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To cite this article: Suellen Hopfer *et al* 2024 *Environ. Res.: Health* **2** 035013

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Repeat wildfire and smoke experiences shared by four communities in Southern California: local impacts and community needs

Suellen Hopfer[1,*], **Anqi Jiao**[2], **Mengyi Li**[2], **Anna Lisa Vargas**[3] **and Jun Wu**[2]

[1] Health, Society & Behavior, Program in Public Health, University of California, Irvine, CA, United States of America
[2] Department Environmental & Occupational Health, Program in Public Health, University of California, Irvine, CA, United States of America
[3] Communities for a New California Education Fund, La Quinta, CA, United States of America
[*] Author to whom any correspondence should be addressed.

E-mail: shopfer@hs.uci.edu

Keywords: community lived experience, wildfire, health equity, climate equity, AB 617

OPEN ACCESS

RECEIVED
5 February 2024

REVISED
27 June 2024

ACCEPTED FOR PUBLICATION
11 July 2024

PUBLISHED
31 July 2024

Abstract

Families in unincorporated communities in Southern California's Eastern Coachella Valley (ECV) increasingly experience the burden of repeat wildfires and smoke. This study describes their lived wildfire and smoke experiences, health impacts, unique community-level inequities that compound wildfire risk and air quality effects, communication preferences, and resource needs for future wildfire preparedness. A wildfire community vulnerability framework informed the focus group discussion guide, exploring individual, community, and local government level factors that potentially influence community response and mitigation behaviors to repeat wildfire and smoke. Ten focus groups with 118 participants occurred in spring 2023 with four communities in ECV, California. Findings center on narratives of acute wildfire-related experiences, including evacuation and burned trailer homes, acute and chronic self report physical and mental health impacts of wildfires and smoke, daily life disruptions, staying indoors for protection, and local interactions described as a community strength in responding to fires. Participants from unincorporated, low-income, and monolingual Spanish-speaking communities predominantly consisting of farm workers requested greater emergency preparedness and response information, training and education in Spanish, postfire resources, lower trash service fees, increased enforcement of illegal dumping and burning, and use of multimodal and bilingual communication channels for wildfire, smoke, and wind alerts.

1. Human exposure to wildfires more than doubled in the last two decades in the US

1.1. Wildfire risk in the United States

In the United States, wildfires have become more frequent and intense compared to previous decades [1]. The currently unprecedented fire seasons of 2020 and 2021 in the Western US led to 7.7 million acres burned and resulted in poor air quality nationwide [2]. Wildfires can produce a vast amount of smoke, which contains fine particulate matter, ozone, carbon monoxide, volatile organic compounds, and other hazardous air pollutants [3, 4] that can travel thousands of miles downwind [5], such as the 2023 case of the Canadian wildfire smoke affecting New York City [6]. In addition to air quality impacts from smoke, heat and aerosols from wildfires notably increase severe weather in downstream regions [7]. Further, extreme heat events and the occurrence of wildfires are strongly correlated [8]. Wildfires often coincide with periods of exceptionally high temperatures, indicating that the intensity of heat can create conditions favorable for wildfires. Importantly, human populations may face the compounded risk of exposure to both wildfire smoke and extreme heat.

Wildfires can also adversely affect water quality in burned watersheds, where postfire erosion and runoff increase the levels of sediment, nutrients, and metals in water, typically for several years or more after wildfires [9, 10]. Contaminants in the watershed from fires subsequently increase levels of contaminants in drinking water, often exceeding health standards. Although advanced treatment facilities may be designed to address wildfire-related contaminants, their effectiveness can vary significantly and not all are sufficiently equipped to handle the influx of sediment and contamination following a wildfire [11, 12]. In addition, wildfires have amplified the risk of damage to water infrastructure, including secondary impacts such as affecting water treatment plant operations, potentially leaving residents without water or facing water quality issues for months [13].

Following the Western Fire Chief Association [14] and geography scholars who surveyed 221 wildfire experts [15], we defined the term *wildfire* in this study as an unplanned and uncontrolled fire, which occurs in wildlands such as forests, rangelands, or grasslands (grasslands are the most relevant to the desert ecosystem in this study). The wildfire term encompasses three fire types: (1) ground or subsurface fires that can occur with a large accumulation of dead vegetation such as humus and peat, (2) surface fires, which include burning of dry vegetation, twigs, leaves, grasses but also litter; and (3) crown fires, which burn in the tree canopy [14]. The Eastern Coachella Valley (ECV), a desert ecosystem, experiences surface wildfires frequently [14, 16]. In our study population, communities may perceive large fires caused by the illegal dumping and burning of green and e-waste, illegal burning of agricultural waste or garbage as wildfires. This perception stems from the fact that these fires are beyond their control and can sometimes escalate into much larger, uncontrollable wildfires. Our definition of wildfire thus, acknowledges wildfire as a socio-ecological phenomenon, referring to the complex interactions between people, community level factors, and nature during all phases of wildfire [15].

1.2. Southern California communities experience wildfires and smoke with increasing frequency and intensity

In California, the likelihood of wildfires has increased by 25% relative to preindustrial conditions due in large part to climate change [17]. More importantly, human exposure to wildfires has more than doubled in the last two decades [18]. Not only do the increasing frequency and intensity of wildfires have a significant and detrimental ecological and economic impact, but wildfire and smoke also pose considerable health threats [19, 20]. Low-income, marginalized communities are among the most disadvantaged in being able to respond to and protect themselves from these increasing threats [21].

Riverside County, in Southern California, has been identified as facing one of the highest health threats from wildfire risk [22–24]. The Coachella Valley is an arid rift valley in Riverside County. Hispanic American populations are well established in Central and ECV, with an estimated 92% of residents from Latino (mostly Mexican American) multigenerational communities. Agriculture and construction are predominant occupations. ECV is a geographical subdivision of Coachella Valley and features four unincorporated communities: Thermal, Mecca, Oasis, and North Shore (see figure 1). ECV is not exempt from the increasing number of wildfires and poor air quality given the extreme heat during much of the year (exceeding 100° Fahrenheit in spring and up to 115°–120° Fahrenheit during summer) and heavy winds in this geographic region [25]. Furthermore, invasive grasslands have taken over, creating fuel for wildfires. Residents of ECV unincorporated communities tend to have lower income, are predominantly monolingual Spanish-speaking, live in more rural, isolated and smaller communities, and are predominately farmworkers; some are undocumented immigrants who left Mexico to escape violence or to find work [26].

1.3. AB 617 communities in ECV

In 2017, Assembly Bill (AB) 617 was signed into law in California to recognize and support communities disproportionately burdened by poor air quality. AB 617 aimed to allocate funding and provide programs that take measures to protect disadvantaged communities. ECV communities were recognized in 2019 as having a high cumulative exposure burden and therefore were designated as an AB 617 community by the California air resource board (CARB) and South Coast Air quality management district (SCAQMD) [27]. Residents of these communities are exposed to significant air pollution from a number of local sources: toxic dust emissions from the drying Salton Sea also referred to as the playa, open burning and illegal dumping, fugitive dust from construction, unpaved roads and dust storms, pesticide drift from agricultural activities, diesel mobile sources from trucks, and air pollution from the Greenleaf Desert View power plant emissions [27]. The bill requires CARB and air districts to develop and implement additional reporting, monitoring, and emissions reduction plans and measures to reduce air pollution exposure in disadvantaged communities. Five components of this mandate include: community-level air quality monitoring, a state strategy and community-specific emission reductions plan (CERP), accelerated review of pollution controls at industrial facilities, enhanced emission reporting requirements, and increased penalty provisions for polluters. Four

Figure 1. Location of Eastern Coachella Valley (ECV) and the four communities of Thermal, Oasis, Mecca, and North Shore.

unincorporated communities in ECV: Thermal, Mecca, Oasis, and North Shore were designated as AB 617 communities [27, 28].

1.4. Cumulative health burdens in ECV

Current evidence suggests associations between wildfires and diverse population-level health consequences such as premature mortality, respiratory morbidity and mortality, cardiovascular disease, and poor mental health [29]. These effects may be amplified by concurrent environmental and social conditions, such as heat [30, 31], sociodemographic factors [23, 32], and social interactions [33]. People who are Black, Hispanic, Native American, children, or older adults or of lower socioeconomic status experience greater vulnerability to wildfire effects [31, 34].

Only a few studies have explored the contexts and impacts of wildfires on community residents to understand what repeat exposure to wildfires and smoke means for residents in these communities. Considering the lack of data, it may be challenging to identify various community impacts of wildfires through retrospective epidemiologic analyses. In this context, a comprehensive examination of the lived experiences of wildfires, health impacts, risk perceptions, mitigation behaviors, community social interactions, and communication preferences is paramount to enhancing our understanding and informs targeted intervention strategies. This study sought to describe the individual level wildfire and smoke experiences, but also investigate community level concerns and local government response to repeat wildfire and smoke.

2. Methods

2.1. Study design and recruitment

A partnership between University of California, Irvine (UC Irvine) and an ECV community organization was established to capture the voices and lived experiences of communities affected by repeat wildfire and smoke. The sites were the four aforementioned rural, unincorporated desert communities located north of the Salton Sea in ECV, California (figure 1): Mecca, Thermal, Oasis and North Shore. A qualitative focus group study was conducted with these four AB 617 communities between February and April 2023.

The ECV community-based organization, Communities for a New California Education Fund (CNC EF) took the lead in moderating the focus groups. CNC EF is involved in grassroots community capacity building in California to ensure families have the necessary resources to thrive. CNC EF engages families in various programs, including affordable housing, voter registration, COVID-19 vaccination, individual taxpayer identification number assistance, environmental justice, do-it-yourself home air filtration systems, to name a few. Together with UC Irvine public health program a partnership was formed to investigate how ECV communities are impacted by repeat wildfires and smoke among multiple contributors to air pollution threats.

Purposive sampling was used to recruit community residents who self-reported having experienced one or more wildfires in the last three years. A print flyer was circulated in person at community events, during door-to-door canvassing, announced at monthly community steering committee (CSC) meetings, and disseminated digitally on CNC EF's Instagram account. CNC EF staff and community leaders (co-authors) recruited ECV community residents.

2.2. Population characteristics

The characteristics of participants are summarized in table 1. Their mean age was 46 years. Almost all (97%) participants self-identified as Hispanic. Most (74%) had not attended college, and a majority 76% had an annual household income less than $50 000. Nearly half (45%) of participants reported that their occupation was related to farm work or agriculture. At each focus group, participants came from the surrounding communities, ranging in size from mobile home parks consisting of about 12 homes to small towns of up to 7000 residents.

ECV is part of yet distinct from the Coachella Valley. Characterized by largely immigrant communities from predominantly Mexico, but also other countries (El Salvador, Honduras, Cuba, and Puerto Rico), most residents identify as Latino (92%). Among the immigrant community, a minority (7%–28%) are citizens and a majority (72%) are non-citizens [35] More than 80 000 people live in the ECV communities [36]. More than half (58%) of adults in ECV have less than a high school education, 48% of residents live below the federal poverty line, and among non-citizen immigrants, one quarter work in agriculture and another quarter work in construction [35, 36].

The focus group sample reflected the ECV population on most demographics except that the study participants were a majority (69.5%) women (table 1). Slightly less than half (44%) of focus group participants reported having less than high school education relative to the ECV communities (58%) [35, 36]. A slightly higher proportion of study participants (59%) reported incomes below the federal poverty level (<$25 000) compared with ECV, where publicly available data indicate 48% live below the poverty line [35, 36]. Regarding age distribution, the focus groups had a slightly smaller proportion of participants aged 18–44 (40% vs. 48% in ECV) but this varied depending on community and slightly higher proportions of residents aged 45–64 (43% vs. 27%) and 65 or older (15% vs. 6.5%). Mecca has the largest population of the four communities at more than 6000 residents, and North Shore has the largest retired population. With respect to occupation, 45% of study participants reported being farmworkers, 22% reported another profession (gardener, hospitality, retail, administration, non-profit, county or city affiliate, homemaker, construction), 18% reported being retired, and 15% preferred not to answer (this likely included undocumented immigrants who may have been fearful about sharing their occupation).

2.3. Focus group procedures

A focus group moderator guide was developed based on the wildfire community vulnerability framework [34] with five areas of focused inquiry: personal lived experience with wildfire, health impacts, response and mitigation behaviors, community social interaction, and wildfire risk communication preferences. In these five areas, probes were used to prompt community members to elaborate on fire and smoke experiences, concerns, and questions as well as individual, but also community and local government level responses. A survey was also implemented at the beginning of the in-person focus groups to collect sociodemographic information, including age, race and ethnicity, gender, community of residence, education, income, and occupation.

Consent was reviewed with community participants. The focus group moderator (co-author) who is bilingual in Spanish and English explained the study purpose and moderated community discussions. Focus groups were held in public spaces within the community (e.g. library, community park, school) and were 60 to 90 min long. Participants were compensated for their time with $50. All focus groups were audio recorded.

We conducted 10 focus group discussions with 118 unique participants between February and April 2023. The focus groups ranged in size from 4 to 24 participants.

2.4. Data analysis

Audio recordings were transcribed in Spanish and then back translated into English. Data analysis began with data immersion. Three authors reviewed the transcripts i.e. the data and conducted all data analyses. Data immersion was followed by primary and inductive data analysis, which involved tagging segments of data relevant to community experiences with wildfire and smoke, identifying concepts discussed in the transcript data about wildfire experiences, and developing descriptive code names for the concepts and experiences [37]. A codebook was developed in Microsoft Excel to document the initial descriptive codes and

Table 1. The descriptive statistics of characteristics of participants in this study ($n = 118$).

Characteristics	Total participants ($n = 118$)	Mecca ($n = 64$)	North Shore ($n = 39$)	Other[a] ($n = 15$)
Age, y				
Mean ± SD	46.5 ± 16.4	40.3 ± 15.1	52.7 ± 15.1	57.6 ± 13.6
<18	1 (0.9)	0	1 (2.6)	0
18–44	47 (39.8)	36 (56.3)	8 (20.5)	3 (20.0)
45–64	51 (43.2)	23 (35.9)	21 (53.9)	7 (46.7)
⩾65	18 (15.3)	5 (7.8)	9 (23.1)	4 (26.7)
Missing/prefer not to answer	1 (0.9)	0	0	1 (6.7)
Gender				
Female	82 (69.5)	46 (71.9)	25 (64.1)	11 (73.3)
Male	35 (29.7)	18 (28.1)	14 (35.9)	3 (20.0)
Missing	1 (0.9)	0	0	1 (6.7)
Race/ethnicity				
Asian	1 (0.9)	0	1 (2.6)	0
Hispanic/Latino	115 (97.5)	63 (98.4)	38 (97.4)	14 (93.3)
Missing/prefer not to answer	2 (1.7)	1 (1.6)	0	1 (6.7)
Education level				
No formal education	23 (19.5)	12 (18.8)	9 (23.1)	2 (13.3)
Primary school	29 (24.6)	15 (23.4)	9 (23.1)	5 (33.3)
Secondary/junior high school	35 (29.7)	21 (32.8)	10 (25.6)	4 (26.7)
Junior college/senior high school	12 (10.2)	10 (15.6)	1 (2.6)	1 (6.7)
Some college	9 (7.6)	5 (7.8)	3 (7.7)	1 (6.7)
Bachelor's degree or higher	7 (5.9)	1 (1.6)	5 (12.8)	1 (6.7)
Missing/prefer not to answer	3 (2.5)	0	2 (5.1)	1 (6.7)
Income level, $				
<$25 000	70 (59.3)	37 (57.8)	24 (61.5)	9 (60.00)
$25 000–$34 999	17 (14.4)	10 (15.6)	6 (15.4)	1 (6.7)
$35 000–$49 999	3 (2.5)	2 (3.1)	1 (2.6)	0
$50 000–$74 999	0	0	0	0
$75 000–$99 999	0	0	0	0
$100 000–$124 999	0	0	0	0
$125 000–$199 999	0	0	0	0
>$200 000	3 (2.5)	1 (1.6)	1 (2.6)	1 (6.7)
Missing/prefer not to answer	25 (21.2)	14 (21.9)	7 (18.0)	4 (26.7)
Occupation				
Farmwork/agriculture	53 (44.9)	31 (48.4)	19 (48.7)	3 (20.0)
Other[b]	26 (22.0)	15 (23.4)	9 (23.1)	2 (13.3)
Retired/unemployed	21 (17.8)	11 (17.2)	6 (15.4)	4 (26.7)
Missing/prefer not to answer	18 (15.3)	7 (10.9)	5 (12.8)	6 (40.0)

[a] The 'Other' group includes people from Thermal ($n = 5$), Coachella City ($n = 2$), and people who prefer not to report the residential information ($n = 8$).

[b] The 'Other' group includes people in various occupations including gardeners ($n = 5$), hospitality workers ($n = 1$), retail store employees ($n = 3$), administrative positions ($n = 1$), non-profit organization staff ($n = 1$), county or city affiliates ($n = 1$), homemakers ($n = 12$), and other unspecified occupations ($n = 2$).

verbatim quotes. Although focus group questions aimed to enlist experiences about wildfire, participants raised the issue of residential trash burning and commercial illegal trash dumping and burning as a significant contributor to persistent smoke and fire. Secondary data analysis involved organizing descriptive codes into higher order conceptual buckets and identifying themes. A deductive approach was taken at this stage of data analysis, organizing data by areas of inquiry (e.g. health effects, communication preferences, wildfire experience narratives, daily disruptions) and informed by the wildfire community vulnerability framework [38]. Additionally, emergent themes were recognized such as community level inequities (e.g. role of waste management). Themes were discussed by the research team and with ECV community leaders as a validity step to ensure the themes resonated with what the community shared—i.e. reflected trustworthiness. Themes were then reviewed relative to the research questions and whether any unique concerns or experiences occurred in the four communities [37, 39].

Rigor (i.e. trustworthiness of the data analysis process) was established through multiple steps taken to ensure transparency in the data collection and analysis process. An audit trail was provided through verbatim transcripts, a detailed codebook, and discussions with the research team. Member checks with community

members ensured credibility, dependability, authenticity, and transferability in the themes derived from the data [40, 41].

The study application (No. 2243) was approved as exempt by the institutional review board on 8 February 2023.

3. Findings

3.1. Fire experience narratives

We report first three prototypical fire narratives: an evacuation narrative, a smoke narrative, and a co-occurring extreme heat and wildfire narrative.

An ECV resident described a fire in February 2022, *I remember there was a huge fire outside. My husband was helping one of my neighbors. At first I thought, 'Oh, the fire's far away, it won't reach us.' Once we started seeing the fire department come in, um, I started going into a panic attack. My husband had to kind of snap me out of it, to say, 'Hey, we need to move the cars, we need to pack as many things as we can, 'cause you need to leave, like, you need to pick up my son from school,' 'cause, like, my neighbor says they were in school. So, I froze for a couple of seconds, and then we started getting as much stuff into the car as we could. My husband started getting the cars out of the ranch. But it was just the uncertainty that was going to happen, you know? We were a total of 12 neighbors. I don't even know that the gas was … that they had already turned off the gas, but I thought, you know, 'We're going to explode here.' … I ended up picking up my son because he is special needs. I couldn't drive him back because he would have really got into a panic attack. It was all black and it was a whole mess of cars. Everybody's trying to see what's going on. Decisions had to be made in seconds. My neighbor had to come home from work and get everything out of her house. The kids were crying. Seeing their panic as well, it was a big impact. It was also the aftermath. We got the gas shut off for two weeks. We had elderly neighbors—the food supply, we had to go eat out for those two weeks, so it ended putting stress on our income.*

This particular lived experience of a fire and evacuation illustrates at least four lessons or considerations: (a) the fear and panic experienced by a mother and neighbors who had to evacuate and the immediacy of having to retrieve a child with special needs was daunting; (b) the acute danger and unpreparedness of this family to mobilize rapidly; (c) the potential for a nearby gas tank to explode and endanger an entire mobile home park; and (d) the aftermath of the fire, including financial and emotional hardships and daily disruptions. This narrative describes acute needs that can inform training and preparedness to help residents respond as effectively as possible to wildfire threats.

Other narratives included descriptions of witnessing fires that were far away yet created intense smoke that affected the community.

Well, personally, it impacted me and my family because when we looked at the fire, we have family that lives on the side of Borrego, [Anza Borrego mountain range] and they spoke to us and look, they managed to see the flames in the mountains, since it was already getting closer, and we all got scared. And apart from that, we looked at all the smoke, that the sky turned all colours, grey, and we smelled all the smoke and it irritated our eyes and we began to have something like— … our throats hurt, my daughters [were] sneezing and our eyes watered, and then the temperature changed, and suddenly it was hot, but then it was like an oven, so hot that my chickens almost died. And apart from that, we were going to bathe every so often because we couldn't stand the heat, it was so hot. And apart from that, I used more water and the water bill went through the roof. And yes, we were shocked, because it is something that we had not seen before, that we thought would not touch us, but that came very close to us.

A third wildfire narrative described how farmworkers witnessed frequent fires and adapted their work practices in response to the extreme heat conditions in ECV (temperatures begin to exceed 99° Fahrenheit in April and reach 115° Fahrenheit or above through August). For instance, they began to plant seeds at night. The persistent extreme heat, drought, strong winds in the spring, accumulating trash (residents have low incomes and cannot afford trash service), and illegal dumping and burning of green waste created conditions conducive to wildfires. Residents described witnessing frequent fires in the early morning and night.

In August, I arrived from the night that I was planting chili peppers. I arrived, and we saw all the firefighters there in the apartments. They had lit all the trash in the back. And this fire was from the undergrowth and everything that has been growing and drying up in nature, like that outside, herbs and everything that grows. There are fires all the time here.

Residents also described witnessing overgrowth, brush, and grasslands burn. Studies on wildfires in arid and semi-arid ecosystems in the Western US have documented a chief concern: the rapid conversion of shrublands and deserts into grasslands through invasive grass species [16]. This is concerning because the change in the ecosystem results in increased wildfire risk, number of large fires, and area burned [16]. Residents across ECV communities described not only the fires they witnessed, but also the health impacts they experienced within temporal proximity to witnessing fires.

3.2. Health impacts from fire and smoke

3.2.1. Physical health impacts from fires

Participants mentioned the physical health consequences of fires. Acute health symptoms related to the respiratory system (breathing difficulty, tight chest) were most frequently discussed, followed by sinus symptoms (sinusitis, throat swelling, mucus, infections, nosebleeds), eye symptoms (e.g. irritation, wateriness, and itchiness), skin rashes and itchy skin, headaches and migraines, and allergies (skin, gastrointestinal). Participants described acute symptoms they experienced, along with chronic symptoms that developed over time, including allergies, migraines, and breathing difficulties. Participants shared that children, older adults, and people with existing asthma and lung problems were especially vulnerable in ECV. Several participants mentioned smoke triggered new asthma or exacerbated existing asthma. Children with asthma were seriously affected and had to stay inside the house during fires. One participant said, '*He tried to get out, but the smoke hit him at the door and knocked him over. … He had asthma. The black smoke affected him. He went to the hospital for it.*'

Difficulty breathing was a major concern expressed by participants, and some of them mentioned that they had to seek medical treatment, use nebulizer treatments, and visit urgent care for severe breathing difficulties or allergic reactions. '*You felt like you wanted to drown, like you lacked oxygen and the oxygen that you were getting was contaminated*,' one participant said. '*My chest starts to screech. I can no longer breathe like I should. I have to get treatment to be able to breathe as I should and if I can't, then I have to go to the hospital.*' Other parents mentioned they had to take their child to urgent care and give him nebulizer treatments routinely because of the poor air quality.

In addition to breathing difficulties, many participants mentioned throat and eye irritation: '*It fills your throat with so much smoke that you felt it.*' One participant said that the smoke affected the eyesight of one of her children, and many others described having watery, irritated eyes. One participant said: '*Since the fires and smoke, we will not go to school, but my parents have to go to work because they provide for us. My mom, due to the smoke—her eyes, she suffers irritation in her eyes and has to put eye drops in her eyes to this day.*' Some participants expressed worry about allergies induced or exacerbated by smoke that affected their children. '*They have gotten very sick, many allergies, many viruses here in this valley. There are a lot of allergies here because the air is very bad.*' Poor air quality from smoke is amplified in the spring in ECV, when dust storms and high winds exacerbate air quality issues in addition to smoke from fire: '*In March, we get a lot of sand storms out here and a lot of debris.*'

My experience is that because of the smoke, me and my other two daughters, the 16-year-old and the 13-year-old, noticed that there were changes in our bodies because she began to get very allergic. She gets a lot of itchy skin and lots of pimples appear. And the doctor took her and he told me that this could be the cause of many things, but it could also be the smoke, the stress of something she has seen, the many changes in the air, and all that. And I tell her, well, what she was looking at was the smoke and what we were seeing. And aside from that, my other daughter has many migraines.

3.2.2. Psychological and mental health impacts from fire and smoke experiences

Participants described experiencing fires that threatened their livelihood, their children's and family's health, their children's schooling, and their homes as scary: '*Firstly, the psychological effects on you, because fire will always scare you.*' Alongside fear, several participants mentioned that they suffered from anxiety and stress, not only during fires but also in their aftermath. Their sources of anxiety and stress included worry about children, physical health problems, isolation, destroyed homes, fear of becoming homeless, financial burdens, and uncertainty. Of note, uncertainty about the future made community members feel fearful and helpless. '*It's just that fear of what's going to happen next. How are we going to get through this?*' one participant said. Another participant whose trailer home burned to the ground said: '*You have nothing left; you don't even know what to do. … I didn't even know who to ask for a favor or to stay with.*'

Other mental health issues identified during discussions with residents included experiencing emotional stress, such as anger from children forced to stay indoors for days due to intense smoke and school closures. One mother indicated that the psychological impact of fires on children cannot be ignored. Others recounted the emotional stress from either losing or leaving behind pets during fire evacuations. One participant described her experience of losing her cats in a fire that burned her trailer: '*You had to evacuate. The truth is I left, and they no longer let me in, and because I have little animals and my cats there, I couldn't find them. I went crazy. I said, "I'm going to look for my kittens." They didn't let me be there anymore, because the smoke was already coming, the black smoke was already eating up all the trailers.*'

3.3. Daily life disruptions from fires and smoke

Daily life was disrupted in some cases by the closure of schools and the cancelling of work particularly farm work. Additionally, outdoor activities for children were substantially decreased due to bad air quality.

Schools closed when the valley filled with smoke. Some participants had to work outside, even during fire days, because they worked in the fields to provide for their families. Their working environment deteriorated and became harmful to their health. One participant described his work in the smoke: '*Imagine working there in the sun and with the smell of smoke. We were almost drowning in there, but we had to work because we couldn't get out.*' Another said, '*What was affected was going to work. … I work in the fields and well, it's eight hours that one works and puts up with all that aroma.*' Some other participants lost their jobs and became unemployed during fires, which brought more financial pressure to their lives.

Energy, water, and food impacts were described. Participants described their daily life being disrupted by shortages of electricity, gas, and clean water during and after a fire. Gas lines and electricity poles affected by fires brought more challenges for residents to maintain normal daily life. One participant said, '*We got the gas shut off for two weeks. … The food supply—we had to go eat out for those two weeks, so it ended up putting stress on our income.*' Following a fire in another town, another participant mentioned that 'the gas bill went through the roof.' Water shortages in ECV make it hard for people to put out fires, and water bills can be very expensive. '*The worst thing is that the fires are all most in hot weather. And it is more difficult to put them out because they are fires, and the weather is hot. … Because now California is already in a drought and there isn't even water or a way to pay for it. And if they want to put them out, the water is very expensive. The bill came to me at about $1,000 dollars last year,*' one participant explained.

3.4. Preparation and mitigation measures

Some participants discussed the need for more resources in the valley to reduce fire risks and strengthen emergency preparedness and overall resilience. They suggested providing trash service at lower cost, assigning first responders, increasing the county budget allocation for ECV, and offering fire prevention educational training (e.g. 'Smokey Bear') for adults and children in Spanish.

Participants discussed preparation and mitigation measures that they took during previous fires. Many discussed staying indoors or in their cars with the windows closed and the air conditioning or a fan on to reduce exposure to fire smoke, along with wearing masks and drinking more water. Two participants who had to work in the fields during fires said that they covered their nose and mouth with cloth masks when working outside. Some participants mentioned that children sometimes do not wear masks even though their parents asked them to do so. To reduce the probability of potential fires, some participants mentioned that they cleaned the area around their houses, watered dry wood, and turned off their gas to eliminate combustible materials.

Participants also said that the local community center should be stocked with emergency kits. Residents described that community centers need '*everything necessary for an emergency, like alcohol, bandages, first aid, masks, water and lamps, a portable radio.*' Participants raised the issue of inadequate state and county-level budget allocation for ECV and called for a shift in resources away from other wealthier regions of Coachella Valley toward ECV:

When they make a budget and distribute it to different departments, they should also leave a part for the eastern areas of the Coachella Valley, because almost all of them use it for the other side and when they want to do something here, they've run out of money. They should allocate or designate certain funds in order to have more resources for this area, which is the eastern part of the valley. We are the forgotten.

This resident also mentioned that the ECV needs more resources and money for education about wildfire preparedness.

3.5. Postfire assistance

Several participants complained about the lack of assistance from their county and Coachella, a city in the area. One participant described feeling helpless after a fire: '*Our landlord and the county [participant lived in a county mobile home park], none of them came to see how we felt, what they can do for us. … The city of Coachella nor the county—no one came to knock on our doors. … It'sbeen a year, and nobody has knocked on our door saying, "How can we help you?" No one.*' Others mentioned that they received only a few masks after the fires and had to survive based on the limited resources they had. This was because no one offered them an evacuation center or provided other suggestions on what steps to take in such situations. Participants said the local fire department responded rapidly in one case but slowly in other fires: '*They got there, but about four hours later. … It was already over. The firefighters always arrive at about four or five hours. … What are they here for? They just come to make the report.*'

3.6. Community interaction as a strength

Participants mentioned that they received help from their neighbors during fires. When asked how they would prepare for a wildfire, one participant answered: '*through the radio or through other people who are*

nearby and ask what is happening.' For example, their neighbors helped pour water on the flames once they noticed the fire and informed one another of the situation immediately. One participant said, '*Through the neighbors, communication, spreading the word that something is happening, so that they alert you so that you take precautions about what is happening. … By means of that, one becomes aware, because if one is asleep.*' They highlighted the importance of more interactions among neighbors and communities to protect themselves and mitigate fire risks: '*Help each other as a group and us as a community and neighbours like us. … Help each other, protect each other. Like the community that we are, be it a neighbour, be it the other. … To notify and to see who passes or who comes or how they are doing. To take care of each other among neighbors.*'

3.7. The role of waste management and code enforcement in wildfire mitigation

Participants expressed concerns about trash pollution from residents but also illegal trash dumping in ECV from trucks bringing in electronic and green waste from Los Angeles and wealthier Coachella resort towns. '*Many people are very unaware of the dumping of trash in the street. It pollutes part of the environment and smells horrible*,' one participant said. Participants described trash being left in the community, including oil cans, mattresses, tires. A resident described witnessing a fire igniting from an abandoned oil can left outside in the extreme heat. Additionally, residents described witnessing fires igniting from other types of trash like mattresses and tires left on the side of the road for months. Another participant also mentioned that compost used around trees once caught fire and produced dense smoke with a lot of odor. Some trash is even dumped in the forest: '*When there's a fire [in the forest], all those chemicals are blown into the Valley and we are exposed to catching diseases because of it.*'

Trash service is expensive for residents in ECV, and many people cannot afford it and instead throw their garbage away elsewhere or burn it. '*If you don't pay for the trash service in full, they don't pick up your trash. What many people do is that they don't want to pay. … So, what do they do? They burn the garbage—diapers, bottles, everything*,' one participant described. Participants said that more affordable trash service and stricter enforcement could benefit residents. Others raised the need for education: '*There are things that lead one to think about improvements, like not littering the streets. You see that, as in this wind, it picks up the garbage and takes it some place, it accumulates somewhere, and with what is happening in the environment, the high temperatures.*'

3.8. Community resident education about wildfire, smoke effects, and emergency preparedness

Several participants expressed wanting to receive fire-related education or training, especially tailored training for adults and in Spanish. Participants said that they feel uninformed and have little knowledge related to fires. A participant said local schools tell children '*about fire prevention and everything. I think that it should not just be for the children. It would be good for adults, too, because one is responsible for the children. I've never seen anything for adults. Or if there is, as they say, it is in English, and here in the community, well, the majority speak Spanish and then it is also difficult.*' There is also a lack of training about how to make an evacuation plan for catastrophic natural disasters, including wildfires and earthquakes. Residents expressed that training on evacuation procedures, including offering a small book or manual, would be beneficial.

3.9. Risk communication preferences for future preparedness

Community residents shared that they received very little to no fire- and smoke-related information from the local government. One resident described receiving no alerts or warnings: '*They did not announce to us, no notifications by radio or the news.*' Participants mentioned receiving air quality and flooding warnings but not fire or smoke alerts. Another resident shared that they did not know who to ask for help: '*I think there is very little information here. What we need is to be informed. They [local government] should inform the community, I think, where they should go, who should be asked to be safer.*' Overall, participants described a lack of risk communication during and after wildfires: '*We are hardly informed here in this valley. We do not know where to go to get communication. We are without knowing.*'

3.9.1. Communication channel preferences

Communication channels preferred by participants included phone notifications (e.g. text or voice message, QR codes with links and phone numbers to call, weather and air quality apps, wind alerts), radio, social media (e.g. Facebook livestreams, Instagram, or WhatsApp neighborhood group chats), television, and being notified by neighbors in person or online. One participant mentioned that for small towns, a siren alarm '*like those horns that are used on ranches*' or '*like an Amber Alert*' (with sound) would be helpful during an emergency.

Participants mentioned that it would be easy and quick to receive messages by phone in an emergency. The use of mobile phones has become increasingly common, and participants perceived wildfire-related alarms or notifications sent by phone as very effective.

I think that right now, in that case, for me, it would be more the cell phone, because right now, we all have the habit of the cell phone. Always, if we don't bring it, we feel like we're missing a hand or something. So, the first thing we do, we look at the cell phone. … For me, it would be a text. Sometimes they send you an alarm on your cell phone. Brief alarms. Yes, something brief or alert if they reach you. … Most of us who are a little older, because we are not very busy with social networks, like the young people, but most of us, the texts would work well.

Participants from North Shore mentioned that residents from that community had organized a digital group chat on WhatsApp to exchange messages and receive alerts. This chat provided an easy way for residents to stay up to date with events and news in North Shore, as one participant shared during focus group discussions: '*We have the group that is from NorthShore, Northshore Group. Alerts received are helpful. It prevents everything, and sometimes they let you know when it's [wildfire or smoke] just starting and then you have time to stay at home and not make plans or go out so as not to expose yourself to the smoke.*' Residents had assigned one member as the designated first responder. This person was entrusted with stocking the local community center with necessary emergency items (e.g. first aid kits, N95 masks, water, lamps, batteries, and portable radios). One resident from this community suggested that other communities could also identify someone to act quickly in the event of an emergency. Another resident suggested assigning veterans to be involved as part of neighborhood watches in the community.

Several participants mentioned the use of radio and television as alternative information channels, because many people there listen to the news on these media. One participant said, '*Since I don't use social networks or the phone much, I don't realize it, but on television, I do think there was some information.*' Another also mentioned that '*the cell phone would be an important way for the majority to have access. Then I think it could be television or radio.*'

3.9.2. Dynamic fire notifications

One participant discussed the necessity of having as many information channels as possible but importantly, that the communication channel can change depending on the dynamic situation of a fire: '*For example, if it is moving forward and I already have to evacuate, I will no longer have access to television, but perhaps I will have access to the radio and my telephone. … The situation can change. I think what they mean is that the more media, the better.*'

Participants also raised the importance of being familiar with evacuation routes, including alternatives. An older participant mentioned: '*Electricity poles fell and there was no way out. Everyone was looking for alternative routes. One exited through the canal, and others through Parkside. New people don't know the other routes. Many went through the canal and sometimes got stuck because they have low cars. The earth is really soft there.*'

Many participants discussed the type of information that they would like to receive during fires. Guidance on possible mitigation measures was the most requested information. '*We don't know where to go to get them to give us that information. … One would not know what to do at a certain time because there is no information. … You do not have information on what to do when there is a fire.*' Participants complained that they did not receive any information, so they did not know what to do to avoid risks before and during a fire. As one participant described: '*[Tell us] there is a fire in a certain place or to take precautionary measures, wear a mask, or do not go down that street.*'

Participants discussed the need for information on fire situations, severity, and potential evacuation routes. Having information about a fire provided via notifications, such as location, severity, and real-time air quality, might help people understand the situation and allow for the best decision-making. Participants were eager to learn where they could go and which streets they should use when they had to evacuate due to a fire. One participant said, '*If they told us on the radio, on television, by any source of information, "Look, in case there is a fire, you can go to the church that is in such a place, you can go to these places." But I haven't heard of that.*' Participants said new residents especially need that information because they might be unfamiliar with the routes.

Some participants mentioned that they would like to know where to receive daily necessities during fires, such as food, clean water, and electricity. '*For example, when there was a problem with the electricity, that is, the poles fell, they told us where we could get water and food.*' Additionally, participants were interested in the potential health effects of fire smoke and health-related advice, especially those with children.

Regarding language, because most residents in ECV speak Spanish, many participants said they preferred to receive messages or notifications in Spanish, although some participants said bilingual messages would be better because their children learned only English in school.

4. Discussion

4.1. Health threats from wildfires and smoke as one of many growing threats to air quality for marginalized unincorporated communities

The growing health impact from increasing wildfires and smoke is projected to escalate, with human exposure to wildfires more than doubling over the last two decades particularly affecting the Western US [18, 42]. Workers in agricultural and farming (i.e. picking fruits and vegetables) are disproportionately burdened with exposure to repeat fire and smoke. These health impacts in ECV unincorporated communities are especially burdensome given the compounding risks of co-occurring extreme heat, poor and unstable housing, low income, (30%–50% of residents live at or below the federal poverty level [35, 43]), occupations outdoors like agriculture and construction, additional environmental pollutants from pesticide drift and fugitive dust. Wildfire and smoke are one of multiple contributors to poor air quality that threatens the health of ECV communities, with indications for long-term health consequences [44].

This study documented self-report health impacts among vulnerable populations, similar to those reported in other geographic regions (Canada, Australia, rural Washington, and northern California) [45–48]. Findings unique to this study highlight the environmental context of these vulnerable and marginalized communities in ECV, where numerous threats to health and air quality have multiplicative effects on residents' health. Additional structural determinants related to living in unincorporated communities threaten health. An example includes few governance structures or community services, and consequential less code enforcements that may result in greater open burning and illegal dumping that contribute to poor air pollution and greater threats to health. Residents feel ill equipped to respond to these threats with protective action. They feel ill equipped not only due to individual circumstances e.g. being low income or having co-existing health conditions, but residents also feel ill equipped to respond because of poor local government response living in an unincorporated community.

4.1.1. Health burdens in ECV from repeat fires and smoke

ECV residents described health impacts from repeat smoke and fires that ranged from respiratory, dermatological, sinus, irritated eyes, headaches, and allergic reactions. Similar health effects have been documented in other communities experiencing smoke from fires, including Indigenous populations in Canada [34, 45, 49], communities in the US, and in Australia [47]. Respiratory impacts from wildfire smoke compounded by already poor air quality have been documented in farmworker communities, with those working outside in the smoke and heat being disproportionately affected [3, 23, 46, 50, 51]. Extreme heat can amplify the health impacts from smoke and fire. This study documented self reported emergency room visits after fires, exacerbated or newly triggered asthma and allergic reactions, increased nebulizer treatments for breathing difficulties, headaches and eye issues among children and adults.

4.1.2. Mental health impacts during and after fires

ECV residents described experiencing significant mental and psychological health impacts both during and after fires. Review studies have reported the mental health effects of fire and smoke [45, 47, 52]. Fear and anxiety were experienced during fires especially for those forced to evacuate, lost their home, but also those who lost their employment or were already unemployed. In the aftermath of fires, ECV participants reported experiencing uncertainty, financial hardships, loss of power, school closures, and work impacts, as recognized in wildfire response literature [49, 53]. Participants shared experiencing significant postfire anxiety and depression regarding fear of becoming homeless, being unable to safeguard children with special needs, or struggling to evacuate in time. ECV community members who are low income and possibly also undocumented may have no safety net to fall back on [27].

Mental health issues of a different and more chronic nature were additionally reported among ECV participants. In the aftermath of a fire and living with persistent smoke in the region, parents expressed frustration related to school closures and having to keep their children indoors for weeks or even the entire summer due to heavy smoke, extreme heat, and extremely poor air quality. Although the health effects of prolonged exposure to smoke in children has been recognized [3], the mental health impacts of children having to remain indoors for weeks under conditions of extreme heat and smoke is less recognized. Policies related to unstable housing for instance can potentially exacerbate conditions under which children must remain indoors [49]. More local government initiatives and mental health services for impacted community residents are needed to address their mental health and psychological needs and provide safe cooling centers for children.

4.2. Communication preferences for future preparedness

Similar to findings in prior research [45, 47, 54], disseminating smoke and fire alerts across various channels—both traditional ones like television and radio and non-traditional platforms such as social media—in multiple formats such as print, video, siren/audio alerts, and maps are needed. Moreover, providing alerts in both Spanish and English is crucial for effectively communicating with ECV residents. ECV residents said they relied on local word-of-mouth alerts; in one community, North Shore, residents organized an online group chat on WhatsApp. However, many study participants reported being unsure about what to do or where to go in the event of an emergency and expressed wanting more information provided in Spanish.

A desire for siren alerts, as ECV residents suggested, has not been reported in the literature. Siren alerts are most important for reaching residents with no access to phone alerts. Phone alerts, on the other hand, are often the fastest alert system in time-sensitive conditions.

Although there is no statewide standard for emergency alerts for wildfire, when a fast-moving fire approaches, employing multiple channels to reach community members effectively is needed. This typically involves phone alerts, activating local word-of-mouth networks, and sending messages via trusted messengers or using locally recognized logos from trusted in-groups or local networks [55, 56]. However, federal alerts are not equipped to disseminate local smoke and fire alerts. For this, local air quality sensors are needed and investments in local smoke alerts. Indigenous communities in British Columbia use multiple channels to communicate wildfire and smoke risk, but educational material or sources with a tribal logo were the most trusted [56].

Additionally, communication channels may need to change in a dynamic emergency—for example, as strong winds shift the direction of a fire and a revised evacuation alert is needed. Traditional communication channels like television and local alerts may work initially, but if residents need to evacuate, then mobile alert systems might need to be deployed as the emergency changes. The need to employ different communication channels for a dynamic situation has been recognized in the literature [47]. Short text (360-character) message alerts and wireless emergency alerts, which are federal alerts, should provide actionable guidance describing the hazard, location, protective action, and how much time people have to act [57–61]. However, under conditions of extreme heat and fire, communication equipment and cell towers may burn, rendering phone alert systems useless.

Finally, many ECV residents work in the agricultural fields as farmworkers despite hazardous conditions like smoke and heat because they rely on this income. Targeting risk messages to subgroups who work outside should employ a behavior adaptation perspective [62]. That is, residents may not be able to remove themselves from risk situations given it is their occupation and source of income. In such cases, wearing N95 masks, for instance, could be emphasized as the best protective action if one must remain in the risk environment during hazardous smoke conditions.

4.3. Unincorporated community status as a structural determinant of health regarding wildfire, smoke, and other air pollution threats

More resources for and local government interaction with unincorporated communities are warranted, given the multiplicative factors compounding ECV residents' vulnerability to disproportionate air pollution burdens. These health threats stem from not only repeat wildfires and smoke but also persistent extreme heat, sand storms, pesticide drift from agriculture, fugitive dust from unpaved roads and wind storms, nearby power plant violations, and frequent illegal dumping and burning of waste [36]. Unincorporated communities historically have fewer services, fewer paved roads, and less code enforcement [44, 63]. Marginalization of unincorporated communities occurs through laws and policies that exclude and neglect unincorporated community needs [63, 64]. Unincorporated communities have often been identified as a burden for local governments [64]. Consequently, unincorporated community status operates as a structural determinant of health [63].

Developing, implementing, and enforcing the ECV CERP is a critical part of implementing AB 617, a California law that addresses the disproportionate air pollution burden experienced by unincorporated communities like ECV. Local burdens are many and include: (a) disproportionate burdens inherent to the landscape and climate change such as persistent extreme heat and dust storms that exacerbate environmental exposures; (b) population characteristics such as low income and marginalization (e.g. undocumented or unstable housing, monolingual Spanish speakers who are linguistically and geographically isolated); and (c) characteristics of living in an unincorporated community, which lacks a municipal government or government structure resulting in limited public services, paved roads, or code enforcement.

Moving policy actions forward was partly facilitated by the establishment of local CSCs in California as a result of environmental justice movements [65–67]. The SCAQMD and one such committee developed the ECV's CERP during a year long process with a published final report issued in July 2021 [36]. Quarterly

meetings are held with the committee to prioritize community concerns. Currently, four programs are being advanced for ECV: a residential air filtration program, a paving project to minimize fugitive dust, a review of the permitting processes for a power plant that has been cited for repeat compliance violations, and enhanced air quality notifications [68].

ECV residents described the economic, financial, energy, food and water impacts they experienced during and after fires. The conditions, including prolonged power outages after fires, having to eat out for several weeks, exorbitant gas and water bills, and not being able to work, cause financial hardships and harms health both physically and psychologically. These families experienced significant disruptions and quality of life burdens. Focus group discussions highlighted the added burden of fires and smoke experienced by these families who are already disadvantaged and living with no safety net [69, 70]. Community members reported receiving no county services in the aftermath of fires. Improved mitigation and response to increasing wildfire and smoke threats requires elevated attention and resources to unincorporated communities that are already disadvantaged on many fronts [71, 72].

4.4. The role of waste management and code enforcement in fire and smoke mitigation

Marginalized and low-income unincorporated communities like ECV often experience additional barriers to taking protective action against health threats from wildfires and smoke. These include lack of governance structures in unincorporated communities. Persistent community inequities like pervasive trash, illegal dumping (not only by residents but equally by e- and green waste trucks from outside the community), and burning of trash or agriculture waste have been documented in the ECV CERP [36]. Open burning has occurred near elementary schools, childcare centers, and homes, exposing young children to toxic air pollution including pesticides. A 50-acre mulch fire erupted in 2019 near three local schools. Such materials catch fire in the extreme heat, which is frequent in this region and the consequential fires produce emissions. Waste management businesses outside of ECV truck in waste from urban centers like Los Angeles and wealthier Coachella communities, including green and electronic waste, into ECV communities [55, 73]. These rural, unincorporated communities experience more compliance violations, less code enforcement, less oversight, and less power to prevent illegal dumping and burning that occurs in this rural desert region [68].

Prioritizing lower trash service fees for residents, greater enforcement, and more training opportunities for fire prevention in Spanish or bilingually has been suggested by residents in our focus group study. Although South Coast AQMD has adopted air quality monitoring into the local CERP plan, an actionable step may include increasing awareness about citizen reporting of illegal dumping and burning (e.g. through the South Coast AQMD's reporting system). The district requires reports from at least six residents about an air quality concern before the district will investigate a complaint [74]. Community reporting of air pollution concerns is another step in the process of documenting air pollution threats. These actions should be prioritized, given that AB 617 designated funds and prevention policies for communities to address air quality issues.

Waste management and lack of code enforcement in unincorporated areas persist as a stand alone problem, but also as a contributor to wildfire risk. The combination of extreme heat, wind, dispersed trash, and overgrowth of invasive grasses amplifies the risk of wildfires igniting and spreading rapidly. Waste management and code enforcement, therefore, have a significant role to play in mitigation of wildfires, especially in these rural and unincorporated communities.

4.5. Building resources, capacity, and networks for low-resource communities

Community interactions emerged as a strength in ECV resident narratives about fire response. Neighbors alerted one another and had organized a digital community group chat in one ECV community to provide electronic alerts to community members during emergencies. Formal interactions between communities and county officials have been less frequent if not absent. Deliberate mitigation and adaptation efforts to help vulnerable communities are urgently needed [21].

Greater interaction and communication are needed between local county emergency responders and AB 617 communities against increasing wildfire and smoke threats. Similar findings have been reported in a prior review across countries [47]. Community members expressed disappointment with postfire response by county officials. This same sentiment has been documented in other California communities experiencing fires [75]. Brenkert-Smith *et al* [33] recognized the greater need for interactions between communities and emergency responders, including fire departments, county officials, and public health professionals in preparing for and mitigating the effects of wildfires and smoke. Information sources need to be made available in Spanish and possibly other languages (e.g. Punjabi in central San Joaquin Valley of California) to reach outdoor workers including farmworker communities in ECV. Having the local county emergency

response division offer community emergency response training on emergency preparedness in Spanish would likely build community member awareness, capacity, and skills.

4.6. Limitations

Data collected for this study reflect the lived experiences of people in ECV communities. The sample of 118 participants reflect the socio-demographics of the ECV communities with the exception that a greater majority of participants were a female (69%). Qualitative group discussions are intended to reveal relevant contextual details in relation to wildfire and smoke experiences for more informed prevention and mitigation planning. With ten focus group discussions stratified by wildfire or smoke experience, data saturation of theoretical codes was likely achieved [41, 76]; however, additional emergent themes may be relevant for other geographic communities. Structural determinants of repeat wildfire and smoke risk on health were discovered namely the role of waste management, code enforcement, and the status of unincorporated communities.

5. Conclusions

These wildfire experience narratives revealed multiple compounding community factors and inequities unique to unincorporated communities and the geographic region of ECV. These factors render families living in these areas particularly vulnerable to wildfire and smoke risk and poorly equipped to respond, mitigate, and recover. Local community social interactions demonstrated a strength in ECV related to alerting and helping each other during emergencies. Yet these communities experience cumulative and compounding vulnerabilities regarding unstable housing, linguistic and geographic isolation, having older family members or those with special needs, and having little interaction with local governments. Educational opportunities in Spanish for community residents should be prioritized, such as training in emergency response, along with efforts to increase awareness about the role of trash in creating fires. Additionally, awareness around reporting and documenting persistent air pollution and sources should be prioritized. Exploring options for financial assistance should be emphasized [63]. Finally, pressure to limit illegal dumping and burning in ECV must continue as a strategy to reduce emissions.

This study contributed to documenting evidence of the impacts of repeat wildfires and smoke in these unincorporated and marginalized communities who regularly experience adverse health outcomes and financial hardships. Community members expressed the desire for accessible (Spanish) education and training in emergency preparedness and fire prevention to respond to the unique needs, burdens, and strengths of ECV communities.

Data availability statement

The data cannot be made publicly available upon publication because no suitable repository exists for hosting data in this field of study. The data that support the findings of this study are available upon reasonable request from the authors.

Acknowledgments

We want to acknowledge the ECV families and community residents who shared their fire experiences and effects, making this report possible and offering strategies to educate and prepare communities to address future fires.

Funding

We acknowledge the California Air Resource Board for funding this Project (#21RD003).

Ethical statement

This research was conducted in accordance with the principles embodied in the Declaration of Helsinki and in accordance with local institutional review board regulations governing human subjects protections in research. All participants gave consent to participate in the study.

ORCID iD

Suellen Hopfer https://orcid.org/0000-0003-3232-9743

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