HEALTH POLICY

Outdoor Workers at Risk

State-Level Exposure to Polluted Air, Wildfire, and Heat

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Executive Summary

Outdoor workers are on the front lines of occupational hazards related to extreme weather and climate change. As air pollution worsens, wildfire seasons lengthen, and heat wave events intensify, workers whose jobs require them to be outside face growing health and safety risks. Even one severe exposure—like extreme heat or heavy wildfire smoke—can cause lasting health problems (Bell et al. 2024; Hadley et al. 2022). Repeated moderate exposures, such as heat above 80°F, can also raise the risk of emergency department visits, heart and lung issues, and occupational injury (Morris et al. 2019; Shire et al. 2020). Yet protections for outdoor workers in the United States remain uneven across states, and most workers lack safeguards against these increasingly common exposures, with stalled federal action leaving gaps unaddressed nationwide.

In this report, we combine federal air quality, wildfire, and heat wave data with new estimates of the size and geographic distribution of the outdoor workforce to identify where outdoor workers face common outdoor exposure risks. While heat, smoke, and air-quality hazards can be highly localized, we report exposure at the state level to align with where most worker-safety authority sits and where recent federal datasets can be reliably combined, although this approach may obscure local hotspots within states. We also outline federal and state policy options to strengthen workplace protections for outdoor workers.

Our key findings include the following:

- **Outdoor work is common nationally.** About 1 in 5 US workers (20.6 percent) are in occupations likely to involve regular outdoor exposure.
- **Outdoor work is unevenly distributed by state workforces.** States with high shares of outdoor workers per total state workforce include Wyoming (29.1 percent), North Dakota (27.0 percent), and Montana (26.2 percent); the lowest shares are found in more urbanized states like Massachusetts (16.5 percent), New York (17.5 percent), and Connecticut (17.8 percent).
- **Exposure to poor outdoor air quality is widespread for outdoor workers.** In 2023, over 8 in 10 outdoor workers (83.1 percent) lived in states with greater than 25 percent of days classified as "poor air quality" (the share of days measured as moderate to hazardous air quality), increasing the risk of respiratory and cardiovascular harm.

- **Almost 2 in 5 outdoor workers are exposed to wildfire risk.** Nearly two-fifths (38.4 percent) of outdoor workers lived in one of the 14 states with elevated wildfire risk (which approximately corresponds to the top quartile of counties nationally for wildfire likelihood and potential impact, based on the Federal Emergency Management Agency risk scale), adding smoke-related air quality threats to already high baseline pollution in many regions. These high-risk states are home to large outdoor labor forces—particularly in places like California and Texas—creating a substantial overlap between wildfire exposure and outdoor employment.
- **Almost 2 in 3 outdoor workers are at risk from dangerous heat waves.** Nearly two-thirds (65.1 percent) of outdoor workers lived in the 25 states and the District of Columbia with elevated heat wave risk (which approximately corresponds to the top quartile of counties of heat wave likelihood and potential consequences, based on the Federal Emergency Management Agency risk scale), compounding the threat of job-related injury and illness. Many outdoor workers live in states with elevated heat wave risk—such as Arizona, California, and Texas—where both heat exposure and outdoor employment are widespread.
- **Outdoor workers are concentrated in states facing multiple climate risks.** California, Florida, and Texas are home to over a quarter of the nation's outdoor workers and generally have low air quality and high wildfire and heat wave risk.
- **Policy implications:** Stronger protections are needed at both the federal and state levels. Federal action can include a comprehensive Occupational Safety and Health Administration heat standard and clear guidance for protecting workers from wildfire smoke. States can enact or expand enforceable heat and air-quality protections that require access to water, rest, and shade; heat acclimatization and training; paid rest breaks; air-quality thresholds that trigger respirator use or relocation to safer work environments; and anti-retaliation safeguards. States can also avoid and repeal preemption laws that prevent local governments from adopting stronger worker protections.

Outdoor Workers at Risk

Background

Outdoor workers are on the front lines of occupational hazards related to extreme weather and climate change. If unmitigated, climate change could drive an estimated $14.5 trillion in US economic damages over the coming decades (Deloitte 2022). Climate-related health risks—especially those linked to ambient air pollution, wildfire smoke exposure, and heat wave events—are already driving substantial and growing health care costs in the US, with recent research projecting further escalation as climate hazards intensify. Over the past decade, ambient air pollution—especially fine particulate matter ($PM_{2.5}$) and ozone—has imposed the largest climate-related health care burden in the US. Air pollution from fossil fuel combustion alone is estimated to cost over $820 billion annually in health-related costs in the US, including medical expenses and the value of 107,000 early deaths (NDRC 2021).[1] Wildfire smoke exposure contributes an estimated $11 to $20 billion in annual health-related costs across the US, including hospitalizations and mortality linked to $PM_{2.5}$ (Crowley et al. 2023).[2] Extreme heat events have also imposed mounting health care costs in the US, estimated at about $1 billion annually (Woolf et al. 2023). In a 2019 study of the 2012 summer season, extreme heat was associated with an estimated 234,000 excess emergency department visits and 56,000 hospital admissions across the US, with especially high costs during severe events like the 2012 Wisconsin heatwave, which led to $252 million in health-related expenses (Limaye et al.2019). These costs are expected to grow. Climate-related hazards—including air pollution from wildfires and extreme heat—are becoming more frequent, more intense, and more prolonged in the US because of climate change, compounding their health and economic consequences (Hayden et al. 2023).

Illnesses and injuries related to air pollution exposure, including wildfires and heat exposure, can have both short-term and long-lasting consequences for worker health, lost wages, and economic mobility (Amoadu et al. 2023; Cabral and Dillender 2024; Molitor et al. 2022).[3] Even a single exposure to extreme heat resulting in heat exhaustion or heat stroke can lead to severe and chronic health issues (Bell et al. 2024), and the same is true of a single severe exposure to wildfire smoke (Hadley et al. 2022).

The following background summarizes the existing literature on the health effects of occupational exposure to air pollution, wildfire smoke, and extreme heat —environmental hazards that disproportionately affect outdoor workers and are projected to intensify with ongoing climate change.

Health Risks Associated with Occupational Air Pollution Exposure, Including Wildfire

Air pollution has long posed a threat to outdoor workers, and risks are increasing as emissions from fossil fuel combustion and wildfires both worsen air quality and accelerate climate change, which in turn contributes to more frequent and intense wildfires.[4] Although some historical sources of air pollution were decreasing as of 2024, such as through the closure of coal-fired power plants, wildfires are projected to increasingly drive worsening air quality, because of more frequent and intense fire seasons fueled by climate change (First Street 2024; Qiu et al. 2024; Sarangi et al. 2023). Wildfires release large quantities of carbon dioxide, further driving this cycle of worsening air pollution and increased temperatures.[5] More frequent and severe wildfires are extending the duration of smoke-driven air pollution, particularly in the Western US, where smoke-related pollution is projected to increase from approximately one month annually in 2024 to three months annually by 2054, offsetting air quality improvements anticipated from other environmental and climate policies (First Street 2024; Qiu et al. 2024; Sarangi et al. 2023).

Occupational exposure to air pollution, including wildfire smoke, presents immediate health risks such as coughing, wheezing, and exacerbation of asthma and chronic obstructive pulmonary disease, and long-term health impacts such as reduced lung capacity and increased cardiovascular strain (Cabral and Dillender 2024; Sorensen et al. 2022). In addition, fine particulate matter and toxic metals from wildfires can cause neurological damage, respiratory issues, and cardiovascular problems, disproportionately impacting outdoor workers like firefighters and construction workers (Boaggio et al. 2022; Fadadu et al. 2024).

Air pollution exposure leads to higher injury risks and lost productivity, contributing to both health and economic burdens for workers and employers (Borgschulte et al. 2022).[6] Studies link air pollution exposure to increased mental health issues, cognitive decline, and workplace accidents because of physical and cognitive fatigue (Bernardini et al. 2020; Braithwaite et al. 2019; Crank et al. 2023; Heo et al. 2021; Lavy et al. 2024; Song et al. 2023). Air pollution exposures also contribute to socioeconomic disparities, with lower access to health care and labor protections potentially compounding the health risks (Borgschulte et al. 2022; Bruyneel et al. 2022).

Increasing Health Risks Associated with Occupational Heat Exposure

Outdoor workers are increasingly vulnerable to heat exposure, as human-induced climate change drives more frequent and severe heat waves (IPCC 2023). In 2024, the US experienced its hottest year on

record, with 17 states also setting statewide annual heat records.[7] Worsening extreme heat events pose an environmental and occupational hazard for workers, adversely impacting their health. More than 1 in 7 outdoor workers (15 percent) in the US reported experiencing heat exhaustion or other heat-related symptoms at work in 2023 (Clemans-Cope et al. 2024). A 2021 systematic review found that a 1.8°F (1°C) increase above average temperatures leads to a 1 percent rise in occupational injuries, and during heatwaves (defined as three or more consecutive days above the 95th percentile temperature), the risk of occupational injuries rises by 17.4 percent compared with non-heat wave periods (Fatima et al. 2021). Although the federal Occupational Safety and Health Administration (OSHA) does not currently have a specific standard addressing heat-related hazards, these risks are nevertheless categorized in the OSHA-National Institute for Occupational Safety and Health (NIOSH) Heat Safety Tool App, which defines "caution" days as those with a heat index below 80°F, "warning" days as those between 80°F and 94°F, and "danger" days as those with a heat index of 95°F or higher (OSHA 2022).[8]

Occupational heat exposure poses significant health risks. Short-term health impacts include cardiovascular issues such as heat exhaustion, heat stroke, hypertension, and ischemic heart disease events in people with underlying heart conditions, as well as adverse pregnancy outcomes, acute respiratory problems, and mental health problems (Bell et al. 2024; Ebi et al. 2021; Liu et al. 2022). Chronic consequences are also documented, including kidney disease linked to recurrent dehydration and cumulative heat strain, and sustained heat exposure can worsen stress and impair mental health (WHO and WMO 2025). High temperatures impair cognitive function and physical performance, leading to injuries and reduced productivity (Amoadu et al. 2023; Varghese et al. 2018).[9] A systematic review and meta-analysis found that worker productivity declines by an average of 2.6 percent (ranging from 0.8 to 5.0 percent) for every 1.8°F increase above about 75°F, as measured by a combined index of air temperature, humidity, sunlight, and wind called the wet-bulb globe temperature (Flouris et al. 2018). Even moderate heat exposure, with temperatures at or above 80°F, is linked to increased health care use, with one study showing that a 1°F increase in average daily temperature can raise the risk of heat-related emergency department visits by 14 percent (Morris et al. 2019; Shire et al. 2020). Certain industries bear a disproportionate burden; for example, construction accounts for roughly one-third of US occupational heat-related deaths despite representing only 6 percent of the workforce, underscoring the sector's extreme vulnerability.[10]

Purpose of This Study

This study describes how workers across US states are exposed to elevated heat waves, wildfire smoke, and poor air quality hazards. We address the research question: *Which states have the largest outdoor worker populations facing the most severe climate-related hazards?* To answer this, we estimate state-level counts and shares of outdoor workers and link these estimates with climate-related environmental risk data. We provide descriptive analyses to identify high-risk states and worker subgroups. The findings can inform state and federal efforts to protect outdoor workers from climate-related health risks.

Methods and Data

This analysis constructs a new state-level measure of the number and characteristics of outdoor workers and links it to climate-related environmental risk indicators to assess how air pollution, wildfire smoke, and extreme heat are associated with outdoor workers' exposures across the US. We use 2023 data from the US Environmental Protection Agency (EPA) Air Quality Index (AQI) and FEMA's National Risk Index (NRI) to capture different aspects of environmental risk relevant to outdoor occupational exposure. County-level data for these indicators are population-weighted and aggregated to the state level, allowing comparison with state-level estimates of outdoor workers developed from the 2023 American Community Survey (ACS). This section describes how we estimate the number of outdoor workers and link them to environmental and extreme weather data to identify states with elevated risks; related methodological caveats are discussed in the limitations section. Both the AQI and NRI are based on historical data and do not incorporate future climate projections, which could shift or intensify geographic patterns of environmental and occupational risk. We population-weight county measures (EPA AQI and FEMA risk scores) to create comparable, policy-relevant state estimates, while acknowledging that this approach may mask local hotspots within states.

Classifying Outdoor Workers by Occupation

Because no single universal definition of "outdoor worker" exists, estimates of outdoor labor force size and exposure can vary across studies. Different research has relied on alternative definitions, thresholds, or data sources, underscoring the need for transparency in how outdoor work is classified. To address this challenge and develop a consistent, replicable measure, we define outdoor workers using a combination of O*NET Work Context data and ACS occupational codes. This approach provides a systematic way to quantify outdoor exposure across all major occupations.

To classify outdoor workers by occupation, we merged 2025 O*NET Work Context data,[11] which includes measures of outdoor exposure for 879 occupations, with the 2023 ACS. The O*NET Work Context questionnaire asks how frequently the sampled worker in an occupation works outdoors exposed to all weather conditions, with a five-level scale ranging from "never" to "every day," including options for "once a year or more but not every month," "once a month or more but not every week," and "once a week or more but not every day." Responses are standardized to a 0–100 scale, where higher values indicate more frequent outdoor work and are averaged across respondents within occupations in the O*NET database. We defined high or medium-high outdoor exposure as occupations with an average context value of 50 or greater on this scale, which means that workers are considered outdoor workers if the average worker in their occupation works outdoors at least once a month. Appendix table A.1 presents the distribution of ACS workers across the O*NET outdoor exposure categories, showing how workers are spread across exposure levels; this distribution helps to show the effect of our ≥50 threshold, demonstrating how the classification captures a broad set of occupations where outdoor work occurs at least monthly while excluding those with only rare or incidental outdoor exposure. Table 1 below shows the exposure values and corresponding frequencies. See the appendix for further information on the conversion of O*NET questionnaire responses to O*NET exposure values observed in the O*NET database.

TABLE 1

O*NET Work Context Questionnaire Values on Outdoor Workers' Exposure to All Weather Conditions

How often does this job require working outdoors, exposed to all weather conditions?

Exposure value	Frequency
100	Every day
75	Once a week or more, but not every day
50	Once a month or more, but not every week
25	Once a year or more, but not every month
0	Never

Source: O*NET Work Context questionnaire.

Notes: Exposure values range from 0 to 100.

To assess the appropriateness of this threshold, we compared O*NET exposure scores with Bureau of Labor Statistics (BLS) categories, indicating whether any outdoor work is required for a given occupation (BLS 2024). Appendix table A.2 shows that among workers we defined as high outdoor exposure using O*NET values (≥75), 83.8 percent are also classified by BLS as having any outdoor exposure, and among those in the medium-high range (50–<75), 76.0 percent are likewise classified as having any exposure. By contrast, only 35.1 percent of workers in the O*NET medium category (25–

<50) are identified by BLS as having any exposure, supporting the validity of the ≥50 threshold for defining outdoor work. No sensitivity analyses with alternative thresholds were conducted; these can be explored in further analyses.

We defined the final unit of analysis as the Census Occupational Code (OCC), with outdoor exposure values calculated at the OCC level for linkage to ACS data. Aligning and aggregating occupational coding systems between O*NET and the ACS required multiple steps. First, we mapped O*NET occupation codes to Standard Occupational Classification (SOC) codes using a Bureau of Labor Statistics crosswalk.[12] When multiple O*NET codes corresponded to a single SOC code, we averaged the O*NET context values for outdoor exposure and attached the aggregated value to the SOC code. Next, because the ACS uses OCC codes, which are more aggregated than SOC codes and consist of 507 unique categories, we converted the SOC-level O*NET context data to the OCC level. We used a BLS crosswalk to map SOC to OCC[13] and merged in National Occupational Employment Estimates from May 2023[14] to determine employment counts at the SOC level. For each group of SOC codes corresponding to a single OCC code, we calculated SOC-level employment shares and used these to weight the O*NET context values. We then aggregated these weighted values to create a final employment-weighted outdoor exposure variable at the OCC level. This process is consistent with other methods of matching O*NET data onto survey data (Kochhar 2023). We merged these occupation-level outdoor exposure estimates with the ACS using OCC codes. These OCC-level exposure measures—our primary unit of observation—were then merged with ACS data for analysis.

Outdoor Air Quality Measures

To assess outdoor air quality at the state level, we compute the population-weighted share of poor air quality days, derived from the EPA's 2023 county-level AQI data.[15] The AQI is a standardized daily measure of air pollution, scaled from 0 to 500, with lower values indicating cleaner air. It reflects the highest concentration among five major pollutants: ground-level ozone, particulate matter ($PM_{2.5}$ and PM_{10}), carbon monoxide, sulfur dioxide, and nitrogen dioxide. AQI values fall into six categories: good (0–50), moderate (51–100), unhealthy for sensitive groups (101–150), unhealthy (151–200), very unhealthy (201–300), and hazardous (301–500).

We define the share of poor air quality days as the percentage of days in a year with AQI values above 50—that is, days categorized as "moderate" to "hazardous." Based on evidence of adverse health effects at pollutant concentrations below current standards, including large US and international cohorts and World Health Organization analyses showing no safe threshold for $PM_{2.5}$ or ozone, we classify AQI ≥ 51 ("moderate" or worse) as "poor" for outdoor workers, whose sustained physical

activity increases inhaled dose and risk (Di et al. 2017; Liu et al. 2019; WHO 2021). This measure is calculated as the complement of the EPA's "good air quality days" indicator. A higher share of poor air quality days suggests greater overall exposure to air pollution across the state. To aggregate from county to state and national levels, we weight each county's share of poor air quality days by its population, so that more populous counties contribute proportionally more to the state value. This approach helps maintain comparability across states with different population distributions and is consistent with our methods for estimating our measures of wildfire and extreme heat events.

Measures of Wildfire and Extreme Heat Events

We use FEMA's NRI to estimate state-level risks of wildfire and extreme heat events, specifically measured as heat waves (multiday periods of unusually hot and humid weather), drawing on 2023 data that encompass historical records on hazard frequency, population density, infrastructure exposure, and resilience.[16] NRI risk scores, standardized between 0 and 100, indicate relative risk, with higher scores reflecting greater vulnerability; a county-level NRI score of ≥75 means the community is at or above 75 percent of other counties. We used the full NRI—combining expected annual loss, social vulnerability, and community resilience—to represent economic exposure as well as overall population-level and equity-related risk. We used population weights to aggregate county-level scores to the state and national levels. This approach is useful for the state-wide comparisons in this analysis, though it may mask localized environmental risks. Future work could extend this analysis to county or subcounty levels to better capture within-state variation in hazard exposure and vulnerability. The two measures used are:

1. **Wildfire risk score:** Reflecting both the likelihood and potential severity of wildfire events (as defined by FEMA's NRI), this measure considers vegetation, historical wildfire incidence, and infrastructure vulnerability. Higher scores denote an elevated risk of wildfires impacting the state. Although the wildfire risk score reflects the likelihood and severity of direct wildfire impacts rather than the full geographic reach of smoke exposure, it provides a useful state-level indicator of population vulnerability in fire-prone areas. Future work could incorporate data on smoke plumes to assess air quality risks extending beyond fire perimeters.
2. **Heat wave risk score:** This score assesses the likelihood and potential impact of heat waves, multiday periods of unusually hot and humid weather (as defined by FEMA's NRI), considering exposure, population vulnerability, and resilience. A higher score signals a greater risk of experiencing damaging heat waves.

The Intersection of Outdoor Workers and Climate Risk

We conduct two types of analyses to examine outdoor workers' exposure to climate risk. In the first, we estimate the share of workers who live in states we define as having high levels of risk for exposure to poor air quality, wildfire smoke, and heat waves. For this analysis, we (1) consider a state to have poor overall air quality if fewer than 75 percent of days in 2023 were classified as "good" corresponding to a high share of poor air quality days (≥ 25 percent of days), with 35 states and the District of Columbia meeting this threshold; (2) define states with wildfire risk scores of 75 or higher as having elevated wildfire risk, with 14 states meeting this threshold, a cutoff that roughly corresponds to—but does not precisely replicate—the upper quartile of county level risk scores; and (3) define states with heat wave risk scores of 75 or higher as having elevated heat wave risk, with 25 states and the District of Columbia meeting this criterion, a cutoff roughly corresponding to the upper quartile of county level risk scores.

In the second analysis, we use bivariate choropleth maps to identify the state-level overlap of outdoor worker prevalence and climate risks (Biesecker 2020). To develop the bivariate choropleth maps, we sorted states into three groups for each variable: the 13 states with the lowest scores, the 13 states with the highest scores, and the 25 states with scores in between. We then examined the intersection of the share of outdoor workers and each of the climate risks. We use a nine-color key to show how two variables intersect. Each axis of the color key represents one variable, split into groups based on the percentiles described above and defined in table 2.

Table 2 shows the percentile breakpoints that inform both the quartile thresholds used in the quantitative analysis and the tertile groupings (three groups) displayed in the choropleth maps; the tertile groupings collapse the two middle quartiles into a single middle category for visual clarity, aligning the two approaches for comparability. In the choropleth maps, darker shades correspond to higher values for both variables, meaning states in the darkest cells experience both more frequent climate risks and the highest shares of outdoor workers. This visualization allows readers to quickly identify states that face a combined environmental and occupational exposure.

TABLE 2

Quartile Breakpoints for Outdoor Worker Share and Climate Risk Indicators

Quartile (percentile breakpoints across states)	Share of state outdoor workers	Share of poor air quality days	Heat wave risk score	Wildfire risk score
First percentile	9.4%	5.5%	32.1	35.9
Twenty-fifth percentile	19.7%	23.6%	65.4	47.1
Fiftieth percentile	21.2%	30.7%	78.3	60.4
Seventy-fifth Percentile	22.9%	34.9%	85.9	78.3
Hundredth percentile	29.1%	48.2%	97.7	98.0

Source: Authors' calculations using 2023 data from the American Community Survey, US Environmental Protection Agency Air Quality Index, and Federal Emergency Management Agency National Risk Index.
Notes: Percentiles reflect the distribution of states across each indicator (heat scores exclude Alaska and Hawaii because of missing data). Values were used to group states into quartiles for figures 3–5. The middle two quartiles were combined for simplified three-category bivariate mapping.

Results

More than 20 Percent of US Workers Are Outdoor Workers

In 2023, approximately 20.6 percent of US workers were classified as outdoor workers—defined as those in occupations where the average respondent reports working outdoors at least once a month, based on linked O*NET and ACS data (appendix table A.2). Many of these workers face risks to their health due to air quality, extreme heat, and wildfire smoke (table 3). In 2023, 83.1 percent of all outdoor workers lived in one of the 35 states and the District of Columbia where more than 25 percent of days had poor air quality (an absolute threshold measure, defined as an AQI between 51–500). Almost 2 out of 5 outdoor workers (38.4 percent) lived in one of the 14 states with elevated wildfire risk. Nearly two-thirds of outdoor workers (65.1 percent) lived in one of the 25 states and DC with elevated heat wave risk.

TABLE 3

Distribution of the US Outdoor Workforce across States with High and Low Climate Risk, 2023

	Distribution of the US outdoor workforce across states by climate risk levels (%)
Share of poor air quality days	
High (>25%)	83.1%
Low (≤25%)	16.9%
Heat wave risk score	
High (>75)	65.5%
Low (≤75)	34.5%
Wildfire risk score	
High (>75)	38.4%
Low (≤75)	61.6%

Source: US Environmental Protection Agency (EPA), "Air Quality Index Daily Values Report," accessed October 15, 2025, https://www.epa.gov/outdoor-air-quality-data/air-quality-index-daily-values-report; and Federal Emergency Management Agency (FEMA), "National Risk Index," accessed October 15, 2025, https://hazards.fema.gov/nri/.
Notes: 2023 EPA Air Quality Index (AQI) is the source for the share of good air quality days. FEMA (2023) is the source for the Heat Wave and Wildfire Risk Scores. Air quality data is aggregated from the county to the state level to construct average county-level measures within each state. The share of poor air quality days is equivalent to having an AQI value between 51 and 500, with a high share of poor air quality days being greater than 25 percent. The National Risk Index heat wave and wildfire risk scores are aggregated from the county to the state level, weighted by county population. Risk scores are aggregated from county-level percentile ranking of annualized heat or wildfire risk compared with all other counties across the US. All risk scores are constrained to a range of 0 to 100. No heat risk data is available for Alaska or Hawaii. A high share of heat and wildfire risk is >75. The share of national outdoor workers is constructed using 2023 American Community Survey and Occupational Information Network data combined with the Standard Occupational Classification of minor occupational groups to determine outdoor exposure estimates.

The Share of Outdoor Workers Is Larger in the South, Mountain West, and Midwest Regions

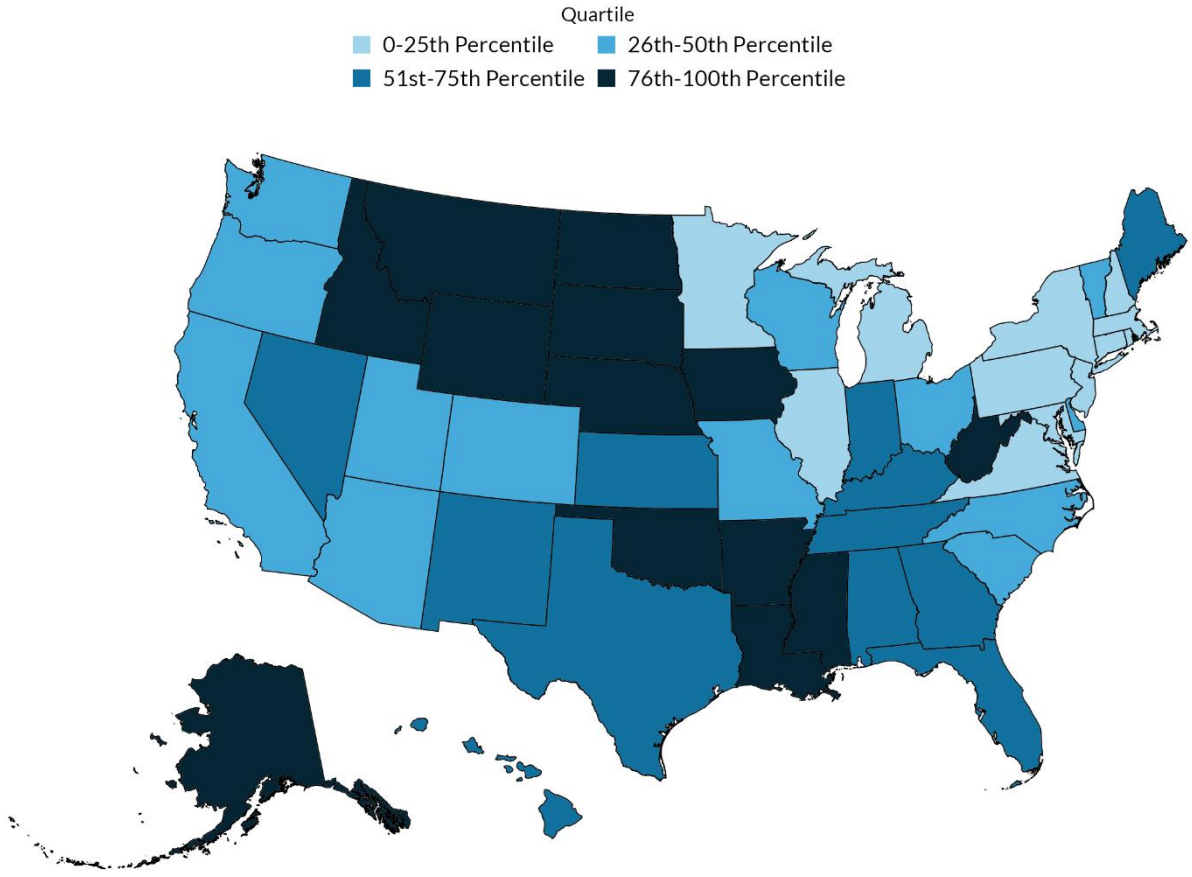
The share of outdoor workers within a state varies in distinct regional patterns (figure 2; appendix table A.3). The rural Northern Mountain (e.g., Wyoming and Montana) and West Central states (e.g., North Dakota and South Dakota) have among the highest outdoor worker shares, led by Wyoming (29.1 percent of state workforce), North Dakota (27.0 percent), Montana (26.2 percent), South Dakota (25.8 percent), and Idaho (24.7 percent), because of strong resource-related and construction sectors.[17] Alaska (24.5 percent) stands out in the Pacific, while California (20.8 percent) is closer to the national average. Some West South Central and East South Central states also have relatively high rates of outdoor workers, with Texas (22.6 percent), Arkansas (23.4 percent), Louisiana (23.3 percent), Mississippi (24.1 percent), and Alabama (22.2 percent) all above average. In the South Atlantic, Florida (21.8 percent) and Georgia (21.3 percent) also have high rates of outdoor workers. In contrast, the states of the Northeast have lower shares—Massachusetts (16.5 percent), Connecticut (17.8 percent),

and New York (17.5 percent)—likely because of more indoor professional jobs. Overall, outdoor work is most concentrated in the South, Mountain West, and rural Midwest.

FIGURE 2

Outdoor Work Is Most Prevalent in the South, Mountain West, and Rural Midwest Regions, 2023

States with higher outdoor work shares tend to be in the South, Mountain West, and parts of the Midwest, reflecting regional industry and labor force patterns



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Source: 2025 Occupational Information Network (O*NET) Work Context Questionnaire and 2023 American Community Survey (ACS).

Notes: Quartile cuts for share of outdoor workers within each state: 0–25th percentile: 9.4–19.7 percent, 26–50th percentile: 19.7–21.2 percent, 51–75th percentile: 21.2–22.9 percent, and 76–100th percentile: 22.9–29.1 percent. Outdoor work is estimated based on O*NET data linked to ACS data by occupation codes, using a crosswalk between Standard Occupational Classification codes and Census Occupational Codes. Outdoor workers are defined as those in occupations where more than 50 percent of workers report working outside at least once a month. This analysis includes workers ages 15 and older across all US states and provides state-level estimates of outdoor worker prevalence.

Poor Air Quality Conditions and High Outdoor Workforce Overlap in Many States, Particularly in the South and Midwest

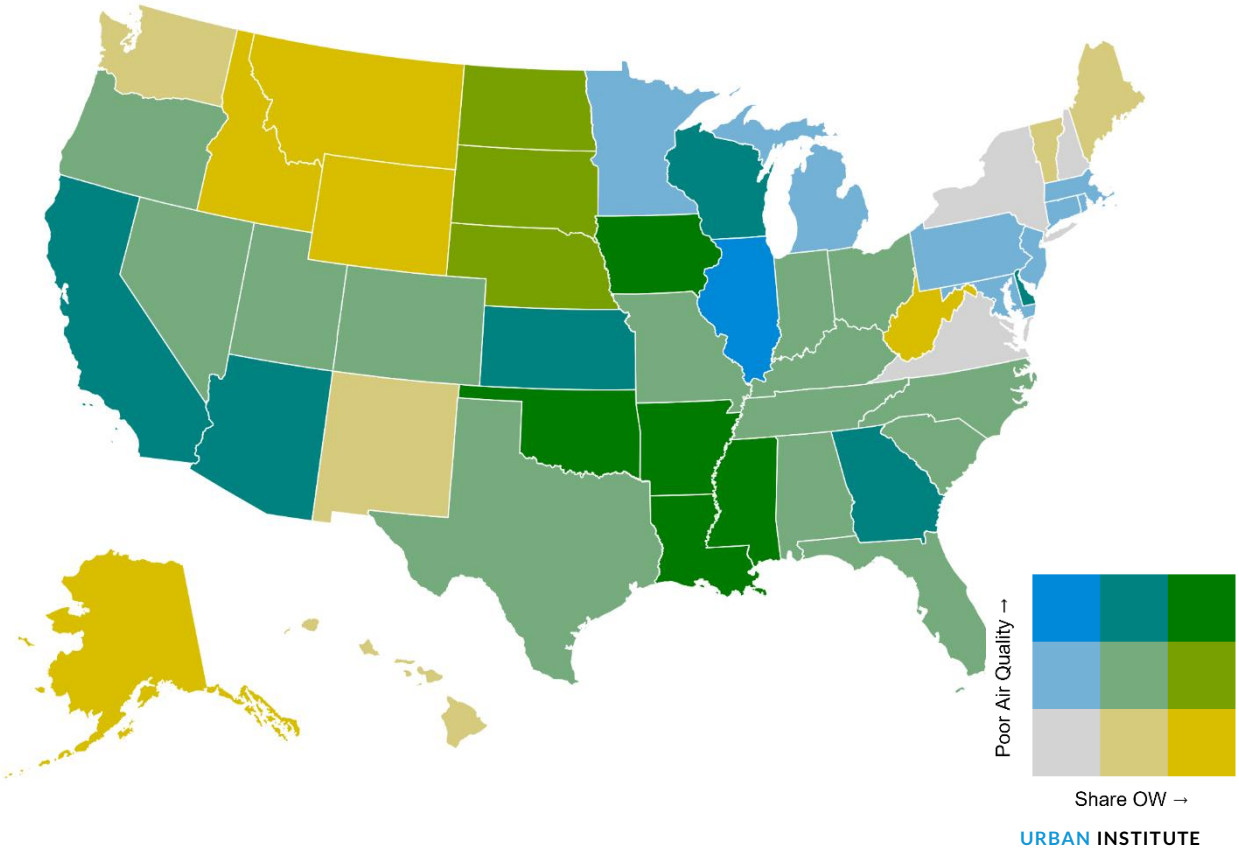
The map in figure 3 illustrates the intersection of the share of outdoor workers and the share of poor air quality days (figure 3; appendix table A.3). Particularly concerning overlaps occurred in states within both the highest quartile of share of outdoor workers (≥22.9 percent) and the highest quartile of poor air quality days (≥34.9 percent). This includes Iowa (23.5 percent of the state workforce and 45.0 percent poor air days), Mississippi (24.1 percent and 42.4 percent, respectively), Oklahoma (23.4 percent and 40.4 percent), Louisiana (23.6 percent and 36.9 percent), and Arkansas (23.4 percent and 34.9 percent). By contrast, North Dakota (27.0 percent of state workforce and 33.2 percent poor air days) and South Dakota (25.8 percent and 25.8 percent, respectively) fall below the top quartile cutoff for poor air quality days, though both have some of the nation's highest outdoor worker shares. These states—primarily in the South and Midwest—demonstrate an elevated burden of occupational exposure to poor air quality, and outdoor workers are a large share of their workforce.

Finally, some large states, such as California, have an average share of outdoor workers (20.8 percent) but, because of their large populations, constitute a large share of outdoor workers nationwide (appendix table A.3). California also experiences relatively high rates of poor air quality (42.2 percent of days), reinforcing concerns about cumulative risks in populous labor markets.

FIGURE 3

Share of Poor Air Quality Days and Share of Outdoor Workers by State, 2023

Some states with large outdoor worker populations have poor air quality



Source: 2023 Environmental Protection Agency (EPA) Air Quality Index data, 2023 American Community Survey.
Notes: States are divided into three groups—bottom quartile, middle two quartiles, and top quartile—based on their share of poor air quality days and on their share of outdoor workers. Breaks for share of poor air quality days are 23.6 percent and 34.9 percent (range is 5.5–48.2 percent). Breaks for share of outdoor workers are 19.7 percent and 22.9 percent (range is 9.4–29.1 percent). The share of poor air quality days per state in 2023, using the EPA's Air Quality Index data, which includes pollutants like ground-level ozone and particulate matter.

Wildfire Risk is High in Several Western and Southern States with Large Outdoor Workforces

Many states with high wildfire risk are also home to a large share of the nation's outdoor workforce. The map below shows 2023 FEMA Wildfire Risk Scores alongside each state's share of outdoor workers (figure 4; appendix tables A.2 and A.3). California faced both a high wildfire risk score (96.0) and the largest outdoor workforce in the country, with 20.8 percent of its workers in outdoor jobs—accounting for 12.0 percent of all outdoor workers nationally. Texas (86.8 wildfire risk score, 22.6 percent state outdoor worker share) and Florida (94.7 wildfire risk score, 21.8 percent of state workforce) also

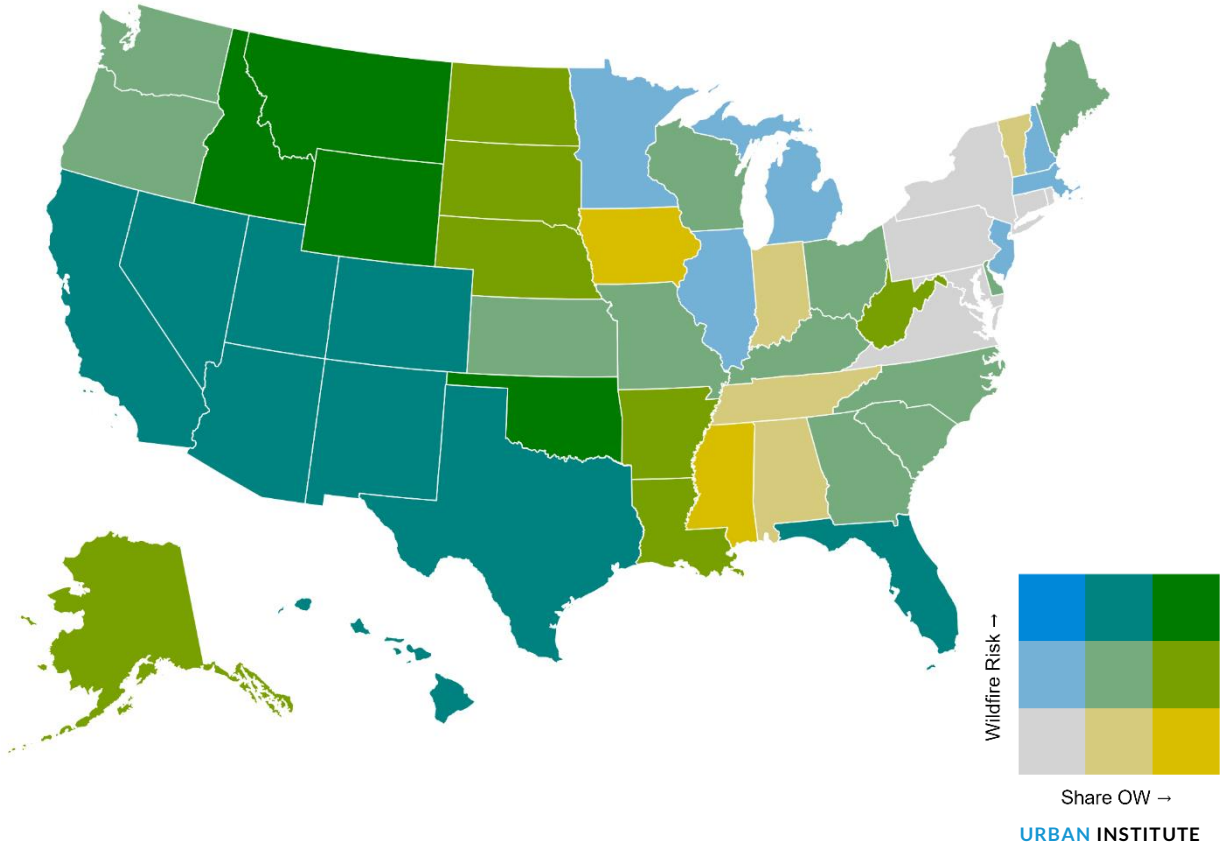
combined high risk scores with large outdoor labor forces, raising occupational health concerns for a large share of outdoor workers nationwide (9.7 and 6.8 percent of the national outdoor workforce, respectively). States with elevated wildfire risk include western areas such as Arizona (97.9 wildfire risk score, 20.9 percent of state workforce), Utah (95.3 wildfire risk score, 19.9 percent of state workforce), and New Mexico (87.6 wildfire risk score, 22.9 percent of state workforce), where dry conditions and high heat intensify wildfire danger for outdoor workers. States with scores ≥ 78.6 fall into the top quartile of wildfire risk nationally; among these, New Mexico, Oklahoma, and Texas also have outdoor worker shares of state workforces above 22.9 percent, placing them in the top quartile for both measures.

Outdoor workers in many other states face lower wildfire risk. For example, Illinois (47.1 wildfire risk score, with 19.4 percent of the state workforce) and New York (37.0 wildfire risk score, 17.5 percent of the state workforce) have relatively large outdoor workforces but relatively low wildfire scores. Others, like Vermont (43.3 wildfire risk score, 21.1 percent of state workforce) and Rhode Island (35.9 wildfire risk score, 18.2 percent of state workforce), fall in the lower quartiles of wildfire risk and have fewer outdoor workers as a share of total state workforce.

FIGURE 4

Wildfire Risk Score and Outdoor Workers by State, 2023

States with the highest wildfire risk often also have large shares of outdoor workers, compounding exposure concerns



Source: 2023 American Community Survey and 2023 Federal Emergency Management Agency (FEMA) National Risk Index (NRI) data for wildfire risk scores.
Notes: States are divided into three groups—bottom quartile, middle two quartiles, and top quartile—based on wildfire risk and on their share of outdoor workers. Breaks for wildfire risk score are 47.1 and 78.3 (range is 35.9–98.0). Breaks for share of outdoor workers are 19.7 percent and 22.9 percent (range is 9.4–29.1 percent). The state-level Wildfire Scores are based on FEMA's NRI data, with population-weighted estimates to capture state-level risk and resilience.

Heat Wave Risk is High in Several Southern and Western States with Large Outdoor Workforces

Many states with large outdoor workforces also face high risk from extreme heat. Figure 5 shows 2023 FEMA Heat Wave Risk Scores alongside each state's share of outdoor workers (appendix table A.3). California faced both a high heat wave risk score (93.5) and the largest number of outdoor workers in the country (12.0 percent of the national outdoor workforce), with 20.8 percent of the state's workforce in outdoor jobs. Texas (91.3 heat wave risk score, 22.6 percent of state workforce, 9.7 percent of

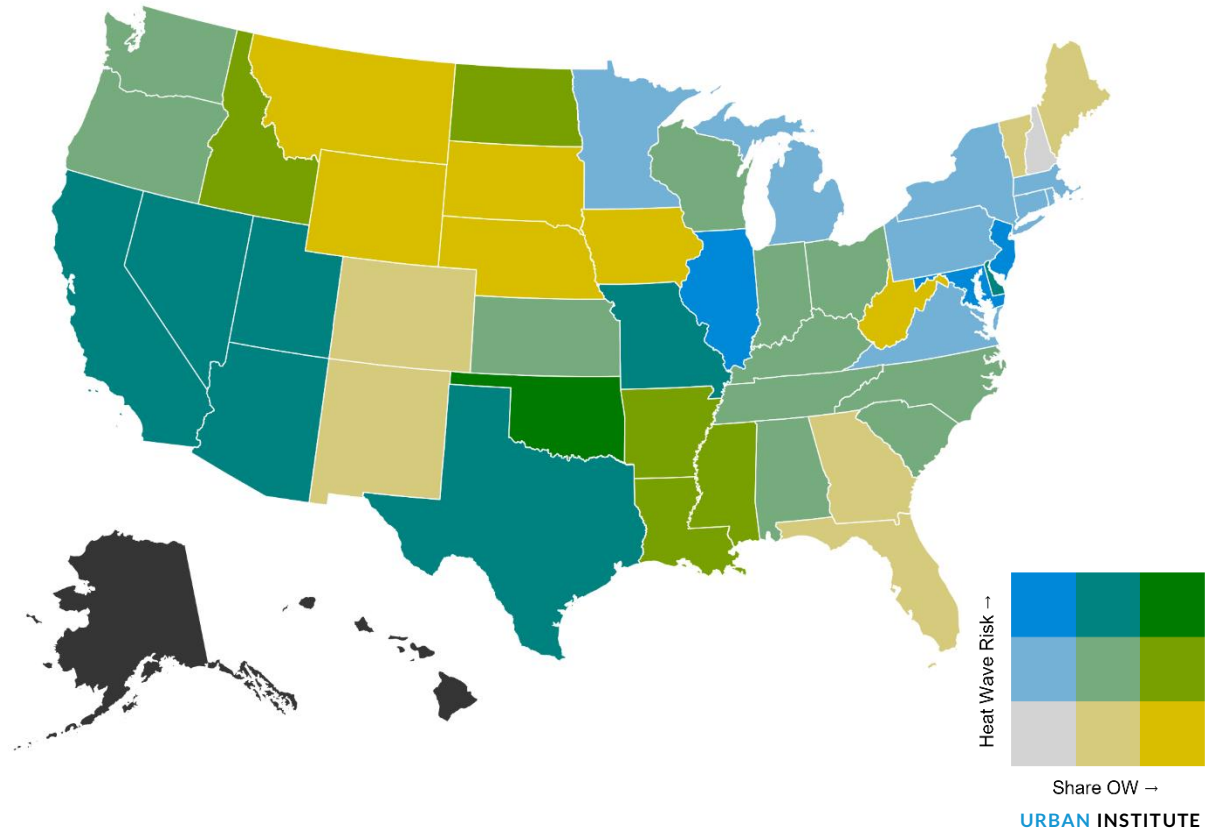
national outdoor workforce) and Florida (63.6 heat wave risk score, 21.8 percent of state workforce, 6.8 percent of national outdoor workforce) also combined elevated risk scores with large outdoor labor forces. Several other states in the south and west had both elevated heat wave risk and high shares of outdoor workers, including Oklahoma (91.6 heat wave risk score; 23.4 percent of state workforce), Nevada (87.5 heat wave risk score; 22.2 percent outdoor workers), Alabama (85.0 heat wave risk score; 22.2 percent outdoor workers), Arkansas (83.7 heat wave risk score; 23.4 percent outdoor workers), Louisiana (82.3 heat wave risk score; 23.3 percent outdoor workers), and Mississippi (82.0 heat wave risk score; 24.7 percent of state workforce). States with heat wave risk scores ≥ 85.9 fall into the top quartile of heat wave risk nationally; many of these states, such as Nevada, Oklahoma, and Texas, also have outdoor worker shares of state workforce above 22.9 percent, placing them in the top quartile for both measures.

Several states, like North Carolina (74.3 heat wave risk, 20.8 percent of state workforce), Ohio (73.1 heat wave risk score, 19.7 percent of state workforce), and Virginia (71.3 heat wave risk score, 18.9 percent of state workforce), have moderate levels of exposure to heat waves and about average shares of outdoor workers. States with the lowest risk—such as Vermont (32.9 heat wave risk score, 21.1 percent of state workforce), Wyoming (32.1 heat wave risk score, 29.1 percent of state workforce), and New Mexico (33.0 heat wave risk score, 22.9 percent of state workforce)—generally have outdoor worker shares of state workforce near the national average, though Wyoming stands out with a much higher share at 29.1 percent.

FIGURE 5

Heat Wave Risk Score and Outdoor Workers by State, 2023

Some states with elevated heat wave risk also have large outdoor workforces



Source: 2023 American Community Survey, 2023 Federal Emergency Management Agency (FEMA) National Risk Index (NRI).
Notes: States are divided into three groups—bottom quartile, middle two quartiles, and top quartile—based on their heat wave risk and on their share of outdoor workers. Breaks for heat wave risk score are 65.4 and 85.9 (range is 32.1–97.7). Breaks for share of outdoor workers are 19.7 percent and 22.9 percent (range is 9.4–29.1 percent). Alaska and Hawaii do not have heat wave risk score data available. The state-level Heat Wave Risk Scores are based on FEMA's NRI data, with population-weighted estimates to capture state-level risk and resilience.

Discussion

Outdoor workers are on the front lines of escalating climate- and extreme weather-related health risks, yet protections remain limited and uneven across the country. Our analysis shows that large shares of the outdoor workforce live in states facing elevated risk from at least one major hazard—air pollution, wildfire, or extreme heat—and many face multiple threats. California, Texas, and Florida, for example, are home to over a quarter of the nation's outdoor workers and generally have low air quality and high wildfire and heat wave risk. These hazards are not evenly distributed: while the South and Mountain

West tend to have both high shares of outdoor workers and elevated heat and wildfire risk, some Midwestern states with smaller outdoor labor forces still face notable air quality challenges. Although our analysis uses state boundaries to align with existing policy authority and available data, state-level measures also enable national comparison across hazards and labor exposures. However, because environmental hazards cross state borders and local governments often share policy authority for preparedness and response, future analyses could extend to cities or counties where data permit. This variation underscores the need for geographically tailored policy responses that address specific climate hazards and local labor conditions.

Taken together, the findings illustrate the urgent need to improve workplace safety for outdoor workers amid worsening climate and environmental threats. In 2023, over 8 in 10 outdoor workers (83.1 percent) lived in states where at least a quarter of days had poor air quality, meaning air quality was "moderate" to "hazardous." Nearly two-thirds (65.1 percent) of outdoor workers were in states in the top quartile for heat wave risk, and almost 2 in 5 (38.4 percent) were in states in the top quartile for wildfire risk.

These estimates show that most outdoor workers are concentrated in places where climate-related exposures are already frequent or severe, heightening the urgency of stronger worker protections. Even moderate exposure to these hazards—such as temperatures above 80°F or intermittent wildfire smoke—can increase the risk of injury, illness, and long-term health problems. Yet most outdoor workers are not covered by enforceable protections against these growing threats. The remainder of this discussion evaluates existing federal- and state-level protections, highlights policy gaps, and outlines options to strengthen safeguards for workers in high-risk environments.

Existing Air Pollution and Wildfire-Related Worker Protections

The US lacks federal protections for outdoor workers from air pollution exposure, including wildfire smoke. Instead, the US relies on a patchwork of industry-specific protections, guidelines, and recommendations for situations such as emergency response and voluntary respirator use in poor air quality conditions. The OSHA Hazardous Waste Operations and Emergency Response standard requires protection for workers involved in hazardous waste operations and emergency responses, including, but not limited to, first responders and workers encountering air pollution from hazardous substance releases, chemical spills, or fires.[18] For wildfires specifically, OSHA advises employers to provide respirators approved by NIOSH for voluntary use in poor air quality conditions because of wildfire smoke, though it does not specify an AQI threshold for mandatory use.[19] Against this backdrop, in February 2024, the EPA finalized stronger National Ambient Air Quality Standards for fine

particulate matter ($PM_{2.5}$), a move that, while not worker-specific, could improve overall air quality and reduce exposure risks for outdoor workers.[20] However, in 2025, the Trump administration signaled a reversal in course, announcing plans to reconsider the 2024 standards and outlining a "path forward" that, if implemented as described, would likely weaken enforcement and delay implementation.[21] Additional actions included granting compliance delays to dozens of coal-fired power plants subject to hazardous air pollution limits, potentially undermining broader clean air protections.[22]

Recent federal administrative changes have further weakened cross-agency federal climate and health capacity. The elimination of the HHS Office of Climate Change and Health Equity (OCCHE) and deep cuts to Centers for Disease Control and Prevention (CDC) programs that support state and local heat preparedness have reduced federal support for addressing both air quality and heat hazards.[23] OCCHE was eliminated in January 2025 under an executive order terminating federal offices linked to diversity, equity, inclusion, and environmental justice, and by February, its staff were placed on administrative leave, and the office's website was removed.[24] Before its elimination, OCCHE had developed tools such as the Heat-Related EMS Activation Surveillance Dashboard and the Climate and Health Outlook Portal to track heat-related medical emergencies. Although these tools continue to operate under other federal agencies like CDC, NOAA, and NHTSA, the loss of OCCHE likely reduced centralized coordination and federal leadership on climate-health equity.[25] Although CDC later reinstated many staff positions after initial layoffs, the disruption temporarily weakened the agency's ability to conduct heat surveillance, wildfire smoke monitoring, and community support.[26]

Alongside the lack of federal standards specifically protecting workers from ambient air pollution exposure, including wildfire smoke, no state has worker protections broadly covering occupational air pollution exposures or hazardous air situations. However, Washington and California have specific protections, such as air quality monitoring and mandatory rest breaks, when the air quality falls into an "unhealthy" range.[27] Additionally, three states, California, Oregon, and Washington, have adopted wildfire smoke protection standards (effective in 2019, 2022, and 2024, respectively) that require employers to provide NIOSH-approved N95 respirators, monitor air quality at outdoor worksites, and offer training on smoke risks and exposure reduction strategies. California mandates that employers make respirators available for voluntary use starting at AQI 151 and requires mandatory respirator use above 500.[28] Oregon mandates voluntary use starting at AQI 101 and requires mandatory use above AQI 251.[29] Washington's requirements are more protective, with voluntary respirator availability beginning at AQI 69, mandatory use at AQI 500, and a robust respiratory protection program at AQI 555.[30] All three states also encourage exposure control strategies like schedule adjustments and early reporting of smoke hazards. In addition, several states have established general air quality standards

that, while not worker-specific, are more stringent than the federal standards promulgated by the EPA,[31] and could lead to better air quality conditions for outdoor workers.

Existing and Proposed Heat Protections for Outdoor Workers

Despite historic and growing exposure to heat-related hazards across many workplaces, occupational protections remain weak, with no comprehensive federal heat-specific standard and limited monitoring of heat-related injuries (Rosenthal et al. 2024). Extreme heat is a recognized occupational hazard that has caused tens of thousands of illnesses and nearly 1,000 deaths among US workers in recent decades (Rosenthal and Bzeih 2025). Yet in the absence of a clear federal definition of extreme heat hazards, it remains difficult for state and local regulators to enforce protections, since demonstrating that heat caused a specific worker's illness or death requires substantial evidence (Rosenthal and Bzeih 2025). Some gaps in extreme heat protections have been filled by labor negotiations, such as agreements between the Teamsters Union and UPS,[32] and protections secured by the United Steelworkers.[33]

Existing and Proposed State-Level Heat Protections

In the absence of federal protections, only seven states have enacted workplace heat protections and only six of these apply to outdoor workers—California (for both indoor and outdoor workers), Colorado (outdoor and indoor), Maryland (outdoor and indoor), Minnesota (indoor), Nevada (outdoor and indoor), Oregon (outdoor and indoor), and Washington (outdoor; Rosenthal and Bzeih 2025). New Mexico has a heat standard under development (outdoor and indoor; NMED 2025). In addition, local efforts to introduce heat safety ordinances have been preempted by state laws in places like Texas and Florida, leaving millions of workers without safeguards.[34] These laws preempt local heat safety ordinances, stripping local governments of the authority to set heat protections for workers, such as required water breaks for construction workers,[35] despite Texas and Florida being among the states most exposed to extreme heat.[36] Florida and Texas laws may disproportionately affect outdoor workers who are more likely to be low-income, Hispanic, uninsured, or noncitizen immigrants—groups identified as having higher outdoor occupational exposure risk.[37]

Existing and Proposed Federal Heat Protections

Although multiple federal initiatives have been launched to address occupational heat risks, their effectiveness has been undermined by recent budget reductions and administrative actions that cut the scientific and enforcement capacity needed to sustain them.[38]

National Emphasis Program. As a partial measure at the federal level, the Biden administration implemented a National Emphasis Program in 2022 that mandated targeted enforcement of heat protections for both outdoor and indoor workers in high-risk industries, such as agriculture, construction, manufacturing, transportation, warehousing, postal services, and landscaping (OSHA 2024). OSHA conducted more than 5,000 federal heat-related inspections, including prioritizing inspections in agricultural industries that employ temporary, nonimmigrant H-2A workers for seasonal labor.[39] The program was extended until April 2026, with no repeal apparent (OSHA 2024). However, beginning in 2025, the Trump administration eliminated the entire NIOSH heat team and dismissed most of the CDC's Division of Environmental Health Science and Practice, which had supported local preparedness for extreme heat and wildfire smoke.[40] These administrative changes risk significantly weakening federal capacity to monitor, enforce, and expand heat protections for workers, even though the National Emphasis Program technically remains in effect.

OSHA Proposed National Heat Safety Rule. In July 2024, OSHA proposed a federal rule aimed at preventing heat-related illnesses and injuries among workers and requiring employers to establish a Heat Injury and Illness Prevention Plan.[41] Key measures include providing water, breaks, shaded areas, air conditioning, ventilation for indoor areas, protective equipment, acclimatization, training, and symptom monitoring. In the proposed protection, two heat index thresholds are specified: at 80°F, employers must offer drinking water and break areas, while at 90°F, they must implement additional measures like mandatory 15-minute rest breaks every two hours, heat illness monitoring, and hazard alerts.[42] Although necessary to reduce health and safety risks for extreme heat for workers, this rule would not cover all workers, particularly those in industries and occupations governed by separate regulations, and state and local government employees without OSHA-approved plans, primarily education and public safety workers.[43]

The public rulemaking remains active, with the informal hearing concluding in July 2025 and a posthearing comment period open until October 30, 2025.[44] Regardless, this proposed rule faces significant political and legal challenges. First, 2024 Supreme Court decisions limiting federal agencies' rulemaking authority[45] may open avenues to challenge OSHA's regulatory scope, especially without new legislation from Congress to clearly define and delegate authority.[46] Second, OSHA and NIOSH have faced major budget and staff cuts. The president's FY 2026 budget would reduce OSHA's funding by 8 percent and eliminate 223 full-time positions, including a 24 percent cut to standards-setting and a 13 percent cut to enforcement.[47] In parallel, NIOSH lost roughly two-thirds of its workforce in spring 2025, including its entire heat team, whose research and testimony have been foundational to OSHA's heat rulemaking.[48] Without NIOSH's heat specialists, OSHA loses an essential resource for evaluating

scientific evidence and responding to public comments, making it likely that the proposed heat safety standard will struggle to withstand industry and legal challenges.[49]

Extreme Weather and Heat Response Modernization Act. In June 2025, federal representatives launched the bipartisan Congressional Extreme Heat Caucus in the House of Representatives, which introduced the *Extreme Weather and Heat Response Modernization Act*.[50] This legislation would strengthen FEMA's authority to respond to extreme heat emergencies, allowing communities to set up cooling infrastructure to protect vulnerable residents. Although not specific to outdoor workers, this caucus and legislation create greater opportunities to minimize risks for communities facing greater heat exposure. However, the Trump administration subsequently announced plans to phase out FEMA after the 2025 hurricane season, which would further erode federal emergency response capacity.[51]

Policy Recommendations

Implementing the following measures could better protect the health and productivity of outdoor workers, allowing federal and state authorities to address the growing threat of extreme heat, air pollution, and wildfire exposure and their disproportionate impact on at-risk outdoor workers.

State Policy Recommendations

- **Adopt and enforce state and local protections for heat, air pollution, and wildfire smoke.** State and local governments can implement tailored workplace safety standards, including enforceable rules for air quality and wildfire smoke exposure modeled on Washington, Oregon, and California. These may include mandatory N95 use, training, AQI monitoring, and rest breaks. In states like Florida and Texas, that preempt local heat rules,[52] alternative strategies may be needed, including litigation against preemptive state laws and supporting expanded federal regulatory efforts through legal challenges and coalition-building.

- **Encourage or require employers to adopt protections stronger than required by the federal government.** State policymakers can support or mandate employer actions that exceed current federal guidelines—such as adopting rest, shade, and hydration practices before OSHA's heat rule is finalized, or implementing strong air quality protections like AQI-based respirator use and work modifications during wildfire smoke events.

- **Fund local education and public outreach campaigns to educate employers, workers, and health care providers.** State and local governments can invest in educational campaigns to promote awareness and compliance with heat, air quality, and wildfire smoke protections.

These campaigns could also equip local health care providers to screen for risk factors and educate workers.

- **Encourage voluntary employer action at the state level.** Employers can be encouraged to voluntarily exceed federal and state heat protection standards to reduce liability and demonstrate commitment to worker safety. Employers can also look to other states for model protections they may choose to adopt voluntarily.
- **Focus monitoring and enforcement on high-exposure occupations at the state level.** State agencies could prioritize monitoring and enforcement of protections for occupations more vulnerable to climate hazards, such as agriculture, construction, landscaping, transportation, warehousing, mining, oil extraction, and emergency response.
- **Launch comprehensive campaigns, including local health care providers, to educate employers and workers on heat and air quality risks and protections.** State and local governments can launch campaigns to raise awareness about environmental risks facing outdoor workers and encourage voluntary employer protections, regardless of new federal rules. These efforts could include partnerships with local health care providers to identify workers at higher risk and offer guidance on reducing exposure.

Federal Policy Recommendations

- **Propose new federal air pollution and wildfire standards.** Proposing new federal standards for air pollution and wildfire smoke exposure could enhance protections for outdoor workers by setting clear, enforceable thresholds for respirator use and air quality monitoring. Washington state's standards provide a model for robust worker protection, requiring voluntary respirator availability at AQI 69 and mandatory use at AQI 500, along with comprehensive training and exposure control measures. Federal adoption of similar standards could create consistent protections nationwide, reducing health risks for outdoor workers and addressing gaps left by the current patchwork of state-level regulations.
- **Approve the proposed federal OSHA heat safety protections, first issued in July 2024.** Approving the proposed federal heat protections would mark a significant step forward in safeguarding outdoor workers from heat-related illnesses. The proposed OSHA rule, which includes measures such as water access, mandatory rest breaks, shaded areas, and heat illness monitoring at specified heat index thresholds, would provide essential protections currently lacking in federal policy. These standards would help reduce health and financial risks for

workers in high-risk industries like agriculture and construction, offering consistent protections across states and addressing the gaps left by limited state-level and local heat safety measures. To complement these standards and align with international best practices, federal policymakers could also encourage development of comprehensive Occupational Heat Action Plans that integrate training, hydration, shaded rest areas, medical surveillance, and engineering and administrative controls (WHO and WMO 2025). Consistent with international guidance, ensure worker participation in designing and implementing workplace heat protections, recognizing that effective measures require input from those most exposed (WHO and WMO 2025).

- **Extend proposed federal heat protection to workers across all employers and industries.** To strengthen protections against heat-related occupational health risks, federal policymakers could broaden the proposed federal heat safety standards to cover outdoor workers across all employers and industries, including those outside OSHA's jurisdiction.[53] Workers currently excluded from the proposal include state and local public sector workers in states without OSHA-approved plans, mining workers regulated by the Mine Safety and Health Administration, Coast Guard, and Federal Aviation Administration personnel, certain Department of Energy workers, such as those at nuclear facilities, and other specific worker categories.[54]

- **Restore and fully fund NIOSH's heat safety research and expertise.** The recent layoffs of NIOSH's entire heat team have severely undermined OSHA's ability to finalize its proposed federal heat standard, as NIOSH's science was central to defining exposures, validating interventions, and supporting enforcement. Without this expertise, the rule faces greater legal and political risk. Immediate federal action is needed to rebuild NIOSH's capacity to inform rulemaking and conduct public outreach.[55] Recognizing the urgency of this issue, federal lawmakers launched the bipartisan Congressional Extreme Heat Caucus in 2025 to advance federal action on extreme heat, including legislation to strengthen FEMA's response and reverse heat-related program cuts at federal agencies.[56]

- **Address legal and administrative challenges to OSHA's regulatory authority through Congressional action.** Recent Supreme Court decisions narrowing federal agencies' rulemaking power underscore the need for Congressional action to clearly define and delegate authority to OSHA to ensure nationwide worker protection.[57]

- **Support labor negotiations and collective bargaining for worker protections.** Policymakers from both major parties have expressed support for unions. This creates an opportunity for bipartisan action to support collective bargaining to close gaps in heat and air pollution protections, including the many outdoor workers without protections related to air pollution and wildfire smoke exposure.
- **Enhance tracking of heat-related occupational health effects.** Current tracking of occupational heat-related health outcomes is sparse and often inconsistent. Official statistics likely undercount heat-related worker deaths, since they are often misclassified as cardiovascular or other causes, and some deaths go unreported, especially in industries with large numbers of undocumented or short-term workers.[58] This underreporting makes the true scale of occupational heat risks even harder to address.[59] To improve surveillance in the short term, the federal government could establish a timely, standardized national system that integrates data from OSHA, BLS, CDC, NIOSH, and FEMA. In the longer term, the federal government could develop a national integrated system and public reporting that links these data with broader public health surveys (e.g., the Behavioral Risk Factor Surveillance System, the National Health Interview Survey, and the Current Population Survey) to enable more timely and comprehensive tracking. This system should capture not only acute heat-related illnesses and deaths but also chronic conditions linked to repeated heat exposure, such as kidney disease, cardiovascular complications, and long-term mental health impacts (WHO and WMO 2025). To ensure comparability across datasets and jurisdictions, federal agencies should adopt standardized heat stress indices, such as the Wet-Bulb Globe Temperature or the Universal Thermal Climate Index, for surveillance and workplace risk assessment (WHO and WMO 2025). Such a system would provide policymakers and employers with actionable information to guide interventions and resource allocation.
- **Promote built-environment strategies to reduce hazard exposure.** Both state and federal governments can help mitigate occupational and community heat exposure by supporting local investments in shade structures, urban forestry, and green space. These strategies not only reduce ambient temperatures but also improve long-term climate resilience and equity outcomes (Marx and Morales-Burnett 2022).

Limitations

This analysis has several limitations. First, the classification of outdoor workers relies on O*NET survey data linked to ACS occupational codes, using a threshold that could overestimate exposure by including

occupations where workers report working outdoors as infrequently as once per month. In addition, the classification assumes that averaging outdoor exposure across workers within broad occupational codes reasonably captures typical conditions, though this may obscure heterogeneity in individual exposure levels.

Second, both the AQI and NRI are based on historical data and do not incorporate future climate projections, which could shift or intensify geographic patterns of environmental and occupational risk.

Third, air quality exposures are based on the share of days with "good" versus "poor" air quality, which may underrepresent short-term spikes in $PM_{2.5}$ or ozone—for example, during wildfire events—and does not distinguish between pollutants with distinct health effects.

Fourth, FEMA's NRI scores for wildfire and heat are composite measures that reflect not only hazard frequency but also community vulnerability and potential economic losses. These indicators, while useful for broad comparisons, were developed for general hazard assessment and not for measuring occupational health risks.

Fifth, county-level risk scores were aggregated to the state level using general population weights, because county-level measures of outdoor worker populations were not available, which may misrepresent exposures in states with substantial intra-state variation. Although state-level analysis supports broad policy insights, aggregating county data can mask localized risks that may be better captured at finer spatial scales (Clark et al. 2022). Nonetheless, these state-level aggregates are critical for identifying national patterns and guiding state policymaking.

Finally, the analysis is descriptive and does not control for confounding factors such as rurality, industry mix, or local labor conditions. Future work can incorporate finer spatial resolution, sensitivity testing of exposure thresholds, and multivariate analysis to more precisely assess the relationship between occupational characteristics and environmental risk.

Conclusion

Outdoor workers face escalating and disproportionate risks from climate-related hazards such as poor air quality, wildfire smoke, and extreme heat—risks that are concentrated in industries like agriculture, construction, and landscaping. Many of these workers lack basic protections against these risks, and federal action is largely stalled under the current administration. Federal legislative efforts could offer a path forward, but face uncertain prospects without broader congressional or executive support. States

can lead by adopting enforceable standards for air quality and heat, expanding protections for at-risk workers, and closing regulatory gaps left by federal inaction. In states where local heat safety ordinances have been preempted, litigation and coordinated pressure campaigns may offer paths forward. In addition to regulatory action, stronger tracking of both acute and chronic heat-related health effects and greater worker participation in shaping protections are also essential. Expanding labor negotiations and collective bargaining is critical for increasing the number of outdoor workers covered by climate-related health and safety protections, particularly workers not covered by existing laws or regulations. Local public outreach campaigns, focused enforcement in high-risk industries, and stronger employer accountability mechanisms can further strengthen protections. Without action, worsening environmental hazards will continue to threaten workers' health, earnings, and productivity across key sectors of the economy.

Appendix A. Conversion of O*NET Questionnaire Responses to Outdoor Exposure Values

The O*NET data are collected using a multistage sampling design that samples workers in targeted occupations from a stratified random sample of establishments. Workers in each occupation are then randomly assigned one of three questionnaires that each contains a different set of questions.[60]

The Work Context questionnaire asks, "How often does your current job require you to work outdoors, exposed to all weather conditions?" Responses are provided on a five-point scale:

1. Never
2. Once a year or more, but not every month
3. Once a month or more but not every week
4. Once a week or more but not every day
5. Every day[61]

To allow comparability across occupations, O*NET standardizes these responses to a 0 to 100 scale using the formula S = ((O—L) / (H—L) * 100, where S is the standardized score, O is the rating score on the 1-5 scale, L is the lowest possible score, and H is the highest possible score. Under this conversion, "Never" = 0 and "Every day" = 100 (O*NET scales).[62]

Responses are then averaged across respondents in an occupation. This assumes that variation within an occupation largely represents measurement error, such that the exposure values we observe in the O*NET database represent mean exposure scores (Handel 2016). Because the original microdata are not available to researchers, only these mean scores are used. For example, a score of 50 indicates that the average worker in the occupation group surveyed by O*NET reports working outdoors once a month or more but not every week.

Appendix table A.1 shows how ACS workers are distributed across these standardized O*NET outdoor exposure categories. This distribution illustrates the relative size of the workforce at low, medium, and high exposure levels and provides context for the ≥50 threshold used in our main analysis.

TABLE A.1

Distribution of ACS Workers across O*NET Categories

O*NET categories	Percent of workers
High exposure (O*NET context ≥75)	14.2%
Medium-high exposure (75>O*NET context ≥ 50)	7.5%
Medium exposure (50>O*NET context ≥ 25)	27.3%
Low exposure (25>O*NET context > 0)	48.1%
No exposure (O*NET context = 0)	2.9%

Source: Authors' calculations using 2025 Occupational Information Network (O*NET) Work Context data and 2023 American Community Survey occupational employment estimates.

Notes: Table shows the distribution of outdoor worker exposure classification based on O*NET outdoor work context scores. "High exposure" corresponds to scores ≥75, "medium-high exposure" to scores between 50 and <75, "medium exposure" to scores between 25 and <50, "low exposure" to scores between 0 and <25, and "no exposure" to scores of 0.

TABLE A.2

Share of Workers in O*NET Exposure Category Reporting Any or No Outdoor Exposure in BLS Classifications

	BLS categories	
O*NET categories	Any exposure	No exposure
High exposure (O*NET context ≥75)	83.8%	16.2%
Medium-high exposure (75>O*NET context ≥ 50)	76.0%	24.0%
Medium exposure (50>O*NET context ≥ 25)	35.1%	64.9%
Low exposure (25>O*NET context > 0)	11.1%	88.9%
No exposure (O*NET context = 0)	4.3%	95.7%

Source: Authors' calculations using 2025 Occupational Information Network (O*NET) Work Context data, 2023 American Community Survey occupational employment estimates, and 2023 Bureau of Labor Statistics (BLS) Occupational Requirements Survey data.

Notes: Table shows the distribution of outdoor worker exposure classification based on O*NET outdoor work context scores. "High exposure" corresponds to scores ≥75, "medium-high exposure" to scores between 50 and <75, "medium exposure" to scores between 25 and <50, "low exposure" to scores between 0 and <25, and "no exposure" to scores of 0. The "Any Exposure" column includes occupations meeting a given O*NET threshold and classified by BLS as having any outdoor work component; "No Exposure" includes occupations below that threshold. Percentages reflect national employment-weighted estimates. Estimates are limited to occupations that have classifications for outdoor work in both the O*NET Work Context and BLS ORS datasets.

TABLE A.3

2023 State-Level Air Quality, Climate Risk Indicators, and Share of Outdoor Workers

State	Share of US outdoor workers	Share of state workers who work outdoors	Share of poor air quality days	Heat wave risk score	Wildfire risk score
National	100.0%	20.6%	32.0%	79.92	66.24
Alabama	1.5%	22.2%	34.9%	85.0	45.4
Alaska	0.3%	24.5%	9.8%	no data	73.6
Arizona	2.1%	20.9%	35.5%	93.7	97.9
Arkansas	0.9%	23.4%	34.9%	83.7	60.7
California	12.0%	20.8%	42.2%	93.5	96.0
Colorado	1.9%	20.2%	31.1%	47.6	79.9
Connecticut	1.0%	17.8%	26.9%	66.8	44.9
Delaware	0.3%	21.2%	44.9%	96.5	76.6
District of Columbia	0.1%	9.4%	48.2%	97.7	47.0
Florida	6.8%	21.8%	27.0%	63.6	94.7
Georgia	3.3%	21.3%	37.6%	65.4	52.7
Hawaii	0.5%	21.3%	5.5%	no data	98.0
Idaho	0.7%	24.7%	22.3%	79.0	86.5
Illinois	3.7%	19.4%	43.5%	93.7	47.1
Indiana	2.1%	21.5%	33.0%	69.6	41.9
Iowa	1.1%	23.5%	45.0%	51.4	43.4
Kansas	0.9%	21.1%	35.2%	85.9	62.2
Kentucky	1.3%	21.7%	29.1%	69.0	47.9
Louisiana	1.4%	23.3%	36.9%	82.3	55.7
Maine	0.4%	22.0%	14.6%	40.0	51.2
Maryland	1.8%	19.2%	24.9%	93.5	43.4
Massachusetts	1.8%	16.5%	25.6%	69.1	60.4
Michigan	2.8%	19.4%	32.0%	83.8	55.8
Minnesota	1.7%	19.0%	34.6%	80.4	71.2
Mississippi	0.9%	24.1%	42.4%	82.0	47.0
Missouri	1.8%	20.6%	32.5%	93.8	58.1
Montana	0.4%	26.2%	22.9%	46.8	84.4
Nebraska	0.7%	22.9%	24.4%	53.7	50.3
Nevada	1.0%	22.0%	25.9%	87.5	97.8
New Hampshire	0.4%	18.8%	17.3%	56.7	61.5
New Jersey	2.6%	18.6%	34.1%	95.5	55.1
New Mexico	0.6%	22.9%	21.6%	33.0	87.6
New York	5.1%	17.5%	21.8%	83.5	37.0
North Carolina	3.2%	20.8%	26.1%	74.3	62.3
North Dakota	0.3%	27.0%	33.2%	66.6	64.5
Ohio	3.4%	19.7%	32.1%	73.1	51.1
Oklahoma	1.3%	23.4%	40.4%	91.6	86.0
Oregon	1.3%	20.7%	27.9%	69.6	61.6
Pennsylvania	3.7%	19.6%	34.2%	78.3	46.4
Rhode Island	0.3%	18.2%	26.4%	69.2	35.9
South Carolina	1.6%	21.4%	32.9%	80.5	64.9
South Dakota	0.3%	25.8%	25.8%	54.2	71.5
Tennessee	2.1%	21.5%	29.0%	79.3	45.9
Texas	9.7%	22.6%	34.7%	91.3	86.8
Utah	1.0%	19.9%	30.7%	91.7	95.3
Vermont	0.2%	21.1%	20.2%	32.9	43.3
Virginia	2.5%	18.9%	18.0%	71.3	39.3

State	Share of US outdoor workers	Share of state workers who work outdoors	Share of poor air quality days	Heat wave risk score	Wildfire risk score
Washington	2.4%	21.0%	19.7%	76.3	67.2
West Virginia	0.5%	23.4%	22.8%	44.1	51.2
Wisconsin	1.8%	20.3%	35.6%	80.9	51.5
Wyoming	0.2%	29.1%	17.0%	32.1	81.4

Source: US Environmental Protection Agency (EPA). "2023 Air Quality Index." Washington, DC: EPA, 2023. Federal Emergency Management Agency (FEMA). "National Risk Index." Washington, DC: FEMA, 2023. 2023 ACS

Notes: 2023 EPA Air Quality Index (AQI) is the source for Share of Good Air Quality Days. FEMA (2023) is the source for the Heat Wave and Wildfire Risk Scores. Air quality data is aggregated from the county to the state level to construct average county-level measures within each state. The share of poor air quality days is equivalent to having an AQI value between 51 and 500. The National Risk Index heat wave and wildfire risk scores are aggregated from the county to the state level, weighted by county population. Risk scores are aggregated from county-level percentile ranking of annualized heat or wildfire risk compared with all other counties across the US. All risk scores are constrained to a range of 0 to 100. No heat risk data is available for Alaska or Hawaii. National climate risk estimates are weighted by state population, outdoor workers as a share of the state workforce, and the national outdoor workforce is constructed using 2023 American Community Survey and O*NET data combined with the Standard Occupational Classification of minor occupational groups to determine outdoor exposure estimates. National outdoor worker shares are weighted by state employment.

Notes

[1] For example, in California's San Joaquin Valley, the annual total societal cost of air pollution—including health care, premature deaths, lost productivity, and school absences—was estimated at $710 million, of which $122 million was direct health care costs such as hospitalizations and emergency department visits (Zarate-Gonzalez et al. 2024).

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Employers must also monitor air quality, adjust work practices to reduce exposure, and train employees on smoke risks and respirator use, promoting early reporting of smoke hazards without fear of reprisal.

[29] Oregon's wildfire smoke protections, effective July 2022, require employers to provide filtering respirators (e.g., N95s, a respirator designed to filter out at least 95 percent of airborne particles) approved by National Institute for Occupational Safety and Health (NIOSH) for voluntary use when the AQI exceeds 101 and mandate their use at levels of 251 and higher, see Juanita Constible, "Occupational Heat Safety Standards in the United States," NDRC, August 12, 2025, https://www.nrdc.org/resources/occupational-heat-safety-standards-united-states; and Teniope Adewumi-Gunn and Juanita Constible, "Re: Rules to Address Employee and Labor Housing Occupant Exposure to High Ambient Temperatures and Rules to Address Employee Exposure to Wildfire Smoke," Letter to Oregon Occupational Safety and Health Division, March 17, 2022.

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