Previous research on human–wildfire interactions has primarily focused on the trauma and devastation caused by wildfires for individuals and communities. Studies demonstrate how experiences with property damage and loss, evacuation, and displacement have acute and long-term impacts on mental health and emotional well-being among affected populations (Papanikolaou et al. 2011; McDermott et al. 2005; Marshall et al. 2007; Tally et al. 2013). Other studies describe individual- and community-level decision-making processes and actions in preparing for and dealing with the aftermath of wildfire events (Penman et al. 2016; McCaffrey 2015). In particular, the role of social capital and community cohesion in aiding with preparation (Bihari and Ryan 2012), mediating uncertainty during a wildfire event (Afifi et al. 2012), or facilitating reconstruction efforts (Carroll et al. 2005) is also examined.

Beyond direct experiences with wildfires, there are health and livelihood consequences connected to exposure to the hazardous air pollutants contained within wildfire smoke. Recent reviews have demonstrated an increased risk of respiratory morbidity and overall mortality among populations exposed to wildfire smoke (Reid et al. 2016; Liu et al. 2015). Several studies have also shown an association between wildfire smoke exposure and specific cardiovascular outcomes

such as cardiac arrests (Dennekamp et al. 2015; Haikerwal et al. 2015); however, the broader relationship between wildfire smoke exposure and cardiovascular morbidity is mixed (Reid et al. 2016). Additionally, wildfire smoke exposure negatively affects quality of life, with several studies assessing a population's willingness to pay to avert future exposure (Lin et al. 2017; Jones 2017), and other studies measuring the extent of the economic costs associated with wildfire smoke in different settings (Kochi et al. 2016; Jones et al. 2016).

Indigenous communities may be especially vulnerable to the effects of wildfires and wildfire smoke. A review of wildfire evacuations in Canada between 1980 and 2007 demonstrated that almost one third of all evacuation events during this period involved First Nation or Métis populations (Beverly and Bothwell 2011). Of note, while only 19% of evacuations overall were caused by smoke, First Nation communities were involved in 75% of these events (Beverly and Bothwell 2011). In Australia, the Indigenous population had an elevated risk of hospitalization for ischemic heart disease (Johnston et al. 2007) and respiratory problems (Hanigan et al. 2008) compared to the non-Indigenous population following wildfire smoke exposure. As a result of their connection and reliance on the land and land-based activities such as hunting and foraging, wildfires may also disrupt livelihoods and contribute to food insecurity among Indigenous communities (Cochran et al. 2013).

In the Canadian context, wildfires are projected to increasingly affect Northern and Subarctic regions (Wang et al. 2015). During the summer of 2014 (June–September), the Northwest Territories (NWT) experienced its worst wildfire season on record. According to the

Department of Environment and Natural Resources Forest Fire Management Program for the NWT, drought conditions led to 385 separate fires across the territory affecting 3.4 million hectares of forested area (NWT Department of Environment and Natural Resources 2015). In total, CAD \$56.1 million was spent on firefighting costs, which exceeded the annual budget of CAD \$7.5 million (NWT Department of Environment and Natural Resources 2015). Beyond the environmental impact and financial cost, human activity was also disrupted during the 2014 wildfire season. Periodic highway closures throughout the summer meant a delay in the movement of goods and people. Fires were observed within the boundaries of four communities—Kakisa, Hay River, Whati, and Gameti—while eight additional communities experienced elevated levels of risk (NWT Department of Environment and Natural Resources 2015). Although there were no fatalities or serious injuries reported during the wildfire season as a direct result of the fires, stories that garnered national media attention acknowledged that the fires, and especially the persistent presence of smoke, had a profound impact on individual and community well-being and livelihoods (CBC News 2014a, b; Fatima 2014).

The objective of this study was to qualitatively explore the lived experience of individuals and communities affected by the 2014 wildfire season in the NWT, and to examine the impact of the wildfires and smoke on mental and emotional well-being, physical health, and livelihoods. We use the vulnerability framework (Ford and Smit 2004; Ford et al. 2010), and its constructs of exposure, sensitivity, and adaptive capacity, to inform our study (Ford et al. 2006; Smit and Wandel 2006). Applied to this climate-health context, exposure is concerned with the health outcomes associated with wildfires and smoke; sensitivity refers to ability of individuals, communities, and institutions, including health systems, to mediate the severity of the exposures; and adaptive capacity describes how these actors approach, prepare for, or adapt to health and livelihood outcomes related to wildfires and smoke. This framework emphasizes the role of institutions in planning for and responding to climate health events, while recognizing how non-climatic factors, in addition to the resilience of individuals and communities, can shape experiences with these events (Ford and Smit 2004; Ford 2012; Papworth et al. 2015).

Methods

Study location

This study was conducted in four Subarctic communities in the NWT that were affected by the prolonged smoke event that resulted from the 2014 wildfires: Yellowknife and N'Dilo

(combined population 19,569); Detah (population 219); and Kakisa (population 36).¹ N'Dilo, Detah, and Kakisa are majority Dene (First Nation) communities, while Yellowknife's population includes both Indigenous (First Nations, Métis, Inuit) and non-Indigenous residents. Yellowknife serves as the NWT's capital with a number of municipal and territorial government services, including the Stanton Territorial Hospital. Yellowknife, N'Dilo, and Detah are located on the north shore of Great Slave Lake (North Slave Administrative Region) and Kakisa is located in the South Slave Administrative Region.

While the communities of Yellowknife, N'Dilo, and Detah were never imminently threatened by fire during the summer, the community of Kakisa underwent a voluntary evacuation as a result of encroaching fires. On June 27, 2014, most residents evacuated to the community of Hay River (135 km east by road). In Hay River, most community members stayed together in the local community hall. After a week and a half, residents were permitted to return to Kakisa. Although fire had surrounded Kakisa, which had precipitated the evacuation, firefighting efforts meant that no structures in the community were damaged by the wildfire.

Research partnership and approach

Anchored by an intersectoral community-based partnership, the qualitative study detailed here was part of a larger project called “Summer of Smoke: A Mixed-Methods Examination of the Health Effects of a Record Wildfire Season in Canada's Northwest Territories.” This larger project was initiated, designed, and led by local physicians, an environmental non-governmental organization in Yellowknife (Ecology North), and local researchers, in close partnership with Yellowknives Dene First Nation and Ka'a'gee Tu First Nation, and with support from academic partners. Integrating quantitative and qualitative methods, the aim of the larger project was to develop a comprehensive understanding of how the 2014 wildfire season affected the health and well-being of residents in the four aforementioned communities. Through ongoing engagement and several outputs, including community-specific documentaries and a policy report, the project aimed to encourage dialogue at both the community and policy levels surrounding risk mitigation and adaptation planning for future wildfire events.

Qualitative data collection and analysis

Guided by a phenomenological approach to explore and understand how wildfires were experienced first-hand, a semi-structured interview guide was collaboratively developed by the research team (Lindseth and Norberg 2004). The interview

¹ 2016 census data from Statistics Canada

guide inquired about health, environmental, and livelihood factors and their relationship with the wildfires in a flexible format to allow for interviewees to elaborate on particular areas of interest or impact. Within each of the majority First Nation communities, the research team partnered with a community coordinator to facilitate and conduct each interview. In Yellowknife, interviews were conducted by a member of the research team. Interviewees were purposively sampled to allow for a broad cross section of backgrounds and experiences to be included. All interviews were conducted in the preferred language of the interviewee and were video recorded.

In total, 30 interviews (10 in Yellowknife; 7 in N'Dilo; 6 in Detah; 7 in Kakisa) were conducted during the period of October–December 2015 with residents of the four communities (Table 1). Interviewees in N'Dilo, Kakisa, and Detah included community members, community leadership, and Elders. In addition to the inclusion of residents from Yellowknife, four interviews were conducted with key informants, including an individual in municipal government, a local physician, a local pharmacist, and a territorial public health official. These key informant interviews provided unique perspectives on the impact of the wildfires in Yellowknife and across the Northwest Territories, in addition to responses by government and the health sector during the wildfire seasons.

The audio portion from each video recording was manually transcribed by a research assistant. Transcripts were checked for completeness and accuracy and shared with the research team. Community coordinators were also provided with completed transcripts from their respective communities. Following familiarization with the data, an iterative reflexive process involving the research team and the community coordinators was initiated to identify themes that emerged from the interviews. This process was informed by our team's a priori understanding of the literature (deductive) and through reading the transcript together (inductive) (Fereday and Muir-

Cochrane 2006). Final themes were established following this collaborative process. Transcripts were then imported into the software package QSR NVivo 11 for coding according to the agreed-upon themes. Any additional themes that emerged from the data during the coding process that were deemed relevant were discussed with the research team prior to inclusion in the analysis.

Results

“Not knowing what lies around the corner”: consequences for mental and emotional well-being

Participants described how the risk of forest fires and the consistent presence of smoke throughout the summer produced feelings of fear, stress, uncertainty, and isolation. All participants experienced the prolonged exposure to smoke as a result of the number and intensity of the forest fires. However, the geographic position of different communities relative to the fires influenced subsequent experiences with the forest fires. In particular, the effect of the voluntary evacuation on mental and emotional well-being featured prominently in interviews with participants from Kakisa. As one First Nation female participant from Kakisa indicated:

“It was scary, frightening, it's like, for a while I thought that the community was going to burn down.”

Another First Nation female participant from Kakisa spoke about the ongoing stress and anxiety related to the wildfires:

“Well, it took a toll on me because being stressed out from the fires and never knowing when we had to leave to be evacuated we didn't know if we were going to come home to a community or to our houses. We didn't

Table 1 List of interviewees included in the study from Yellowknife, N'Dilo, Detah, and Kakisa

Community	Representation	Interviewees
Yellowknife (<i>n</i> = 10)		6 females; 4 males Municipal government official (<i>n</i> = 1); physician (<i>n</i> = 1); pharmacist (<i>n</i> = 1); territorial public health official (<i>n</i> = 1); community members (<i>n</i> = 6)
N'Dilo (<i>n</i> = 7)	Residents represented by the Yellowknives Dene First Nation (N'Dilo)	5 females; 2 males Elders (<i>n</i> = 3); community members (<i>n</i> = 4)
Detah (<i>n</i> = 6)	Residents represented by the Yellowknives Dene First Nation (Detah)	4 females; 2 males Community members (<i>n</i> = 6)
Kakisa (<i>n</i> = 7)	Residents represented by the Ka'a'gee Tu First Nation	4 females; 3 males Community leadership (<i>n</i> = 1); Elder (<i>n</i> = 1); community firefighter (<i>n</i> = 1); community members (<i>n</i> = 3); youth (<i>n</i> = 1)

know nothing. We didn't know, didn't know what to expect. Not knowing what lies around the corner there. So it was really stressful...It was really draining because you don't know what's in store for us when we got back home."

In all communities, the most common sentiment expressed among participants as a result of living through the "summer of smoke" was a feeling of personal and community isolation. At the individual level, many participants ($n = 15$) spoke of how the presence of dense smoke throughout the summer meant that they were often confined to their house. This reality was especially noted for children and the elderly. One First Nation female participant from Kakisa explained:

"You couldn't open the windows. As soon as you go outside for like a few minutes and, you felt like your lungs were hurting and then, yeah, so we had to stay inside, keep the kids inside, they're wondering why they couldn't play outside, and, but like, yeah, just kind of felt isolated and that was that."

During the summer, there was a period of time when the main highway to all communities was closed due to the movement of the fires. The closure of the highway was noted in several interviews ($n = 6$) as the moment when these feelings of isolation were extended to the community level. Beyond the closure of the highway, some participants discussed how the summer of smoke influenced community dynamics and well-being. Reflecting on this isolation, a female participant from Yellowknife stated:

"You know, I think that people were more isolated because people weren't out working in their gardens. They weren't out walking around...they weren't out participating in things the way they normally are. So that really impacts community, sense of community, community cohesion, all of those things."

Although these feelings were most pronounced during the summer of smoke, some participants discussed the longer-term impacts of the summer on their mental and emotional well-being, in addition to the well-being of their families and their communities. A First Nation female participant from Kakisa explained:

"People still talk about the fire and how it affected them emotionally...We're still dealing with it, we still struggle with it...We don't know if we're going to be hit with another fire again so it kind of stalls you from doing a lot of things and you can't really go anywhere too far out of the community because you don't know if the fire is going to come back or not."

"Sequestered in the house": consequences for physical activity and well-being

The consistent presence of smoke throughout the summer also had broad consequences for physical activity and well-being among participants and within their communities. In particular, participants spoke of how the smoke was directly responsible for a noticeable decrease in the physical activity of their neighbours, in addition to a decrease in their own physical activity. Often, extended time indoors was viewed as one way to relieve physical symptoms that were connected with the persistent smoke outside. One First Nation male youth participant from Kakisa reflected:

"I spent most of my time just staying inside, just laying in bed. Just staying away from outside, from all the smoke. Just [to] keep my [smoke-related] headache from getting worse."

In addition to staying inside, some participants discussed how they intentionally reduced their physical activity level in order to cope with the heavy smoke. One female participant from Yellowknife detailed how her lack of physical activity contributed to a feeling of lethargy during the summer:

"I consciously didn't ride my bike. I didn't exert myself...I just didn't do that. I just assumed that would put me at risk. So I didn't do anything that required a lot of heavy breathing so to speak, right? But, I would say that I had a general feeling of low energy...I would say that the main kind of physiological kind of impact would be a low energy, almost, a lethargy, you know, which is not in keeping with my personality (laughs) or the way that I function."

As a result of the persistent smoke, most participants experienced mild physical symptoms such as itchy eyes, a headache, or a sore throat either at one point in time, or for an extended period during the summer. However, several participants ($n = 9$) described how the smoke triggered serious physiological symptoms in either themselves or in a family member. The most prominent symptom discussed was related to respiratory functioning, which in some cases severely impeded activity levels and well-being. One female participant from Yellowknife explained:

"I couldn't breathe...And I couldn't work... 'cause, it doesn't matter how good of a smoke mask you have when the doors are open, that smoke just keeps coming, bellowing in. So I couldn't go to work, couldn't go outside and do my gardening...couldn't enjoy my grandchildren outside. I was sequestered in the house."

Similarly, another First Nation female participant from N'Dilo stated:

“I usually do caribou hide and moose hide outside...But I felt that when I was working on my moose hide and caribou hide I was short of oxygen...I was short of breath and I couldn't even go for a walk.”

The consistent presence of dense smoke throughout the summer was unbearable for some individuals with pre-existing respiratory health problems. One male interviewee from Yellowknife explained:

“I've got a niece of mine [who] is asthmatic you know. She was having real, real troubles. She had to actually physically leave town...the puffer just couldn't keep up.”

For these individuals, leaving their community, and often the NWT, until the conditions improved was the only way to cope with the smoke.

“The lost summer”: separation from the land and traditional activities

In bridging the consequences of the summer of smoke for emotional, mental, and physical well-being, some participants discussed how the consistent presence of smoke prevented them from engaging in traditional summer activities, such as berry harvesting and fishing. In particular, the emotional impact of this separation from the land was highlighted by several participants. In reflecting on this emotional impact, a female participant from Yellowknife stated:

“It was the lost summer...the attachment to the land and place, what it does, and when you get alienated, you know, from that place...it takes a deep, emotional toll, if not a spiritual toll.”

Another First Nation female participant from Yellowknife shared a similar sentiment:

“It was like we didn't have a summer, for me, because, usually we get outside, we do things on the water...we enjoy being in the North. We enjoy being outside. We enjoy the environment. We enjoy cooking. Everything that's outside, we enjoy, and, I feel like I lost that...that impacts you emotionally and mentally.”

In addition to the negative effect on emotional well-being as a result of being separated from the land, some First Nation participants connected their inability to participate in

traditional land-based activities, and their subsequent decrease in physical activity, as a key impact of the smoke. A First Nation male participant from Detah explained:

“You want to go out and do some activities out on the land, and [the smoke] made us stay home, like, we always go out like I have a boat and stuff like, my family and that we go out and we usually go camping in the summer. It kinda put a damper on that for a while cause [you] can't go out in the smoke and you don't know where you're going and just that the smoke was too thick.”

With fewer opportunities to participate in traditional land-based activities, several participants discussed how their separation from the land influenced their livelihoods and food security. In particular, a First Nation female participant from N'Dilo stated:

“My family, they're hunters and trappers and myself, I depend on the wildlife and the wild meat and the fish, the wild game, to help subsidize with our food supply because the cost of living in Yellowknife is just way too high. And then after that summer, no more meat.”

Importantly, some participants saw their inability to participate in land-based activities along with the decreased availability of country foods as part of a broader process of environmental change. Consequently, participants who were dependent on hunting, foraging, and fishing to meet their needs were uncertain about the future viability of these activities and the related consequences for their food security and well-being. A First Nation female participant from Kakisa commented on how the wildfires affected her ability to forage:

“It's pretty dry, this year we hardly see any berries, 'cause the fires burned all the berries. And the ones you did find were just small and dried up, and there's no water, no rain. It's been pretty awful the past couple of years now.”

Similarly, another First Nation female interviewee from N'Dilo connected environmental changes she was witnessing to the availability of country food:

“Animals are dying; it's so sad. And wherever you go you know, you expect to see birds and you expect to see some live food, because we need our country food. Our Elders are suffering because they're not eating their country food. I can't live on chicken. I can't live on pork chop. I can't live on beef. It don't taste as good as caribou meat and moose meat. This

is how I was brought up ever since I was very young.”

“It brought people together”: stories of adaptation and resilience

Prior to and early on in the summer, steps were taken by some individuals and households to prepare for the potential serious wildfire season. In particular, there was mention of a community-based program (FireSmart), initiated by the Government of Northwest Territories in Yellowknife and Kakisa, that provided a workshop to encourage residents to remove brush and other flammable materials from around their houses. However, for some interviewees in Kakisa ($n = 2$), there was a sentiment that this program should reach more people in subsequent years to ensure broad participation.

As previously referenced, the direct threat of wildfires and the experience with evacuation featured prominently in interviews with participants from Kakisa. However, these experiences also fostered opportunities for community members to support and care for each other. When the wildfires threatened the houses of some residents, community firefighters were quick to ensure that the houses were spared. Residents also evacuated and stayed together in Hay River, and offered support in uncertain moments. In the other communities included in the study, this sense of community support was also present. In Yellowknife, one female interviewee commented:

“I think the real positive thing is it brought people together. People talked about it. People were concerned about things and about other people and helping, and it’s the thing I love about the North is that, when the chips are down and bad stuff’s happening, everybody pulls together.”

In response to the isolation and lack of physical activity felt during the summer, several community-based initiatives emerged. In N’Dilo, community members worked together to host activities at the local community hall to promote physical activity among children and provide everyone with an opportunity to socialize. In Yellowknife, a similar initiative took place whereby a recreation facility waived user fees to encourage indoor physical activity.

“The new norm”: situating the summer of smoke within broader environmental change

In discussing the potential causes for the prolonged smoke event and widespread wildfires, a minority of participants

viewed the event as part of a natural environmental process. This group of respondents did not have a strong reaction to the wildfires and did not explicitly comment on the need for subsequent action around community-based adaptation. In particular, one respondent mentioned that the wildfire was “nature taking care of itself.”

However, for the majority of participants, the summer of smoke was perceived to be a part of a broader environmental change process underway in their communities. At the community level, several respondents referenced the significance of the lack of precipitation leading up to the summer of smoke and how these dry conditions facilitated the spread and intensity of the fires. Additionally, climate change, and its impact on Subarctic areas and populations, was frequently cited as a primary contributing factor to the summer of smoke. In response, some respondents saw a need for increased dialogue and education within their communities concerning the current impacts of climate change and how adaptation could mitigate these impacts.

Finally, there was trepidation expressed among some participants concerning how the summer of 2014 may foreshadow future wildfires and other climate change-related events. Several participants mentioned that their frame of reference for what a typical wildfire season might look like had shifted as a result of the summer of smoke. A male participant from Yellowknife explained:

“I don’t want us to ever have to go through something like that, but I think more and more, we realize, and a lot of people realize that, unfortunately, something like that might become the new norm.”

For these respondents, there was advocacy for improved planning and adaptation now to mitigate adverse impacts associated with the inevitability of future wildfires.

Discussion

The extent of exposure: mental and physical health and well-being

For the majority of interviewees, there was a direct connection between the wildfires and smoke and a decrease in their mental and emotional health (McDermott et al. 2005; Marshall et al. 2007). For residents of Kakisa, their experience with evacuation was a source of acute and ongoing fear, uncertainty, and anxiety (Tally et al. 2013; Afifi et al. 2012). However, a key feature of the Kakisa evacuation was that community members primarily evacuated and stayed together in Hay River, which mitigated the potential for an added emotional stressor related to a fragmented evacuation and the separation of families, as documented elsewhere (Scharbach and

Waldram 2016). Concurrently, although ongoing anxiety, fear, and stress about the future possibility of similar events was indicated across communities (Kulig et al. 2013), residents from Kakisa explicitly mentioned the evacuation as a source of ongoing concern. Thus, the experience of evacuation may have led to differential emotional responses and impacts among residents from Kakisa compared to residents from other communities (Marshall et al. 2007; Kulig et al. 2013).

Extended time indoors and the associated decrease in outdoor physical activity were the most common actions reported by participants to reduce their exposure to wildfire smoke. While staying indoors is often promoted as a public health measure to limit exposure to poor air quality, a number of factors, including frequent window opening, living in an older home, or a lengthy smoke event such as the one experienced during the summer of 2014 in the NWT, may create conditions whereby air quality inside is worse than outdoors (Allen et al. 2012; MacNeill et al. 2012). In addition, although reducing outdoor physical activity can plausibly reduce an individual's exposure to wildfire smoke, there is a lack of evidence that fully investigates this relationship (Dix-Cooper 2014). Meanwhile, reduced levels of physical activity during the summer would be expected to have negative impacts on chronic disease management in addition to mental health and emotional well-being (Warburton and Bredin 2017). Thus, subsequent research should explore the conditions under which staying indoors and reducing outdoor physical activity can be protective against wildfire smoke, as well as indoor recreation policy initiatives to compensate for reduced outdoor physical activity. This is especially important as our study demonstrated that extended periods of time indoors had consequences for individual mental health and community cohesion. Indeed, feelings of isolation that were primarily attributed to extended time indoors were responsible for stress and anxiety among participants in all communities.

Respiratory problems were among the most serious physical health outcomes reported by participants in our study. Our parallel quantitative study corroborated this finding, where we found an association between wildfire smoke exposure and an increased incidence of visits to medical facilities for certain respiratory problems, including asthma and pneumonia (Dodd et al. 2018; Howard et al. 2018). These findings are also in line with recent reviews that have demonstrated an increased risk of respiratory infections as a result of wildfire smoke exposure (Liu et al. 2015; Williamson et al. 2016). With the likelihood of similar wildfire seasons in the future, there is a need to monitor new cases of respiratory infection and manage existing cases within this population.

Conceptualizing sensitivity: land and livelihoods

Our study explored the ways in which the wildfire season of 2014 created a sense of disconnectedness from the land and

disrupted livelihoods. Critically, interviewees, and particularly First Nation interviewees, underscored how these experiences of dislocation from the land had implications for their own mental and physical well-being, as well as the well-being of their communities (Cunsolo Willox et al. 2013). These sentiments expressed by the participants align with the concept of *solastalgia*, or distress and anxiety induced by place-based environmental change (Albrecht et al. 2007). Immediate changes to the local environment from the wildfires, in addition to ongoing observable processes of climate change, were sources of fear, sadness, anxiety, apprehension, and anger for interviewees.

Connected to the concept of solastalgia, First Nation interviewees highlighted the direct impact of the wildfire season on their livelihoods. Across Canada, and particularly Northern regions, environmental and climate change is altering and disrupting hunting, foraging, fishing, and trapping among Indigenous communities (Ford et al. 2010; Cunsolo Willox et al. 2013; Cunsolo Willox et al. 2012). For individuals and households engaged in subsistence livelihood activities, environmental and climate change has direct consequences for food and nutritional security (Beaumier and Ford 2010; Wesche and Chan 2010).

Several First Nation interviewees explained that the 2014 wildfire season compounded and accelerated existing challenges to their livelihoods and food security. In addition, the wildfires and smoke created conditions of acute food insecurity (e.g., limiting access to traditional hunting grounds) during the summer of 2014, while also having long-term implications for food security among individuals engaged in subsistence hunting, fishing, foraging, and trapping (e.g., reduction in available country food sources) (Cunsolo Willox et al. 2012; Beaumier and Ford 2010; Ford 2009). Thus, the extent of the impact of the 2014 wildfire season on First Nation livelihoods and food security needs to be viewed in relation to past, present, and future transitions as a result of environmental and climate change.

Enhancing adaptive capacity and looking to the future

There was consensus among interviewees of the need for comprehensive adaptation planning to mitigate the impact of future wildfire seasons. Some interviewees who had engaged in planning or mitigation activities (e.g., clearing vegetation) around their household prior to the beginning of the wildfire season experienced greater perceived preparedness and resilience during the wildfire season (Prior and Eriksen 2013). Motivations to engage in mitigation efforts may be mixed within a community, and previous experience with a severe wildfire season may not immediately translate into the uptake of mitigation measures at the household level (McGee et al. 2009). As others have demonstrated, “preparedness” in

practice is dependent on a number of interrelated social, cultural, economic, and environmental factors (McCaffrey 2015; Eriksen and Prior 2013; Penman et al. 2013).

Thus, and as was advocated for by several participants, there is a need for community-based adaptation and education initiatives in this context to address the different stages of a prolonged wildfire and smoke event. First, these initiatives should provide information and tools that equip individuals and communities with mitigation strategies prior to future wildfire and smoke events (McCaffrey 2015; McFarlane et al. 2012). Second, effective, timely, and accurate risk and public health communication is needed prior to and during future wildfire events (Steelman and McCaffrey 2013). Among the communities included in this study, this communication should incorporate smoke forecasting, due to its impact on physical and mental well-being. Finally, at the conclusion of a severe wildfire season, debriefing initiatives should take place in and with affected communities to inform future planning surrounding wildfires. This may be especially important to support families who may be undergoing their own recovery process following a wildfire event (Botey and Kulig 2014). Additionally, acknowledgement of the significance of local connections to place and the implications of place-attachment for mental and physical well-being are a critical component and need to be included in adaptation planning (Cunsolo Willox et al. 2012; Christianson et al. 2014). This acknowledgement involves an inclusion of local knowledge, values, and context in subsequent planning processes.

Conclusion

Using a community-based and qualitative approach, this study explored the lived experience of the wildfires and prolonged smoke event in four communities in the NWT during the summer of 2014. Our study highlighted the need for comprehensive and inclusive approaches to community-based education and adaptation. These initiatives include preparation prior to wildfire seasons, effective communication during wildfire and smoke events, and broad consultation following wildfire seasons that recognize and value the contributions of local knowledge to planning processes for subsequent wildfires. Wildfires are an immediate and significant environmental and public health threat in Canada, as evidenced not only by the wildfire season of 2014 in the NWT, but also more recent wildfire events in Alberta (2016) and British Columbia (2017). As climate change continues to create conditions that favour the spread of extreme wildfires throughout Canada, there is a need to proactively address the impacts of wildfires and smoke on mental and emotional well-being, physical health, and livelihoods among affected populations.

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Compliance with ethical standards

This project was reviewed and approved by the Aurora Research Institute (license numbers 15733; 15801), the Stanton Territorial Ethics Board, and the Wilfrid Laurier University Research Ethics Board (REB no. 4700). Prior to conducting any interviews, written or oral informed consent was obtained.

Conflict of Interest The authors declare that they have no conflict of interest.

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