



Photo by United Farm Workers

# Wildfire Smoke as an Occupational Risk Factor

## Clinician's Guide



January 2025



Photo by Stephanie Rodríguez / CAUSE

## Introduction

Wildfire smoke poses a significant health risk, particularly for vulnerable populations such as farmworkers, given the nature of their jobs and their extended exposure to outdoor environments. This guide provides clinicians and community health workers (CHWs) with an overview of the effects of exposure to wildfire smoke, the reasons why farmworkers are more vulnerable to wildfire smoke, specific considerations for farmworkers, and practical strategies for preventive measures.

## Background on Wildfires and Their Exponential Increase

There are approximately 2.5 million farmworkers in the United States.<sup>1</sup> Working in the fields, they often face the worst effects of weather, including extreme heat and wildfires.

Over the last forty years, large fires have doubled in the western United States. Research shows that warmer and drier weather, has lead to longer, more active fire seasons.<sup>2</sup> By 2050, research finds a 35% increase in worker smoke exposure days for farmworkers in the Central Valley of California.<sup>3</sup>

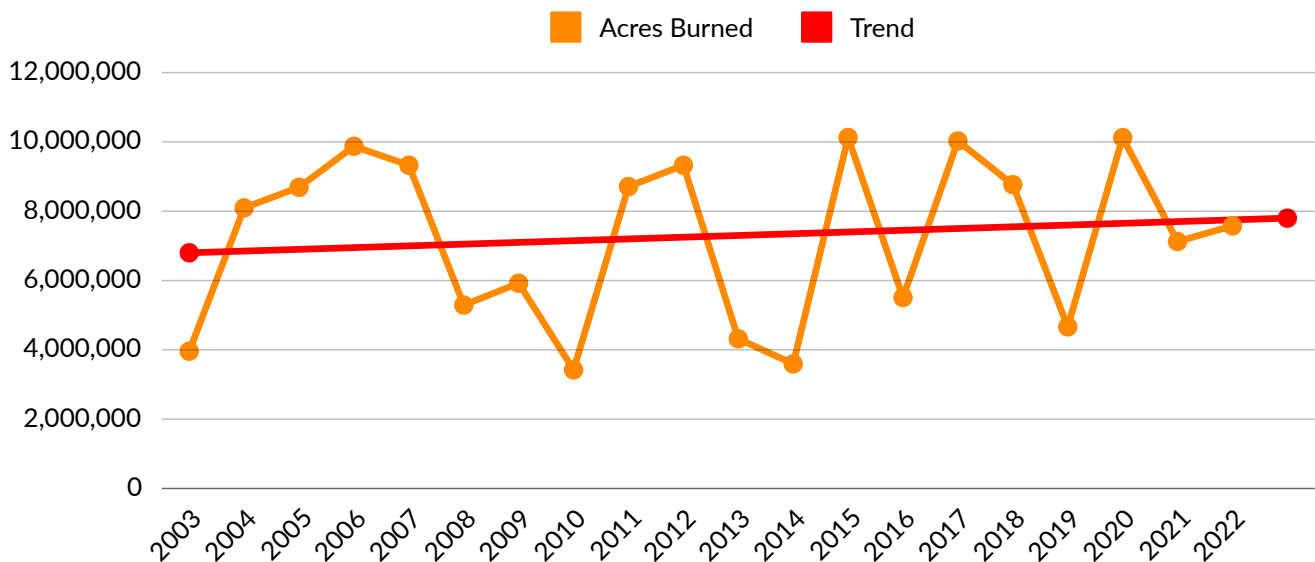


Figure 1: Wildfires and Acres



## How Does Wildfire Smoke Affect Air Quality?

Wildfire smoke releases harmful pollutants into the air, including fine particulate matter (PM<sub>2.5</sub>), the primary pollutant of concern in public health. Particulate matter (PM) is a mixture of solid particles and liquid droplets in the air. The size determines where PM is deposited. Some PM are large enough to be seen by the naked eye, such as dust, dirt, soot, or smoke, and do not usually reach the lungs but can cause irritation to the nose, eyes, and throat. Very fine PM, smaller than 2.5 microns in diameter (70 times smaller than the width of a human hair), PM<sub>2.5</sub>, poses the most significant health risk to the public because it can reach deep into the lungs and even enter the bloodstream. Research indicates that PM<sub>2.5</sub> in wildfire smoke can be up to 10 times more harmful to humans than pollutants from other sources.<sup>4</sup>

PM<sub>2.5</sub> is not the only pollutant of concern regarding wildfires; carbon monoxide and ozone can also be present. Carbon monoxide is a colorless, odorless gas that dilutes rapidly. This is of little concern to the general public unless they are close to the wildfire, but it may be a risk to farmworkers given the potential of their closer vicinity to fires. Ozone is also associated with wildfire smoke. Although not emitted directly by the wildfire, it forms in the plumes of smoke that move downwind in the presence of sunlight and other pollutants.

Wildfires are not only harmful due to the pollutants they release, but in recent years, wildfire season has coincided with increasing extreme heat.

## What is Air Quality?

Air Quality is a measure of the concentration of pollutants in the air at a specific location. The Environmental Protection Agency has developed the Air Quality Index (AQI) to provide a way to quickly determine whether air quality is reaching unhealthy levels in their communities. The AQI runs from 0 to 500; the higher the AQI value, the greater the level of air pollution and the greater the health risks. AQI was not designed for workers, especially those with pre-existing conditions such as diabetes or asthma, exposed to the outdoors and, subsequently, wildfire smoke. For farmworkers, it is important to consider health harms at lower AQI levels.

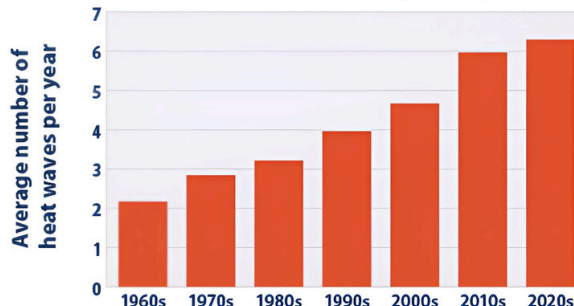
### AQI Basics for Particle Pollution

- 0 to 50** Air quality is satisfactory, and air pollution poses little or no risk
- 51 to 100** Air quality is acceptable. There may be a risk for some people.
- 101 to 150** Members of sensitive groups may experience health effects.
- 151 to 200** Sensitive groups may experience more serious health effects.
- 151 to 200** Health alert: The risk of health effects is increased for everyone.
- 151 to 200** Health warning of emergency conditions: everyone is likely to be affected.

Figure 2: AQI Basics for Ozone and Particle Pollution

An extreme heat event is a period of persistent, unusually hot days. The frequency of these extreme heat events has increased steadily in the last 50 years. In 1960, there was an average of two heat waves per year; between the 2010s and 2020s, there was an average of six.<sup>5</sup> Hotter temperatures directly contribute to drought and dryness as they increase the rate of evaporation, leading to drier soils and vegetation. Even when precipitation levels remain the same, higher temperatures can cause drought conditions, increasing the likelihood of wildfires.

Moreover, extreme heat in and of itself is a danger for farmworkers. Farmworkers have more than 35 times the risk of heat-related mortality than workers in other industries.<sup>6</sup> It also makes breathing more difficult and can exacerbate certain respiratory conditions such as asthma and chronic obstructive pulmonary disease (COPD), a condition caused by damage to the airways or other parts of the lung. Both extreme heat and wildfire smoke can increase the risk of cardiac and respiratory disease and even death. A 2024 study found that simultaneous exposure to extreme heat and wildfire smoke led to more hospitalizations than either hazard alone.<sup>7</sup> Farmworkers are more vulnerable now to harmful outcomes due to the compounding effects of extreme heat and wildfire smoke.



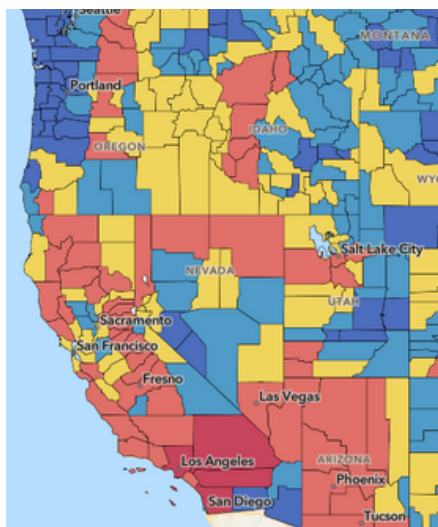
**Figure 3: Heat Wave Frequency**

## Why Are Farmworkers Disproportionately Affected by Wildfires?



Photo by United Farm Workers

Farmworkers are more vulnerable to the effects of wildfire smoke than others. In recent years, farmworkers have been forced to choose between earning a wage and having economic security, and evacuating an active wildfire zone. A recent study found that a California air monitoring program aimed at determining when it was safe to work during wildfires did not adequately protect farmworkers.<sup>8</sup>



**Figure 4: Map of Wildfire Risk in the United States**

Economic security is not the only social determinant of health that makes farmworkers more vulnerable to wildfire smoke. Farmworkers often live in substandard housing that is expensive relative to their incomes. Economic necessity often makes it necessary for farmworker families to share housing with non-family members.<sup>9</sup> Wildfire damage to their homes and a need for housing leaves farmworkers vulnerable to predatory practices by landlords. Some employers provide farmworkers with housing; choosing to evacuate to safety and away from wildfire smoke might lead to farmworkers losing their jobs and, subsequently, their housing. Often, farmworkers fear retaliation from their employers for choosing safety over work.

Furthermore, farmworkers often have pre-existing or underlying conditions that make them more vulnerable to wildfire smoke. Farmworkers are regularly exposed to pesticides at work, leaving them susceptible to several health problems. Table 1 summarizes how wildfire smoke affects different life stages, populations, and people with pre-existing conditions.



# Table 1: Potential Health Effects from Wildfire Smoke Exposure by Lifestage and Population



## People with asthma and other respiratory disease

Breathing difficulties (e.g. coughing, wheezing, and chest tightness) and exacerbations of chronic lung diseases (e.g. asthma and COPD) leading to increased medication usage, emergency department visits, and hospital admissions.



## People with cardiovascular disease

Triggering of ischemic events, such as angina pectoris, heart attacks, and stroke; worsening of heart failure; or abnormal heart rhythms could lead to emergency department visits, hospital admissions, and even death.



## Children

Coughing, wheezing, difficulty breathing, chest tightness, decreased lung function in all children. In children with asthma, worsening of asthma symptoms or heightened risk of asthma attacks may occur.



## Pregnant women

Limited evidence shows air pollution-related effects on pregnant women and the developing fetus, including low birth weight and preterm birth.



## Older adults

Exacerbation of heart and lung diseases leading to emergency department visits, hospital admissions, and even death.



## People of low socioeconomic status

Greater exposure to wildfire smoke due to less access to measures to reduce exposure, along with higher likelihood of untreated or insufficiently treated health conditions could lead to increased risks of experiencing the health effects described above.



## Outdoor workers

Greater exposure to wildfire smoke can lead to increased risks of experiencing the range of health effects described above.



## N95 Respirators: Medical Evaluation and Fit Testing

Regulations that include requirements regarding the use of N95 respirators will also require employers to ensure that workers are properly fit-tested. The Occupational Safety and Health Administration's (OSHA) Respiratory Protection standard outlines a medical evaluation process that starts with the administration and review of the OSHA Respirator Medical Evaluation Questionnaire, which is reviewed by a physician or licensed healthcare professional. This evaluation aims to ensure that the respirator itself will not cause harm or exacerbate any pre-existing conditions. These often include questions about smoking, pulmonary or lung conditions, and specific use of medications. A positive response to select questions on the Medical Evaluation Questionnaire requires a follow-up medical examination.

Workers must also be fit-tested for respirator use. This process can be carried out by individuals trained to perform fit testing and does not have to be conducted by a physician or healthcare provider. Fit testing should be performed on a regular basis—gaining or losing weight, facial hair, and pregnancy can all impact mask fit. A mask that is not fit-tested may not provide adequate protection for workers.

Methods of prevention and protection that work for, and are accessible to, the general public are often inaccessible to farmworkers. Frequently, evacuation orders and emergency systems are not targeted to farmworker communities because they are often not linguistically accessible since the information is often provided in English. Due to farmworkers' remoteness and rural location, they often do not have cellular reception or, in some instances, do not have access to a cell phone to receive emergency alerts or to check air quality. As a result, farmworkers often rely on their employer for information on dangers such as wildfires.

Personal Protective Equipment (PPE), such as properly fitted N95 respirators, can help reduce exposure to wildfire smoke. Current practice for effective use requires both medical clearance and formal fit testing as part of a respiratory protection program, which is usually not available to farmworkers. While necessary to minimize exposure to pollutants, such as pesticides or wildfire smoke, filtering facepiece respirators, such as the N95, can increase the work of breathing. They can also trap heat and potentially increase the risk of developing heat-related illness. As extreme heat events and wildfires continue to coincide, farmworkers often have to choose to protect themselves from one or the other. The physical exertion required during farm work exacerbates the risk of heat-related illness as well as the effort needed to breathe through a well-fitted mask.



Trained individuals can perform a fit test. They do not have to be a physician or healthcare provider.

By contrast, engineering controls that provide filtered and cooled air can reduce exposures with no increased risk. These currently include vehicle cabs and permanent structures with air conditioning that can be useful during rest breaks, while movable structures that provide air filtration and shade are under development.

# Policy

There is currently no federal regulation to protect workers against wildfire smoke or excess heat. The National Institute for Occupational Safety and Health (NIOSH) published a [draft hazard review](#) on wildfire smoke exposure among farmworkers and other outdoor workers. The purpose of this hazard review is to provide an overview of the adverse health effects of occupational exposure to wildfire smoke among farmworkers and other outdoor workers.

Currently, only **California, Oregon, and Washington** have regulations to protect workers from wildfire smoke as well as from heat.

## California

California - Under [California's Wildfire Smoke Emergency Standard](#), employers must implement control measures when the AQI for PM2.5 is at or above 151. These measures include:

- A system of communicating wildfire smoke hazards and available protective measures in a language and manner understandable by workers;
- Training to workers on wildfire smoke hazards and protections;
- Monitoring worker exposure to PM2.5 at the start of each shift and periodically throughout the shift;
- Implementing engineering or administrative controls, such as structures with air filter controls or the provision of respirators.
  - At an AQI above 500, employers must provide and require workers to use NIOSH-approved particulate respirators.

## Washington

Under [Washington's Wildfire Smoke Standard](#), employers must implement control measures when the AQI for PM2.5 is at or above 101. These measures include:

- Providing enclosed buildings, structures, or vehicles where air is adequately filtered
- Relocating work to a location with a lower ambient air concentration of PM2.5
- Changing work schedules to a time with a lower ambient air concentration of PM2.5
- Reducing work intensity;
- Providing additional rest periods;
- Providing N95 respirators (at an AQI above 300).

Employers must provide workers with N95 respirators. In addition, employers must establish a system for communicating wildfire smoke hazards in a language and manner understandable by all workers, provide training on wildfire smoke hazards and protections, monitor for symptoms of wildfire smoke exposure, and ensure prompt medical attention when needed.

## Oregon

Under [Oregon's Wildfire Smoke Standard](#), employers must implement control measures when the AQI for PM2.5 is at or above 101. These measures include:

- Assessing and monitoring air quality at locations where workers are exposed;
- Providing training to workers on the symptoms and hazards of wildfire smoke and protections;
- Implementing a two-way communication system to inform workers and supervisors about changes in air quality, and to report health or exposure issues;
- Implementing engineering and administrative controls such as relocating workers or changing work schedules;
- Providing NIOSH-approved respirators such as N95 respirators.
  - At an AQI above 277, employers must implement a Wildfire Smoke Respiratory Protection Program that mandates the use of NIOSH-approved respirators.



# How to Best Support Farmworkers Exposed to Wildfire Smoke

## Best Practices for Clinicians

In a clinical setting, it is important to identify whether your patients are employed in agriculture or other essential occupations or which patients are potentially vulnerable because they may not have the resources to protect themselves by staying indoors or evacuating wildfire areas.



**Discuss the effects of wildfire smoke exposure and symptoms to look out for when exposure occurs.**

For farmworkers with chronic health conditions, work to develop a wildfire smoke action plan. See Table 2 for an example of a wildfire smoke action plan created for patients with respiratory disease/asthma.<sup>10</sup>

**Explain the importance and benefits of PPE and how to use it appropriately. It is important also to flag the harmful effects of PPE when it is extremely hot.**



**Discuss with farmworkers how they can access emergency alerts in a language they understand, such as phone alerts and tuning into your local radio station.**



**Help farmworkers prepare for an emergency evacuation:**

Discuss the importance of ensuring access to their medications, including packing them if they choose to evacuate. Share resources that reinforce health and safety information about wildfires and help farmworkers understand the community resources available to them in an evacuation or wildfire emergency.

**Train farmworkers to use the Air Quality Index (AQI) as a guide to understand the level of pollutants in the air and discuss what levels are safe to work in and at what levels they should take precautions.**

This will allow them to make informed decisions about potential health risks they might face and when to take extra precautions. It is important to note that AQI was not designed for workers, especially those with pre-existing conditions such as diabetes or asthma. For farmworkers, it is important to consider health harms at lower AQI levels.

**Table 2: Wildfire Action Plan for Patients with Respiratory Disease/Asthma**

AQI less than 100	AQI between 100 - 150	AQI between 150 - 200	AQI more than 200	AQI more than 500
<p>OK to go outside and be active.</p> <p>Stay on your maintenance inhaler therapy.</p>	<p>Avoid strenuous physical activity outside, especially during rush hour or near high-traffic areas. Stay on your maintenance inhaler therapy.</p>	<p>Try to stay inside where possible, and make sure that your air purifier is turned on. Stay on your maintenance inhaler therapy.</p>	<p>Stay inside and turn on your air purifier. Stay on your maintenance inhaler therapy.</p> <p>Use your albuterol with your maintenance inhaler every four hours as needed. If you are having symptoms with this - call your doctor's office!</p>	<p>Stay inside with your air purifier on. Use albuterol four times a day and every four hours as needed with your maintenance inhaler.</p> <p>If you are experiencing chest tightness or difficulty breathing, start taking prednisone (40mg a day) and call your doctor's office!</p>

Credit to Dr. Maeve MacMurdo.





## Best Practices for Community Health Workers

While working with farmworkers, discussing and preparing for a wildfire emergency is essential. Offering training for farmworkers on how they can best protect themselves is critical to raising awareness of the harmful effects of wildfire smoke. Sharing necessary resources and distributing emergency preparedness kits can be crucial. Below are some other ways in which Community Health Workers can support farmworker communities:

- Discuss with farmworkers how they can access emergency alerts in a language they understand, such as phone alerts and tuning into your local radio station.



- Guide farmworkers in building a Go-bag or stay-bag and discuss the must-have items they should carry, such as medication, PPE, important documents, and water.



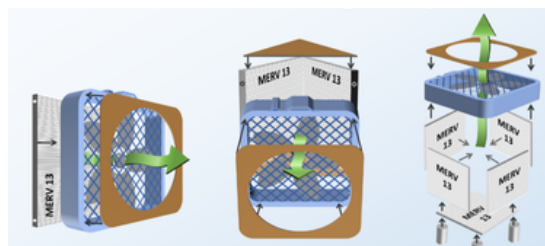
- Discuss what laws and regulations exist in your state to protect farmworkers from wildfire smoke and inform farmworkers of their rights.



- Train farmworkers to use the Air Quality Index (AQI) (Figure 2) as a guide to understand the level of pollutants in the air and discuss what levels are safe to work in and at what levels they should take precautions. This will allow them to make informed decisions about potential health risks they might face and when to take extra precautions.



- Share information with farmworkers on creating a DIY, do it yourself, Air Cleaner to help reduce wildfire smoke indoors. [www.epa.gov/air-research/research-diy-air-cleaners-reduce-wildfire-smoke-indoors](http://www.epa.gov/air-research/research-diy-air-cleaners-reduce-wildfire-smoke-indoors)



# Resources

## Educational Materials



### Clear the Air! Protect Your Health from Bad Air - Comic Book

This MCN Comic Book “Clear the Air! Protect Your Health from Bad Air”, available in English and Spanish, provides basic information on respiratory health and air pollution, including smoke from wildfires. It reviews the respiratory system, particulate matter, and sources of air pollution and discusses ways workers and their families can protect themselves.

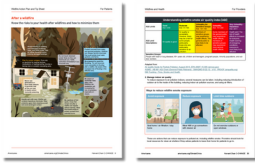
[www.migrantclinician.org/resource/clear-air-protect-your-health-bad-air.html](http://www.migrantclinician.org/resource/clear-air-protect-your-health-bad-air.html)



### Wildfire Smoke Exposure Resources – UC Davis Western Center for Agricultural Health and Safety

English: <https://aghealth.ucdavis.edu/wildfires>

Spanish: <https://aghealth.ucdavis.edu/es/wildfires>



### Provider and Patient Resources – AmeriCares

[www.americares.org/what-we-do/community-health/climate-resilient-health-clinics/](http://www.americares.org/what-we-do/community-health/climate-resilient-health-clinics/)



### CDC Webpage With Some Helpful Info:

<https://blogs.cdc.gov/niosh-science-blog/2023/02/03/diy-filtration/>



### Heat-Related Illness Clinician's Guide – FJ and MCN

[https://www.farmworkerjustice.org/wp-content/uploads/2021/06/2021-Heat-Stress\\_Clinicians\\_Guide\\_FINAL.pdf](https://www.farmworkerjustice.org/wp-content/uploads/2021/06/2021-Heat-Stress_Clinicians_Guide_FINAL.pdf)



### Wildfire Smoke and Ash Health Safety Tips – South Coast AQMD

<https://www.aqmd.gov/home/air-quality/wildfire-health-info-smoke-tips>



### Preparing for Wildfires – Information and Resources to Support Farmworker Communities During Wildfire Season – FJ and MCN

<https://www.youtube.com/watch?v=os5p34sHkO8>



### Wildfire Smoke: A Guide for Public Health Officials – EPA

<https://www.youtube.com/watch?v=waMXCFMqYnA>



## Guide on Respiratory Protection – OSHA

<https://www.osha.gov/respiratory-protection>



## Respiratory Fit Test Guide – Ag Health & Safety Alliance & Great Plains Center for Agricultural Health

<https://gpcah.public-health.uiowa.edu/wp-content/uploads/2024/02/2024-Respirator-Fit-Test-Guide.pdf>



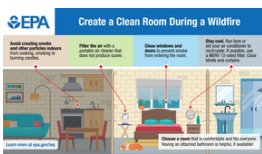
## Medical Evaluations for Workers Who Use Respirators (English/Spanish) – OSHA

<https://www.osha.gov/video/respiratory-protection/med-evaluations>



## Wildfire Smoke and People with Chronic Conditions – CDC

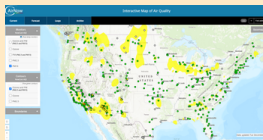
<https://www.cdc.gov/wildfires/risk-factors/wildfire-smoke-and-people-with-chronic-conditions.html>



## Create a Clean Room to Protect Indoor Air Quality During a Wildfire (English/Spanish) - Includes information on how to build a DIY Air Cleaner – EPA

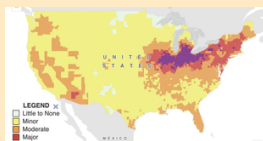
<https://www.epa.gov/emergencies-iaq/create-clean-room-protect-indoor-air-quality-during-wildfire>

# Mapping Tools



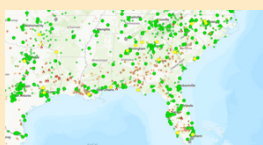
## AirNow Interactive Map

<https://gispub.epa.gov/airnow/?showgreencontours=false>



## CDC Heat Risk Tracking Map

<https://ephtracking.cdc.gov/Applications/HeatRisk/>



## Fire and Smoke map tool

<https://fire.airnow.gov/>

## References / Other Resources

1. Martin, P. (2020, June 24). *US Farm Employment and Farm Workers*. Retrieved January 7, 2025, from <https://www.wilsoncenter.org/article/us-farm-employment-and-farm-workers>
2. USGCRP, 2017: Climate Science Special Report: Fourth National Climate Assessment, Volume I [Wuebbles, D.J., D.W. Fahey, K.A. Hibbard, D.J. Dokken, B.C. Stewart, and T.K. Maycock (eds.)]. U.S. Global Change Research Program, Washington, DC, USA, 470 pp; Chapter 8 <https://science2017.globalchange.gov/chapter/8/>
3. Miriam E Marlier et al 2022 Environ. Res. Lett. 17 094045 <https://iopscience.iop.org/article/10.1088/1748-9326/ac8c58/pdf>
4. Zhang, D., Wang, W., Xi, Y., Bi, J., Hang, Y., Zhu, Q., Pu, Q., Chang, H., & Liu, Y. (2023). Wildfire worsens population exposure to PM2.5 pollution in the Continental United States. Research square, rs.3.rs-3345091. <https://doi.org/10.21203/rs.3.rs-3345091/v2>
5. (n.d.). *Climate Change Indicators: Heat Waves*. United States Environmental Protection Agency. Retrieved September 27, 2024, from <https://www.epa.gov/climate-indicators/climate-change-indicators-heat-waves>
6. Gubernot, D. M., Anderson, G. B., & Hunting, K. L. (2015). Characterizing occupational heat-related mortality in the United States, 2000-2010: an analysis using the Census of Fatal Occupational Injuries database. *American journal of industrial medicine*, 58(2), 203–211. <https://doi.org/10.1002/ajim.22381>
7. Chen Chen et al. ,Exploring spatial heterogeneity in synergistic effects of compound climate hazards: Extreme heat and wildfire smoke on cardiorespiratory hospitalizations in California.Sci. Adv.10,eadj7264(2024).DOI:[10.1126/sciadv.adj7264](https://doi.org/10.1126/sciadv.adj7264)
8. Chunga Pizarro, C. A., Buchholz, R. R., Hornbrook, R. S., Christensen, K., & Méndez, M. (2024). Air quality monitoring and the safety of farmworkers in wildfire mandatory evacuation zones. *GeoHealth*, 8, e2024GH001033. <https://doi.org/10.1029/2024GH001033>
9. Farmworker Justice. (September 2014). *Farmworkers Housing and Health in the United States: A general introduction and overview*. <https://www.farmworkerjustice.org/wp-content/uploads/2015/07/Intro-to-Farmworker-housing-and-health-FW-Housing-Symposium.pdf>
10. CDC (n.d.). *Wildfire Smoke and People with Chronic Conditions*. CDC.gov. Retrieved October 31, 2024, from <https://www.cdc.gov/wildfires/risk-factors/wildfire-smoke-and-people-with-chronic-conditions.html>

- Figure 1: (n.d.). *Wildfires and Acres*. National Interagency Fire Center. Retrieved January 9, 2025, from <https://www.nifc.gov/fire-information/statistics/wildfires>
- Figure 2: (n.d.). *Air Quality Index (AQI) Basics*. AirNow. Retrieved September 27, 2024, from <https://www.airnow.gov/aqi/aqi-basics/>
- Figure 3: (n.d.). *Climate Change Indicators: Heat Waves*. United States Environmental Agency. Retrieved January 9, 2025, from [www.epa.gov/climate-indicators/climate-change-indicators-heat-waves](https://www.epa.gov/climate-indicators/climate-change-indicators-heat-waves)
- Figure 4: (n.d.). *Wildfire*. FEMA. Retrieved January 9, 2025, from <https://hazards.fema.gov/nri/wildfire>
- Table 1: (Ammann et al., 2021). *Wildfire Smoke: A Guide for Public Health Officials [Guide]*. U.S. Environmental Protection Agency. [https://www.airnow.gov/sites/default/files/2021-09/wildfire-smoke-guide\\_0.pdf](https://www.airnow.gov/sites/default/files/2021-09/wildfire-smoke-guide_0.pdf)

- (n.d.). *Health Effects Attributed to Wildfire Smoke*. United States Environmental Protection Agency. Retrieved September 27, 2024, from <https://www.epa.gov/wildfire-smoke-course/health-effects-attributed-wildfire-smoke>
- (n.d.). *Wildfire Smoke Exposure*. UC Davis Western Center for Agricultural Health and Safety. Retrieved September 27, 2024, from <https://aghealth.ucdavis.edu/wildfires>
- The National Institute for Occupational Safety and Health (n.d.). *Outdoor Workers Exposed to Wildfire Smoke*. CDC. Retrieved September 27, 2024, from <https://www.cdc.gov/niosh/topics/firefighting/wffsmoke.html>
- Rott, N. (2021, March 5). Study Finds Wildfire Smoke More Harmful To Humans Than Pollution From Cars. *NPR*. <https://www.npr.org/sections/health-shots/2021/03/05/973848360/study-finds-wildfire-smoke-more-harmful-to-humans-than-pollution-from-cars>
- Gross, L. (2021, September 21). Fires Fuel New Risks to California Farmworkers. *Inside Climate News*. <https://insideclimatenews.org/news/21092021/wildfires-california-farmworkers-smoke-health/>
- Ho, V. (2020, August 23). ‘An impossible choice’: Farmworkers pick a paycheck over health despite smoke-filled air. *The Guardian*. <https://www.theguardian.com/us-news/2020/aug/22/california-farmworkers-wildfires-air-quality-coronavirus>
- O'Dell, K., Goldberg, D., Kerr, G. H., Wei, Z., Zhang, H., Henderson, B., Kondragunta, S., & Anenberg, S. (n.d.). *Exploring the value of future geostationary satellite-based atmospheric composition data for improving health and air pollution injustice in the US*. NOAA. [https://haqast.org/wp-content/uploads/sites/91/2022/11/HAQASTWI\\_ODell.pdf](https://haqast.org/wp-content/uploads/sites/91/2022/11/HAQASTWI_ODell.pdf)
- Aguilera, R., Corringham, T., Gershunov, A. et al. Wildfire smoke impacts respiratory health more than fine particles from other sources: observational evidence from Southern California. *Nat Commun* 12, 1493 (2021). <https://doi.org/10.1038/s41467-021-21708-0>