
Heat-Related Workplace Deaths

Identification

1. Description

Extreme heat events (i.e., heat waves) have become more frequent in the United States in recent decades (see the **Heat Waves** indicator), and studies project that the frequency and intensity of extreme heat events will continue to increase as a consequence of climate change (Marvel et al., 2023). When people are exposed to extreme heat, they can suffer from potentially deadly heat-related illnesses, such as heat exhaustion and heat stroke. Thus, as extreme heat events increase, the risk of heat-related deaths and illness is also expected to increase (IPCC, 2022; Sarofim et al., 2016). Tracking the rate of reported heat-related deaths over time provides a measure of how climate change may affect human health and well-being.

Some people are particularly vulnerable to heat-related health threats because they work outdoors. Outdoor workers face increased risks of extreme heat exposure, as do workers who have limited or no access to air conditioning, such as in warehouses and railyards. Between 2000 and 2010, workers in agriculture, forestry, hunting, fishing, construction, waste, and remediation services accounted for about two-thirds of heat-related occupational deaths in the United States (Gubernot et al., 2015).

This “A Closer Look” feature tracks changes in occupational heat-related deaths in the United States from 1992 to 2022. It displays all-sector totals as well as totals specific to the construction sector, which is consistently the single sector with the most heat-related fatalities (Dong et al., 2019). For context in understanding particular vulnerabilities, the feature also presents a map showing the percentage of each county’s workforce that works in outdoor occupations.

2. Revision History

June 2024: Feature published.

Data Sources

3. Data Sources

This feature is based on data from the Census of Fatal Occupational Injuries (CFOI), which is compiled by the U.S. Bureau of Labor Statistics (BLS). The CFOI is the most comprehensive source of fatal workplace injury data for the United States and should capture all deaths that occur because of injuries occurring in the workplace. This feature’s supplementary map provides data from the BLS Quarterly Census of Employment and Wages (QCEW) program.

4. Data Availability

Data for Figure 1 of this feature are publicly available at BLS’s CFOI website: www.bls.gov/iif/oshcfoi1.htm. Users can access the data in multiple formats via multiple interfaces,

including query tools and tabular downloads. More information about the CFOI and BLS's Injuries, Illnesses, and Fatalities data, including metadata, can be found at: www.bls.gov/iif/home.htm. Data for the example map of outdoor workers, which is based on occupation types, are available on BLS's QCEW website: www.bls.gov/cew/downloadable-data-files.htm.

Methodology

5. Data Collection

This feature is based on data that are annually collected, verified, and coded for the CFOI program. The scope of the CFOI is broad, encompassing all workers in any employment status across all sectors (private, federal [including resident military], state, and local government) who have been fatally injured while engaging in a work-related activity in the United States, including territorial waters. This scope is broader than the subset of industry sectors and establishments that fall under the statutory jurisdiction of the U.S. Occupational Safety and Health Administration (OSHA).

BLS gathers data from many sources, including multiple federal and state agencies. The complete list of CFOI data sources appears below and is described in more detail at:

www.bls.gov/opub/hom/cfoi/data.htm.

- Death certificates
- State workers' compensation reports
- Medical examiner reports
- Coroner reports
- News media reports
- Autopsy reports
- Toxicology reports
- Police reports
- OSHA reports
- Mine Safety and Health Administration (MSHA) reports
- Federal Employee Compensation reports
- Fatality Assessment and Control Evaluation reports
- Department of Defense military reports
- U.S. Coast Guard reports
- Longshore and harbor workers incident reports
- National Transportation Safety Board reports
- Federal Emergency Management Agency/U.S. Fire Administration reports
- Agricultural reports
- Other governmental reports
- Informant report/questionnaires
- Employer report/questionnaires
- Hospital, physician, ambulance reports
- Funeral home reports
- Federal Railroad Administration reports

- The National Highway Traffic Safety Administration’s Fatality Analysis Reporting System
- Social Security Death Index
- Traffic bureau reports
- Survey of Occupational Injuries and Illnesses
- Online sources
- Other state OSHA reports

Many cases begin with a report by an employer. For workplaces covered by federal OSHA jurisdiction, the regulations known as OSHA’s Recordkeeping and Reporting Standards (specifically, 29 CFR Part 1904 Subpart E) require employers to report all work-related fatalities within eight hours. Visit: www.osha.gov/report.html for more information about this requirement and how it is implemented. In some states, known as “State Plan” states, OSHA has delegated authority to corresponding state agencies, and they receive reports directly from employers. MSHA, the military, and other agencies similarly compile reports on any deaths occurring under their jurisdiction.

BLS reviews each case and substantiates it using multiple source documents (e.g., death certificates, autopsy reports, and news media reports). For a sense of the types of documents compiled, see BLS’s chart with the number of documents used by type in 2022: www.bls.gov/charts/census-of-fatal-occupational-injuries/sources-of-data-fatal-work-injuries.htm. Information about the circumstances surrounding each fatal incident, the worker, and the nature of their employment is captured in more than 30 data elements for each case. BLS’s public-facing database provides an aggregated version of this information without revealing personal or case-specific information. More information can be found on the BLS CFI website, including state-level death data: www.bls.gov/iif/state-data.htm.

Data collected for the CFI program are coded using various standardized classification systems. Since 2003, CFI has used the North American Industry Classification System (NAICS) to classify industries into sectors and the Standard Occupational Classification (SOC) to code occupations. BLS also developed the Occupational Injury and Illness Classification System (OIICS) to classify the circumstances of each injury, illness, and fatality case with respect to five variables: nature of injury or illness, part of body affected, event or exposure (the manner in which the injury or illness was produced or inflicted), primary source (the object, substance, exposure, or bodily motion that was responsible for producing or inflicting the disabling condition), and secondary source (the object, substance, or person, if any, that generated the source of injury or contributed to the event or exposure). Although there is an inherent level of subjectivity in how a fatality is classified, each case and its associated source documents are validated multiple times to ensure that information is being correctly transcribed and coded.

The CFI program began in 1992. No comprehensive compilation of nationwide workplace fatality data exists for the time before 1992.

The QCEW has similar documentation on methodology and the data collection process, which can be found at: www.bls.gov/cew/downloadable-data-files.htm.

6. Derivation

Figure 1. Heat-Related Workplace Deaths in the United States, 1992–2022

This feature reports annual counts of fatalities that have been classified with OIICS codes related to environmental heat as the primary source of injury. These codes are:

- OIICS 1.0 code: 9362 (pre-2011)
- OIICS 2.01 code: 9262 (2011 to present)

This code (titled “Heat—environmental”) classifies injuries caused by high atmospheric and environmental temperature extremes that occur indoors or outdoors. Thus, this code is mainly applied to cases of heat stroke, heat exhaustion, and the like. The change in code number between 2010 and 2011 is due to a major revision of the OIICS manual in 2010; however, the definition of this particular code did not change, just the numbering. Thus, it was not necessary to insert a dividing line in Figure 1. The OIICS also has a “Heat—environmental” code under “Event or Exposure” that is virtually synonymous with the version under “Primary Source.” Querying either option in BLS’s database leads to nearly identical death counts. For consistency, EPA chose to focus on “Heat—environmental” under “Primary Source” for this analysis.

In addition to obtaining annual data for all fatalities coded with “Heat—environmental” as the primary source, EPA queried analogous data for the construction sector. EPA chose to highlight the construction sector because of its consistent data availability and because it represents the largest plurality of environmental heat-related fatalities on an annual basis in the specified period. Some other sectors could also be of interest for climate-related reasons, but they have limitations such as:

- Being lumped into larger “supersectors” for detailed data reporting (for example, agriculture is combined with fishing and forestry).
- Experiencing substantial changes in definition and scope as a result of the 2002–2003 SIC/NAICS transition.
- Experiencing such low death counts that certain years’ data have been suppressed. For privacy reasons, BLS’s data system does not display totals for specific sector/year/cause of death combinations if only a few cases qualify for inclusion. Section 8 on comparability (below) describes this suppression in more detail and explains how it affects the total shown for 2019.

EPA developed this feature using publicly available data from the CFOI. No extrapolation was performed on a spatial or population basis because the data collection mechanism already provides complete coverage of the target population. Data were not projected forward into the future nor reconstructed for years prior to 1992.

Example 1. Distribution of Outdoor Workers in the United States, 2018–2022

EPA has created a map for 2018–2022 showing the percentage of the workforce in each county that works in specific industries that typically require substantial outdoor work. The map reports data collected by BLS’s QCEW. It includes the following NAICS categories:

- 11 (agriculture, forestry, fishing, and hunting)
- 21 (mining, quarrying, and oil and gas extraction)
- 23 (construction)
- 4911, 4921, 4922 (delivery services)
- 5621:5629, 22 (utility workers)

- 6242 (emergency and other relief services)
- 9221 (police)

NAICS sector 10 (total, all industries), is used as the denominator for each county. For consistency, the analysis is limited to records where the employer ownership type is classified as “total covered.” The map presents an average of data over five years (2018–2022).

7. Quality Assurance and Quality Control

Each fatality case and its corresponding source documents are reviewed in a multi-step process by regional and national BLS staff. This process ensures accuracy and consistency throughout the nation in how the data are transcribed and coded. BLS cross-references multiple sources, as described in the CFOI *Handbook of Methods* at: www.bls.gov/opub/hom/home.htm:

To compile counts that are as complete as possible, the census uses multiple sources to identify, verify, and profile fatal worker injuries. Information about each workplace fatal injury—occupation and other worker characteristics, equipment involved, and circumstances of the event—is obtained by cross-referencing the source records, such as death certificates, workers' compensation reports, and Federal and State agency administrative reports. To ensure that fatal injuries are work-related, cases are substantiated with two or more independent source documents, or a source document and a follow-up questionnaire.

More quality assurance/quality control information can be found in the CFOI *Handbook of Methods* at the web location noted above.

Analysis

8. Comparability Over Time and Space

Data collection has been largely consistent since 1992. One of the key sources, OSHA, has modified its recordkeeping rules numerous times since then, but the fundamental requirement to report all occupational fatalities has been in place from the start, with consistent applicability to all establishments under OSHA jurisdiction. The CFOI's inclusion of many additional data sources beyond OSHA is intended to ensure that the program has consistently captured all occupational deaths nationwide.

Before 1997, BLS used the 1987 Standard Industrial Classification (SIC) system to classify industry sectors; the “construction” division represented SIC code families 15 through 17. These are the codes used to define “construction” for the purposes of this feature. From 1997 to 2002, BLS used the 1997 edition of the NAICS, with sector 23 covering construction. Since 2003, BLS has defined industry sectors according to the NAICS; construction is currently covered by the NAICS 23 code family according to the 2022 edition of the NAICS. The industry sector classification beginning with the 2002 NAICS reflected significant changes in the coding of sector 23, including reclassifying each subsector from 1997 to the following subsectors: Construction of Buildings (236), Heavy and Civil Engineering Construction (237), and Specialty Trade Contractors (238). The classification beginning in 2002 also adopted some resource-extraction-related jobs, including oil and gas pipeline and related structures construction, and site

preparation and related construction activities on a contract or fee basis. Because of these differences in industry coding, construction numbers for 1992–1996, 1997–2002, and 2003–2022 are not directly comparable with each other. More information on the implications of evolving industry classifications can be found at: www2.census.gov/library/publications/economic-census/2002/core-business-statistics-series/ec0200cbdg.pdf.

BLS reports an accurate total death count for each year, but does not publish counts for specific causes of death, sectors, or geographic areas if those counts fall below a suppression threshold. This is a standard practice to avoid revealing information that might be possible to associate with a specific person. In 2019, BLS updated its disclosure methodology for the CFI to strengthen the protection of confidential data. This essentially raised the threshold for reporting data breakouts, which affected Figure 1’s construction total for 2019. It is also BLS’s stated reason for reporting no heat-related deaths at all for 2020. It is unclear to what extent that year’s COVID-19 pandemic and its associated workplace changes might have influenced the number of heat-related deaths or their documentation. For more information on BLS’s disclosure methodology, see: www.bls.gov/iif/factsheets/disclosure-avoidance-in-the-cfi.htm. The segment of Figure 1 called “all other industry sectors” is truly all industry sectors other than construction, given the comprehensive coverage of the CFI, and thus faces less impact from changing classifications than individual industries.

Figure 1 displays vertical dashed lines at each of the points in time described above, signaling a break in the continuity of the data.

The OIICS manual was revised in 2010 and the numerical index for “Heat—environmental” as a primary source changed. However, the underlying definition of the code remained consistent, allowing for comparisons of data before and after the new index numbering went into effect. For more information about 2010–2011 OIICS changes, see: www.bls.gov/iif/oiics_201_changes.pdf.

9. Data Limitations

Factors that may affect the confidence, application, or conclusions drawn from this feature are as follows:

1. Even in years with reported data, total counts are relatively small, leading to high year-to-year variability.
2. When a fatality is coded as being heat-related, it does not mean that high temperatures were the only factor that caused the fatality. Pre-existing medical conditions can greatly increase an individual’s vulnerability to heat. Conversely, there may be fatalities that were not coded as heat-related for which heat was a contributing factor.
3. Extreme temperatures are not the only factor that can affect trends in heat-related fatalities. Other factors include the vulnerability of the population, the extent to which people have become acclimated to higher temperatures, and the extent to which employers and workers in outdoor occupations have adapted to extreme heat. Potential adaptations include frequent mandatory breaks, emphasis on hydration, and switching shifts to cooler times of the day (including nighttime).

4. As described in Section 8, “Comparability Over Time and Space,” the set of codes that BLS used to classify sectors changed in 1997 and 2003, the codes used to classify causes of death changed in 2011, and sector suppression thresholds changed in 2019. The 2011 change does not create a concern because this particular cause of death had a one-for-one match. For the other changes, Figure 1 shows dashed lines to represent discontinuities, but this only affects construction death counts (total death counts have not changed), and even the construction death counts should reflect a fairly close sector definition match. Thus, these coding system changes should not affect the overall conclusions that can be drawn from this feature.
5. This data set relies in part on deaths reported to government agencies by employers. Studies indicate that underreporting does exist, and there is reason to believe that the rate of underreporting could be higher in certain cases, such as those involving workers who are undocumented or short-term (e.g., migrant workers or day laborers). Some deaths might not be properly categorized as heat-related or may not be attributed to an occupational cause if the death occurs off the job site (for example, after the employee has left work for the day) (Hayden et al., 2023).
6. This feature uses death counts rather than crude death rates. Reporting the total number of deaths per year is useful for communication because it puts the exact number of lives in perspective, but it does not account for changes over time in total population, total employment, or sector-specific employment.

10. Sources of Uncertainty

Uncertainty estimates are not available for this feature. Because statistics have been gathered from the entire target population (i.e., all U.S. workplace deaths in a year), these data are not subject to the same kinds of errors and uncertainties that would be inherent in a probabilistic survey or other type of representative sampling program.

Some uncertainty could be introduced due to the discretion of BLS staff in coding each case. There is additional uncertainty due to the CFI’s reliance on external source documents; for instance, death certificates reflect the professional judgment of a medical examiner. These sources of uncertainty could contribute to misidentified or underreported heat-related fatalities.

11. Sources of Variability

There is substantial year-to-year variability within the data, due in part to overall small numbers of fatalities. Further study is needed to determine the extent to which year-to-year variations in heat-related deaths of workers might reflect general weather conditions or specific extreme heat events.

12. Statistical/Trend Analysis

This feature does not report on the slope of the apparent trends in occupational heat-related deaths, nor does it calculate the statistical significance of these trends. OLS regressions on both “all industries” (total) and “construction” yield small but statistically significant ($p < 0.05$) positive slopes.

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