Beyond Events:

Measuring the Ongoing Impacts of Climate Change on Health

# Executive Summary

Extreme weather and climate events, such as wildfires, hurricanes, and floods, capture our attention because of their immediate and often devastating impacts. Accordingly, critical attention to preparedness and response, including surveillance, has advanced.1

Here, we aim to complement extreme climate event and health surveillance preparedness work with a focus on the persistent, intensifying, and ongoing changes in climate that continue between climate events and even in the absence of climate events. This framing invites attention to how climate change affects the leading causes of death and disability like cardiovascular disease and diabetes, nutrition and physical activity, infectious diseases, maternal and child health, mental health, and health equity.

To provide insight on existing surveillance practice, we reviewed surveillance indicators available on websites of a sample of 48 local and state health departments (L/SHDs). For the health departments in our sample undertaking surveillance of climate change impacts on health, we categorized their related indicators. Temperature and air quality related indicators were, by far, the most commonly reported category type, and they varied widely in form and measure. There were also substantial gaps in the types of health outcomes covered, with few climate and health impact measures related to mental health, injury, maternal and child health, or chronic diseases.

The reasons for our findings are likely many. This is a rapidly evolving area and measurement of health impact can be complicated. It often requires the integration of climate data into public health platforms and may spur the development of new techniques to assess exposure. In some cases, the pathways through which climate hazards affect health are not fully elucidated, and attributable risk is under investigation. Still, as demonstrated by a number of health departments in our sample, there is much we do know, tools we do have, and data platforms available to do more.

We close our report with a list of ten areas for further consideration as efforts to advance this nascent area of surveillance are underway. The areas for further consideration became evident throughout the course of this study; from conversations with partners and stakeholders we engaged with along the way; and through expert peer reviewer feedback. These areas relate to indicator standardization; indicator prioritization; indicator categorization; the use of other existing indicators; the creation of new indicators; a focus on populations of concern; national guidance; Tribal and Territorial Health Authority surveillance systems; leveraging indicators for policy and planning; and leadership, workforce and fiscal challenges and opportunities.

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# Introduction

While extreme weather events and their impact on health garner much attention, less commonly discussed is the ongoing and cumulative effect of climate change on health that continues to accrue between and in the absence of climate events.

Admittedly, it is difficult to draw a line between acute weather events and ongoing climate changes that affect health. Summers are getting longer and hotter, and weather events are becoming more frequent and intense. The end of one event and beginning of the next is less discrete. While it is critical that local and state jurisdictions are prepared to respond to the impact of climate events, expanding from an event-focused, framing can highlight the range of climate change health effects on already common conditions. For example, increased temperatures and sustained poor air quality can stress our hearts, resulting in immediate and longer-term increased risk for myocardial infarction, stroke, and pulmonary disease.2 Increased temperature and poor air quality are also linked to poor birth outcomes, as well as worsening mental health, increased infectious disease risk and widening health inequities. Changes in climate can also extend the range of vector born illnesses, like West Nile Virus and Lyme Disease.3

Damaged physical infrastructure, either from a climate event (e.g., hurricane) or a slow erosion due to environmental stressors, can affect health too. For example, repeat flooding can compromise housing and create conditions for mold, triggering allergies and pulmonary problems. Climate change can negatively affect other social determinants of health, like employment, education, health care delivery, and access to food. For example, increasing temperatures can create drought conditions, disrupting food system supply chains, which can increase food prices, leading to food insecurity, poorer health, and widening disparities over time.4

Some populations are more vulnerable to the impact of changing weather patterns than others. Children, older adults, people who are pregnant, people with disabilities, people who are linguistically or socially isolated, people who live, work or engage in recreation outside, and those who are already disadvantaged through the impacts of racism and other systemic biases can be especially affected.

The negative impact of climate-related environmental stressors on health is well-established, conceptually and empirically. For those interested in a deeper understanding of climate impacts on health in the US, the recent, comprehensive National Climate Assessment 5 (NCA5) is one of many excellent resources.3

## Models and Frameworks

There are many models and frameworks describing how climate change influences health. The World Health Organization’s (WHO) Climate Change graphic (Figure 1) captures how vulnerability (mediated through an interplay of an individual or community’s susceptibility and the ability to adapt), climate related hazards, and exposures, interact to introduce risk across health outcomes and health systems and facilities.

## Figure 1. Climate Change and Health Risk

*Source: World Health Organization’s Climate Change Factsheet*5

A diagram of climate change

Description automatically generated

# Leveraging Local and State Health Department Action

U.S. local and state public health agencies are in a unique position to respond and lead in areas related to climate change and health. They have deep knowledge of their communities and are responsible for implementing programs and policies that protect and improve the health of their community. Local and state health departments (L/SHDs) have particular expertise in health surveillance as a cornerstone of understanding population exposures and health, identifying opportunities for intervention, and monitoring impacts. However, L/SHD engagement in this space has been limited.

There are over 3,000 LHDs, which include both county and city health departments. Of those, 6% are “large,” serving a population over half a million; together, large LHDs cover more than half of the US population.6 In a recent survey by the National Association of County and City Health Officials (NACCHO), 10% of LHDs reported being “actively involved in climate change policy or advocacy.” This includes one third of all large LHDs.6

A 2020-2021 survey conducted by the Association of State and Territorial Health Officials (ASTHO) found that, overall, state and territorial health department capacity to address climate change was “low.”7 Only 15% of the 39 participating jurisdictions included “preparing for the public health consequences of climate change” as a top five priority.

## Public Health Surveillance

Public health surveillance is a core public health function, referred to by the Centers for Disease Control and Prevention (CDC) as one of the “Essential Public Health Services.”8 Public health surveillance, “the systematic, ongoing collection, analysis and dissemination of data,” is essential for ensuring public health action is timely, responsive, and data-driven.9

According to the CDC, an environmental public health surveillance indicator “provides information about a population’s health status with respect to environmental factors.” The CDC describes environmental surveillance indicators as follows:10

* **Hazard indicators:** Conditions or activities that identify the potential for exposure to a contaminant or hazardous condition.
* **Exposure indicators:** Biologic markers in tissue or fluid that identify the presence of a substance or combination of substances that could harm an individual.
* **Health effect indicators:** Diseases or conditions that identify an adverse effect from exposure to a known or suspected environmental hazard.
* **Intervention indicator:** Programs or official policies that minimize or prevent an environmental hazard, exposure, or health effect.

Accordingly, the CDC states that ideal indicators are measurable, can be tracked over time, are based on an epidemiological link between an environmental measure and health outcome, are informative, are tied to defined objectives, are action oriented, and use clear case-definitions.10

## Surveillance Indicators for Climate Change and Health

There has been a substantial amount of work already initiated in the area of climate and health surveillance through a variety of US federal agencies. Most notable and ongoing is the CDC’s Climate-Ready States and Cities Initiative (CRSCI) which utilizes the [CDC’s Building Resilience Against Climate Effects](https://www.cdc.gov/climate-health/php/brace/index.html) (BRACE) framework11 and the CDC’s [National Environmental Public Health Tracking Program](https://ephtracking.cdc.gov/).12 We draw our organization of surveillance indicators for this report from CRSCI activities.

In 2023, the US Environmental Protection Agency (EPA) funded 88 projects through [The Environmental Justice (EJ) Government-to-Government Program](https://www.epa.gov/environmentaljustice/environmental-justice-government-government-program), designed to support utilization of state and local data and strengthening of multi-sector community partnerships between various health and environmental agencies and groups.13 [EJ screening](https://www.epa.gov/ejscreen) and mapping tools are available,14 and [cumulative impact assessments](https://www.epa.gov/healthresearch/cumulative-impacts-research) that integrate environmental and health indicators for funded projects are a related area of the larger EJ workstream.15 Additionally, EPA released its’ fifth report of climate change indicators for the US in July 2024 to understand the changing climate.16

The National Institute for Environmental and Health Sciences’ [Climate and Health Outcomes Research and Data Systems (CHORDS)](https://www.niehs.nih.gov/research/programs/chords) project makes available standardized linked data sets that can be used to create indicators linking climate and health variables.17 Recently, the federal government has launched an initiative targeting a single climate hazard, heat. A variety of key resources for communities and health care systems are available through the [2024 US Department of Health and Human Services (HHS) Resources for Health Initiative](https://www.hhs.gov/sites/default/files/hhs-resources-extreme-heat-health-2024.pdf),18 including the CDC’s [heat and health tracker](https://ephtracking.cdc.gov/Applications/heatTracker/),19 HHS’s Office of Climate Change and Health Equity (OCHHE) [Climate and Health Outlook Portal](https://storymaps.arcgis.com/stories/93ea47545cc944139e3fcefa919cb42b),20 and the [National Weather Service Heat Risk Forecast Tool](https://www.wpc.ncep.noaa.gov/heatrisk/).21 The Council of State and Territorial Epidemiologists’ (CSTE) recent report on [Occupational Health Surveillance for Tracking Climate Related Health Impacts on Workers: Heat Wildfire and Floods](https://cdn.ymaws.com/www.cste.org/resource/resmgr/occupationalhealth/publications/CSTE_OH_Surveillance_and_CC_.pdf) focuses on a key climate-vulnerable population.22 There are also government tools that allow for forecasting climate-related events, like droughts ([Drought.gov](http://drought.gov/)).23

Even given this variety of federal investments in climate and health, there is limited detailed information on how L/SHDs are engaging in this work, particularly as it relates to surveillance. There is no established set of standard indicators for L/SHD use outside of those related to emergency preparedness and response to climate events,1 the latter largely measuring drivers of climate events, preparedness of systems and measures of community vulnerability.

To provide insight into how L/SHDs are currently capturing the impacts of persistent and ongoing climate change on the health of their communities, we undertook an assessment of surveillance indicators drawn from websites of a sample of L/SHDs related to climate change impacts on health.

# Methods

Briefly, we created a sample of states, counties and cities using a methodology designed to capture health departments likely to be engaged in climate change and health surveillance. Our sampling methodology is described in Appendix A (page 28).

We first searched SHD websites of our sample of states and LHD websites of our sample of counties and cities for indications of the health departments’ intention to conduct surveillance related to the impact of climate on health (which we called “climate and health linked surveillance”). We define surveillance as the “ongoing systematic collection, analysis and interpretation of data.” Health surveillance was considered linked to climate change if the jurisdiction’s health department website included: 1) a ‘climate and health’ dashboard on their website; or 2) an environmental health dashboard plus a narrative description linking climate change and health on either their website or in an on-line report associated with the L/SHD website; or, 3) a statement on its’ website about the relationship between climate and health that included indicators that were being used for surveillance.

To guide the organization of our extraction of climate and health surveillance indicators from those L/SHDs meeting the definition of “climate and health linked surveillance,” we used categories used by CDC CRSCI recipients: temperature impacts, air quality impacts, vector borne impacts, food and nutrition impacts, mental health impacts, populations of concern.24

We added another category, “other” to capture any climate related indicators that did not fall into the existing categories.

Indicators on L/SHD websites that met our criteria for linked surveillance were placed within these categories if the website explicitly stated that the health outcome was associated with climate change. If not, the indicator was not extracted. For example, even if a L/SHD website discusses the impact of climate on health we did not include an indicator on birth defects found on its’ site unless the L/SHD website explicitly notes that birth defects are associated with climate change.

Because a multitude of measurements could be used for the same indicator, we created “indicator types” to group the indicators within the categories thematically (Tables 2-8, pages 17-26); for example, a “heat-related illness hospitalization rate” indicator type encompasses all indicators that capture heat-related illness hospitalizations, such as crude or age-adjusted rates.

Data were collected from February to July 2024.

# Results

***Sample description***

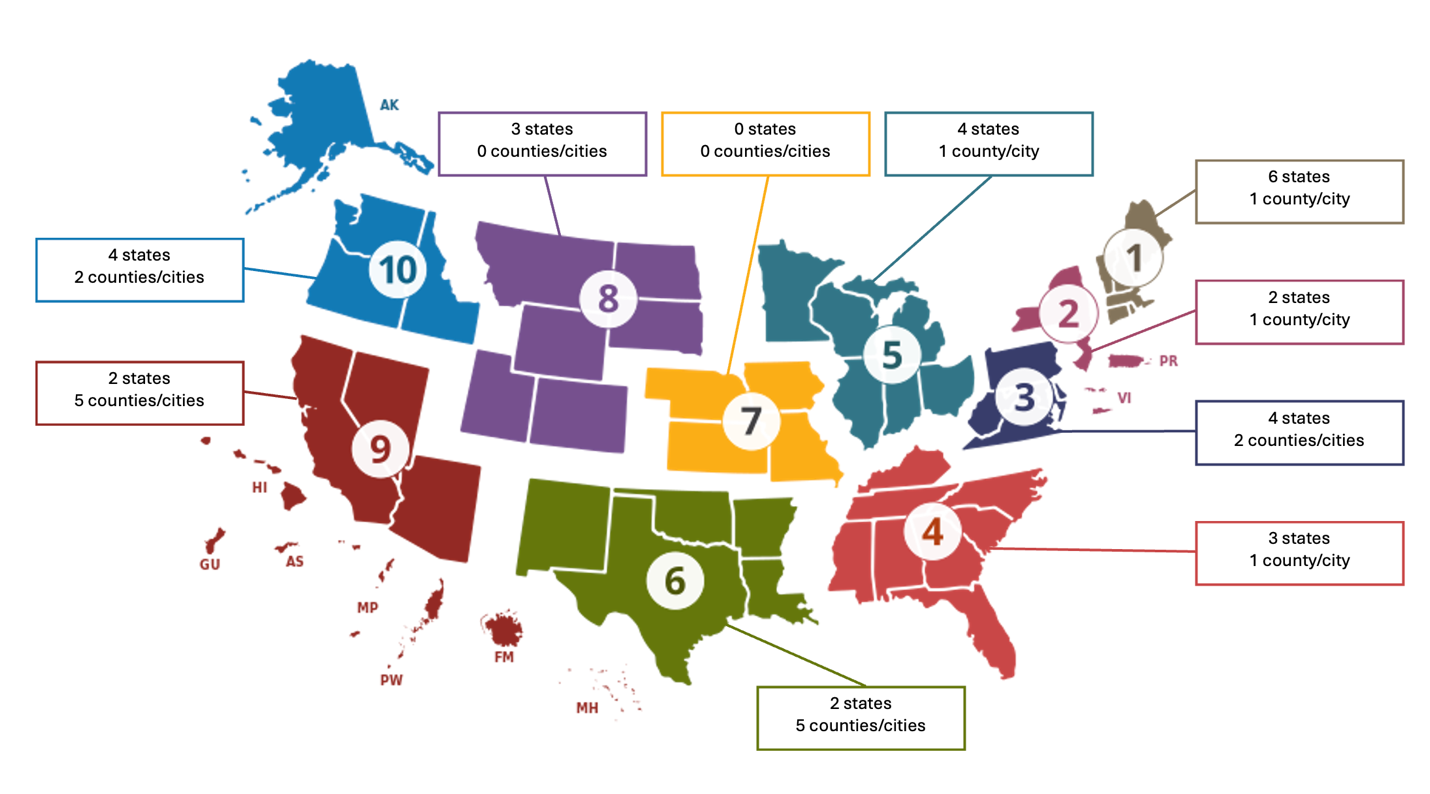
Our total sample of 48 jurisdictions includes 30 states and 18 counties and cities. Sampled states included states with small, medium and large populations (median size 5.9 million people),28 while counties and cities sampled are dominated by large and medium sized jurisdictions (median size 1.3 million people).26 (Table 1) Almost all Health and Human Services (HHS) Regions25 are represented (90% and 80% of HHS regions for states and for counties and cities, respectively). (Figure 2)

## Table 1. Population size estimates of jurisdictions in our sample

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | | **States, n (%)**  **N = 30** |  |  | **Counties and Cities, n (%)**  **N = 18** |
| **2023 State Population Estimate** | | | **2023 County and City Population Estimate** | | |
|  | Small (<2 million)7 | 9 (30%) |  | Small (<50,000)6 | 0 |
|  | Medium (2 million to 10 million)7 | 13 (43%) |  | Medium (50,000-500,000)6 | 2 (11%) |
|  | Large (>10 million)7 | 8 (27%) |  | Large (>500,000)6 | 16 (89%) |

## 

## Figure 2: Number of states, counties and cities in our sample by US Department of Health and Human Services (HHS) Region



*Note: HHS organizes the US into 10 regional offices that are formally referred to by number, as noted above.*

*Source: Adapted from HHS Regional Offices Map*25

Of the 48 jurisdictions in our sample, 31 (65%) had health department websites that met our definition of having linked surveillance. This included 20 SHDs (67% of SHDs in our state sample) and 11 LHDs (61% of LHDs or counties and cities in our sample).

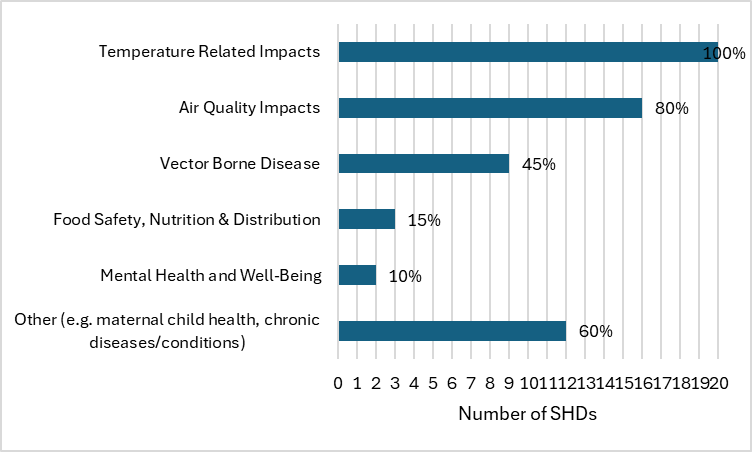
Category Results

### Summary results

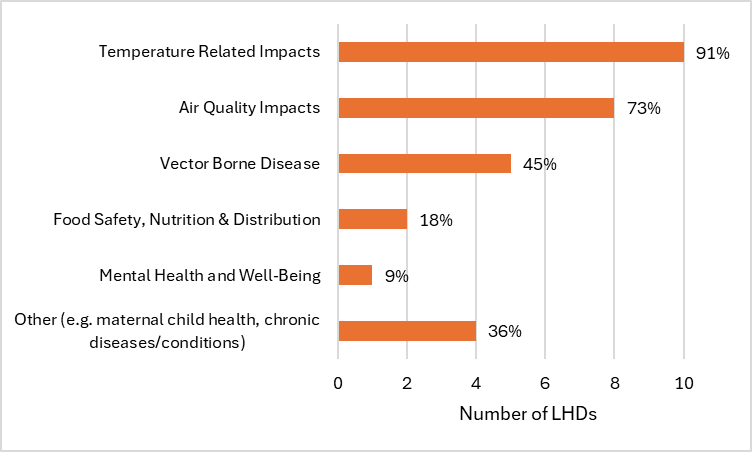
Of all sampled L/SHDs with linked climate and health surveillance, temperature and air quality related indicators were the most common types of indicators reported by L/SHDs (Appendix B). Every SHD with linked surveillance reported at least one temperature related indicator, as did 91% of SHDs. The second most reported indicator category was air quality.

Food safety and nutrition, mental health and well-being, other impacts (e.g., maternal and child health and chronic diseases, injuries and additional environmental indicators), were amongst those categories with very limited climate related health indicators identified. While in aggregate this “other” category appears common, there were a wide range of types of indicators, but little consistency between jurisdictions.

## Figure 3. Number and percent of SHDs (n=20) with linked surveillance that had 1 or more indicators in a category



## Figure 4. Number and percent of LHDs (n=11) with linked surveillance that had 1 or more indicators in a category



## Figure 5. Number of indicator types\* per category in SHDs (n=20) and LHDs (n=11) with linked surveillance

*\*Indicators were grouped thematically into indicator types within each category*

A green and orange chart

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**A chart of different colors

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Category Results

### Indicators by Category

#### Temperature Surveillance Indicators (Table 2, page 17)

The most common temperature indicators included emergency department visits or hospitalizations for heat-related or caused illness, including heat stress. While heat-related health outcomes were most common, some L/SHDs also reported emergency department visits or hospitalizations for cold-related or caused illness. There was substantial variation in how indicators were presented (e.g., per 100,000 population, crude rate, age-adjusted rate) and the types of indicators being assessed. Heat vulnerability indices were measured by three LHDs. There were also temperature indices, events, and projections that captured exposure such as the number of heat days and the number of heatwave events.

Humidity, or the amount of water vapor in the atmosphere, can also impact how temperature affects the body27 but there were no observed surveillance indicators that measured humidity or related health outcomes.

#### Air Quality Surveillance Indicators (Table 3, page 19)

Air quality is the second most commonly surveilled climate impact on health: 88% of SHDs and 67% of LHDs with linked surveillance collected at least one air quality related surveillance indicator. The most common type of air quality indicator was emergency department visits or hospitalizations for asthma, followed closely by emergency department visits or hospitalizations for chronic obstructive pulmonary disease (COPD).Air quality indicators had the highest number of different types of indicators and the most exposure indicators (see surveillance indicator types under *Public Health Surveillance* section, page 5).

Indicators that capture exposure include those that use an Air Quality Index and Air Toxic Cancer Risk Screening Percentile and those that measure fine particulates, ozone, and pollen. Other indicators measure clinical outcomes related to carbon monoxide exposure and wildfire-related impact.

Vector Borne Disease Surveillance Indicators (Table 4, page 21)  
The most common type of vector borne disease indicator observed for L/SHDs with linked surveillance was case count or rate of West Nile virus and the case count or rate of Lyme Disease. Other indicators included those for tick and mosquito-related illnesses, such as chikungunya, dengue virus and malaria. Exposure indicators included surveillance of birds, mammals, or mosquitoes for West Nile virus.

Food Safety, Nutrition & Distribution Surveillance Indicators (Table 5, page 23)  
All of the food safety, nutrition and distribution indicators were collected by, at most, one LHD or SHD, with no dominant indicator types. There were a wide range of foodborne illness indicators collected, such as rate of emergency department visits for foodborne illnesses, rate of hospitalization for foodborne illness, and the count or rate of salmonella, campylobacteriosis, and cryptosporidiosis.

There were also a range of other types of indicators, such as those capturing food access (e.g., limited access to healthy food); food safety violations (e.g., food service establishments with <36 critical violation points); and water safety (e.g., arsenic concentration in drinking water).

#### Mental Health and Well-Being Surveillance Indicators (Table 6, page 24)

Mental health and well-being indicators were the least likely to be included in this sample of L/SHDs with linked surveillance. No mental health indicator was collected by more than one LHD or SHD. Indicator types included those that directly capture climate impact, such as the percentage of people who are worried about global warming and the percentage of people who think global warming will harm future generations, while others capture general mental health information, such as the rate of hospitalizations due to schizophrenia and other psychotic disorders.

### *Other Indicators (Table 7, page 25)*

There were a wide range of other surveillance indicators related to climate change and health that did not fit into the specific CDC CRSCI-derived categories. Types of indicators founds are summarized in Table 7 for illustrative purposes. It is important to note that some of these indicators were reported once on a website or report without sufficient time to determine if they will be repeated over time. We grouped them into the following sub-categories: chronic diseases/conditions, maternal and child health, environment, and injury.

#### Chronic diseases and conditions indicators included cancer incidence, heart attack hospitalization, stroke prevalence, and obesity prevalence among adults. Examples of maternal and child health indicators reported are low birth weight, preterm birth rates, and infant mortality rates as part of health departments’ climate and health surveillance. Those that fell under “environment” were particularly varied, with indicators such as carbon monoxide and child lead poisoning, household crowding and court ordered evictions.

#### Populations of Concern (Table 8, page 27)

In some instances, L/SHDs incorporate a measure of social vulnerability in their surveillance data, such as the [CDC/ATSDR Social Vulnerability Index](https://www.atsdr.cdc.gov/placeandhealth/svi/index.html).30 Some surveillance data is presented by sub-populations , such as children, women of childbearing age, linguistically disadvantaged, and economically disadvantaged.

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# Summary Key Findings

In our sample of L/SHDs, we found no standard set of indicators for surveillance of the ongoing impacts of climate on health.

The types of climate and health indicators most commonly identified in this sample of L/SHDs were hazard indicators, with exposure indicators only sometimes reported. Indicators specific to the health effects of climate change, such as cardiovascular disease outcomes or maternal health, are less well represented.

Temperature appears to be an exception when it comes to reporting associated health outcomes indicators, likely for a few reasons. First, the temporal and causative link between temperature and specific temperature-related illnesses, such as heat stroke and hypothermia, is clearly described. Second, case detection through electronic health records is possible because heat- and cold-related illnesses have specific diagnostic criteria and ICD-10 codes. Third, historic and current temperature data is easily accessible for analysis. And fourth, this area has substantial most federal support and engagement in recent months. For example, CDC has developed the [Climate Change and Extreme Heat website](https://www.cdc.gov/nceh/multimedia/infographics/climate_change_extreme_heat.html) and a [Heat and Health Tracker website](https://ephtracking.cdc.gov/Applications/heatTracker/),19 and numerous federal agencies have collaborated to develop the [National Integrated Heat Health Information System](https://www.heat.gov/).31 Still, determining the health impact of heat on underlying conditions, like heart and lung disease, or other non-heat related ICD codes, appears to be a work in progress.

Limitations

This assessment relied on a sample of L/SHDs and on publicly available information on health department websites alone. Jurisdictions that did not post related indicators or health departments that did not acknowledge the relationship between climate and health online during the time of our data collection will not have information included in our report. Additionally, while we made a concerted effort to extract information consistently and in alignment with traditional surveillance approaches, variation in L/SHD activities, indicators, reporting, and the complexity of many websites may mean some information was left out unintentionally through our data collection methods.

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# Areas for Further Discussion

Public health agencies have unique strengths that can advance policy and practice in the face of increasing climate change related health impacts. Surveillance is one of them. There is much to be learned about the obstacles facing L/SHDs in harnessing this basic tool of public health for these purposes.

Based upon our findings from this study, from conversations with partners and stakeholders we engaged with along the way, and through expert peer reviewer feedback, we have identified a number of areas worthy of further consideration, as well as questions to help guide efforts to advance L/SHD surveillance of climate and health.

1. ***Standardization***

While temperature and air quality indicators have some similarity across L/SHDs, most of the categories are characterized by a wide range of indicator types or an absence of indicators. Further, the “Other indicators” table (Table 7) describes a wide range of indicators that are collected by one or two L/SHDs. What would be the benefits of creating a set of standardized indicators that could be selected for use by L/SHDs? If there is benefit, how might this work proceed, including how might federal partners support the effort?

1. ***Prioritization***

There has been significant federal investment in developing and tracking indicators related to heat and health, which were widely collected in this sample. Are there other types of indicators that are of particular interest that should be prioritized for development and use at the L/SHD level?

1. ***Indicator categories***

In our review of L/SHD websites, we identified a number of indicators that fell in the category of “other,” such as those related to chronic diseases, maternal and child health, and injuries. These outcomes naturally align with many existing core L/SHD-funded programs. As such, it may be helpful to align future indicator development with common L/SHD program areas such as cardiovascular disease and diabetes prevention, physical activity and nutrition, maternal and child health. The WHO figure presents similar, though broader, health categories as areas of impact by climate change.(Figure 1) In an effort to break down silos and expand partnerships within and outside of L/SHDs, and to explicitly encourage indicator development in these areas, should climate-related indicator categories be expanded or reframed?

1. ***Use of other existing indicators***

There are a number of indicators currently collected by L/SHDs but often not linked to climate by L/SHDs. For example, injury rates are often reported by L/SHDs. More high heat days increase the risk of injuries and violence. Other existing data sources within public health agencies, such as the [National Syndromic Surveillance Program](https://www.cdc.gov/nssp/php/about/index.html), could provide information for L/SHD use on a variety of health outcomes related to climate health impacts.32 Is there value in reviewing a broader range of health outcomes currently reported by L/SHDs through a climate impact lens?

1. ***Creation of new indicators***

While some existing climate and health indicators directly capture the link between climate and health, such as hospitalizations for heat related illness or the percentage of people worried about global warming, many do not. The majority of the climate surveillance indicators we identified capture health outcomes without directly reporting on a climate variable, such as the case count of West Nile virus or the case count of Salmonella. What new indicators should be prioritized for development? Are there other indicators that could more directly link climate and health outcomes? Are there new or evolving methods that could be applied? How might modeling, artificial intelligence and non-traditional data sources be used?

1. ***Key populations of concern***

Among the populations of concern indicators (Table 8) there are a number of ways to assess and rank population vulnerability. Considering that some groups of people may be at greater risk of more severe health outcomes from climate change, it is imperative to have dedicated assessment of climate change and health among marginalized and disadvantaged groups (e.g., Black, Indigenous, and other people of color, outdoor workers, people who are unhoused, older adults, children and pregnant people). While there are existing vulnerability indices available (e.g., [CDC/ATSDR Social Vulnerability Index](https://www.atsdr.cdc.gov/placeandhealth/svi/index.html)),30 L/SHDs may consider incorporating additional social and demographic variables in surveillance systems or pursuing data integration with other data sources to determine specific vulnerabilities. Are there populations of concern that should be prioritized for collecting and presenting data? Are there standardized variables or questions for assessing social and demographic features or characteristics?

1. ***National Guidance***

The CDC and other federal agencies make a wide range of climate and health indicator information available at the city, county, and zip code level. Are there specific areas where data is missing or not easily available? What guidance would be most helpful for L/SHDs from federal and national partners for improving climate and health linked surveillance? Click here to enter text.How can L/SHDs capitalize on the investments already made across federal and national agencies?

1. ***Tribal Health Authorities and Organizations and Territories***

We recognize that Tribal health authorities and organizations, and territorial health departments, are critical leaders and partners in addressing climate change, while also representing communities that are particularly vulnerable to the negative health impacts of climate change. There is a wide range of work already underway, including through the CDC’s [Climate Ready Tribes Initiative](https://www.nihb.org/public_health/climate_ready_tribes.php).33 Future work in this area should consider how to support Tribal health authorities and organizations, and territorial agencies that are leading projects related to health and climate change surveillance. While Tribal health authority and Tribal organization data are not collected here, are there organizations that we should share this data with and explore future collaborations? How can L/SHDs best support Tribal health agencies and organizations in climate and health work?

1. ***Surveillance for policy and planning***

While levels of governance vary by jurisdiction, L/SHDs often have some unique authority, including regulatory, in the areas of health care delivery, food safety, and food purchasing, to name a few. There has already been much work in the area of climate emergency planning and response surveillance. Are there specific climate surveillance indicators or indicator types that would be helpful for future L/SHD policy and planning as it relates to non-climate emergency response in these areas (i.e. related to the ongoing and persistent impacts of climate change)? How might new or existing indicators be used to guide local practice, such as opening of warming or cooling centers for groups vulnerable to extreme temperatures?

1. ***Leadership, workforce and fiscal challenges and opportunities***

Collecting surveillance data on health outcomes related to climate surely includes additional challenges beyond those described above. They may include the areas of leadership, funding, resources, workforce and training, and other support that L/SHDs need to collect, interpret, and share this type of data. What are the key challenges to using a climate lens for existing or new surveillance data that L/SHDs face and how can they be overcome?

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# Next Steps

Deeper analysis and study of this area is warranted to better understand the full scope of L/SHD related activities, and barriers and facilitators. It is our intention that this unique preliminary assessment of this under acknowledged area of climate impacts may stimulate increased attention, collaborations and study. As a research team, we are actively exploring next steps.

# 

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# Tables

## Categories and Indicator Types

Below are a series of tables summarizing the indicator types reported by states, counties and cities with L/SHDs with linked surveillance by category. Listed with Indicator types

### Table 2. Temperature Indicator Types in Use in States, Counties and Cities with Linked Surveillance

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Temperature Indicator Types** | **# of States** | **% of States**  **N=20** | **# of Counties and Cities** | **% of Counties and Cities**  **N=11** |
| ***ED Visits or Hospitalizations for Heat-Related or Caused Illness, Including Heat Stress*** | | | | |
| ​​​​​Count or rate of urgent or emergency department (ED) visits for heat-related or caused illness | 18 | 90% | 6 | 55% |
| Count or rate of hospitalizations for heat-related or caused illness | 16 | 80% | 5 | 45% |
| Excess ED visits at 75F, 95F | 1 | 5% | 0 | 0% |
| ***Heat-Related or Caused Mortality, Including Heat Stress*** | | | | |
| Count or rate of heat-related or caused deaths | 7 | 35% | 7 | 64% |
| Excess deaths attributed to other causes worsened by heat | 1 | 5% | 1 | 9% |
| ***ED Visits or Hospitalizations for Cold-Related or Caused Illness*** | | | | |
| Count or rate of urgent or ED visits for cold-related or caused illness | 5 | 25% | 2 | 18% |
| Count or rate of hospitalizations for cold-related or caused illness | 3 | 15% | 1 | 9% |
| ***Cold-Related or Caused Mortality*** | | | | |
| Count or rate of cold-related or caused deaths | 2 | 10% | 1 | 9% |
| ***Heat Vulnerability*** | | | | |
| Heat Vulnerability Index (HVI) or Extreme Heat Vulnerability Index | 3 | 15% | 3 | 27% |
| Adaptive capacity | 1 | 5% | 0 | 0% |
| ***Temperature Indices, Events, or Projections*** | | | | |
| Number of heat days (# of days above a threshold, varies by jurisdiction) | 5 | 25% | 2 | 18% |
| Number of heatwave events or heat event days | 3 | 15% | 1 | 9% |
| Average temperature | 2 | 10% | 3 | 27% |
| Projected number of extreme heat days | 2 | 10% | 1 | 9% |
| Number of heat nights | 1 | 5% | 1 | 9% |
| Paved surfaces | 1 | 5% | 0 | 0% |
| Projected number of extreme heat nights | 1 | 5% | 0 | 0% |
| ***Cardiovascular Disease*** *(when jurisdiction specifically noted association with temperature)* | | | | |
| Count or rate of hospitalizations due to heart attack | 1 | 5% | 0 | 0% |
| Count or rate of hospitalizations due to heart attack among adults | 1 | 5% | 0 | 0% |

### Table 3. Air Quality Related Indicator Types in Use by States, Counties and Cities with Linked Surveillance

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Air Quality Indicator Types** | **# of States** | **% of States**  **N=20** | **# of Counties and Cities** | **% of Counties and Cities**  **N=11** |
| ***Incidence or Prevalence of Asthma*** | | | | |
| Current or lifetime prevalence of adult asthma | 3 | 15% | 2 | 18% |
| Current or lifetime prevalence of pediatric asthma | 3 | 15% | 2 | 18% |
| Percent of adults with asthma who miss workdays or limit usual activities because of asthma | 1 | 5% | 0 | 0% |
| Prevalence of uncontrolled (not well-controlled or poorly controlled) adult asthma | 1 | 5% | 0 | 0% |
| Incidence of asthma | 0 | 0% | 1 | 9% |
| Incidence of pediatric asthma attack | 0 | 0% | 1 | 9% |
| Prevalence of asthma among public school children | 0 | 0% | 1 | 9% |
| Prevalence of asthma among Medicaid enrollees | 0 | 0% | 1 | 9% |
| Prevalence of persistent asthma among public school children | 0 | 0% | 1 | 9% |
| ***Emergency Department (ED) Visits or Hospitalizations for Asthma*** | | | | |
| Count or rate of hospitalizations due to asthma | 13 | 65% | 2 | 18% |
| Count or rate of ED visits due to asthma | 11 | 55% | 3 | 27% |
| ***Asthma-Related Mortality*** | | | | |
| Count or rate of deaths due to asthma | 3 | 15% | 0 | 0% |
| ***Incidence or Prevalence of COPD/Chronic Lower Respiratory Disease (CLRD)*** | | | | |
| Prevalence of adult COPD/CLRD | 1 | 5% | 1 | 9% |
| ***ED Visits or Hospitalizations for COPD/CLRD*** | | | | |
| Count or rate of hospitalizations due to COPD/CLRD | 9 | 45% | 1 | 9% |
| Count or rate of ED visits due to COPD/CLRD | 7 | 35% | 0 | 0% |
| ***COPD/CLRD Mortality*** | | | | |
| Count or rate of deaths due to COPD/CLRD | 2 | 10% | 0 | 0% |
| ***Particulate Matter (PM) 2.5*** | | | | |
| Average ambient concentrations of PM2.5 | 12 | 60% | 3 | 27% |
| Number or percent of days/person-days over the National Ambient Air Quality Standard of PM2.5 | 11 | 55% | 0 | 0% |
| Percent of population exposed to "poor" PM2.5 levels | 2 | 10% | 0 | 0% |
| ***Ozone*** | | | | |
| Number or percent of days/person-days over the National Ambient Air Quality Standard of ozone | 10 | 50% | 0 | 0% |
| Average ambient ozone concentration | 3 | 15% | 1 | 9% |
| ***Pollen and Other Allergic Disease (except asthma)*** | | | | |
| Length of pollen season (days) | 1 | 5% | 0 | 0% |
| Number of elevated pollen days | 1 | 5% | 0 | 0% |
| Percent of pollen by type and species | 1 | 5% | 0 | 0% |
| Weekly pollen counts by type | 1 | 5% | 0 | 0% |
| Count or rate of ED visits for allergic disease | 0 | 0% | 1 | 9% |
| ***Air Quality Indices and Air Toxics*** | | | | |
| Number or percent of days in a specified Air Quality Index category | 2 | 10% | 3 | 27% |
| Average Cancer Risk Estimates | 1 | 5% | 0 | 0% |
| Air Quality Index score | 1 | 5% | 0 | 0% |
| Air Toxic Cancer Risk Screening Percentile | 1 | 5% | 0 | 0% |
| Average air toxics concentration estimates | 1 | 5% | 0 | 0% |
| Diesel Particulate Matter Percentile | 1 | 5% | 0 | 0% |
| Greenhouse gas emissions (MMT CO2e (Million Metric Tons of Carbon Dioxide equivalents) | 1 | 5% | 0 | 0% |
| Number or percent of days with stagnate air | 1 | 5% | 0 | 0% |
| Respiratory Hazard Risk Percentile | 1 | 5% | 0 | 0% |
| Traffic Proximity and Volume Percentile | 1 | 5% | 0 | 0% |
| ***Carbon Monoxide*** | | | | |
| Count or Rate of death due to carbon monoxide poisoning | 2 | 10% | 0 | 0% |
| Count or rate of hospitalizations due to carbon monoxide poisoning | 2 | 10% | 0 | 0% |
| Count or rate of emergency visits for carbon monoxide poisoning | 2 | 10% | 0 | 0% |
| ***Cardiovascular Disease*** | | | | |
| Count or rate of hospitalizations due to heart attack | 2 | 10% | 0 | 0% |
| Count or rate of ED visits due to heart attack | 1 | 5% | 0 | 0% |
| ***Wildfire-Related Impacts*** | | | | |
| Number of wildfires | 1 | 5% | 1 | 9% |
| Number or percent of acres burned by wildfires | 1 | 5% | 1 | 9% |
| Count or rate of ED visits for allergic diseases during wildfires | 1 | 5% | 0 | 0% |
| Count or rate of ED visits for asthma-like illness during wildfires | 1 | 5% | 0 | 0% |
| Count or rate of hospitalizations due to asthma during documented wildfires | 0 | 0% | 1 | 9% |

### Table 4. Vector Borne Indicator Types in Use by States, Counties and Cities with Linked Surveillance

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Vector Borne Indicator Types** | **# of States** | **% of States**  **N=20** | **# of Counties and Cities** | **% of Counties and Cities**  **N=11** |
| ***West Nile Virus*** | | | | |
| Count or rate of West Nile human cases | 2 | 10% | 3 | 27% |
| Count or rate of West Nile deaths | 0 | 0% | 1 | 9% |
| Number of mosquito pools positive for West Nile virus | 1 | 5% | 1 | 9% |
| Number of mosquito samples tested for West Nile virus | 1 | 5% | 0 | 0% |
| Number of dead birds positive for West Nile virus | 0 | 0% | 1 | 9% |
| Number of bird samples tested for West Nile virus | 1 | 5% | 0 | 0% |
| Count or rate of West Nile equine cases | 1 | 5% | 0 | 0% |
| Number of mammal samples tested for West Nile virus | 1 | 5% | 0 | 0% |
| Count or rate of chikungunya virus human cases | 1 | 5% | 1 | 9% |
| Count or rate of dengue virus human cases | 1 | 5% | 1 | 9% |
| Count or rate of zika virus human cases | 1 | 5% | 1 | 9% |
| Count or rate of malaria human cases | 1 | 5% | 0 | 0% |
| Count or rate of Eastern Equine Encephalitis virus (EEEV) human cases | 1 | 5% | 0 | 0% |
| Count or rate of EEEV caprine cases | 1 | 5% | 0 | 0% |
| Count or rate of EEEV equine cases | 1 | 5% | 0 | 0% |
| Count or rate of EEEV ratite cases | 1 | 5% | 0 | 0% |
| Number of mosquito pools positive for EEEV | 1 | 5% | 0 | 0% |
| ***Lyme Disease*** | | | | |
| Count or rate of Lyme Disease cases | 4 | 20% | 2 | 18% |
| ***Other Tick-related Indicators*** | | | | |
| Count or rate of emergency visits for suspected tick exposure | 1 | 5% | 0 | 0% |
| Count or rate of tickborne diseases | 1 | 5% | 0 | 0% |
| Number of ticks reported | 1 | 5% | 0 | 0% |
| ***Other Vector Borne Indicators*** | | | | |
| Count or rate of emergency visits related to vector borne zoonotic diseases | 1 | 5% | 0 | 0% |
| Count or rate of Babesiosis | 0 | 0% | 1 | 9% |
| Count or rate of hospitalizations for cryptosporidiosis, shigellosis, and giardiasis | 0 | 0% | 1 | 9% |
| Count or rate of hospitalizations for diarrheal and gastrointestinal illness and gastrointestinal conditions following extreme storm events | 0 | 0% | 1 | 9% |
| Count or rate of locally acquired vector borne disease | 0 | 0% | 1 | 9% |

### Table 5. Food Safety, Nutrition, & Distribution Indicator Types in Use by States, Counties and Cities with Linked Surveillance

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Food Safety, Nutrition, Distribution Indicator Types** | **# of States** | **% of States**  **N=20** | **# of Counties and Cities** | **% of Counties and Cities**  **N=11** |
| ***Foodborne Illness*** | | | | |
| Count or rate of Campylobacterosis | 1 | 5% | 1 | 9% |
| Count or rate of Cryptosporidiosis | 0 | 0% | 1 | 9% |
| Count or rate of ED visits and hospitalizations for foodborne illnesses | 0 | 0% | 1 | 9% |
| Count or rate of Giardiasis | 0 | 0% | 1 | 9% |
| Count or rate of Salmonellosis | 1 | 5% | 0 | 0% |
| Count or rate of Vibriosis | 0 | 0% | 1 | 9% |
| Foodborne gastrointestinal illness outbreaks | 0 | 0% | 1 | 9% |
| ***Food Safety Violations*** | | | | |
| Arsenic concentration in drinking water | 1 | 5% | 0 | 0% |
| Food service establishments with <36 critical violation points | 1 | 5% | 0 | 0% |
| Haloacetic acids (HAA5) concentration in drinking water | 1 | 5% | 0 | 0% |
| Nitrate concentration in drinking water | 1 | 5% | 0 | 0% |
| Onsite sewage system failures with corrective action initiated within 2 weeks, | 1 | 5% | 0 | 0% |
| Total trihalomethanes (TTHM) concentration in drinking water | 1 | 5% | 0 | 0% |
| ***Food Access*** | | | | |
| Limited access to healthy food | 1 | 5% | 0 | 0% |
| ***Other Illnesses Related to Food and Nutrition*** | | | | |
| Count or rate of Tuberculosis | 1 | 5% | 0 | 0% |

### Table 6. Mental Health and Well-being Indicator Types in Use by States, Counties and Cities with Linked Surveillance

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Mental Health and Well-being Indicator Types** | **# of States** | **% of States**  **N=20** | **# of Counties and Cities** | **% of Counties and Cities N=11** |
| ***Concern and Worry about Climate Change*** | | | | |
| Percent of people who are worried about global warming | 1 | 5% | 0 | 0% |
| ***Self-Rating of Mental and Emotional Health*** | | | | |
| Student self-rating of general emotional and mental health | 1 | 5% | 0 | 0% |
| Percent of 10th graders who report feeling sad or hopeless almost every day for two weeks or more in a row during the past twelve months | 1 | 5% | 0 | 0% |
| Percent of adults who reported poor mental health during the past 30 days | 1 | 5% | 0 | 0% |
| ***Perceptions of Climate-Related Harm*** | | | | |
| Percentage of people who think global warming will harm future generations | 1 | 5% | 0 | 0% |
| Percentage of people who think global warming will cause personal harm | 1 | 5% | 0 | 0% |
| ***Psychoses*** | | | | |
| Rate of hospitalizations due to schizophrenia and other psychotic disorders | 0 | 0% | 1 | 9% |

### Table 7. Other Indicator Types in Use by States, Counties and Cities with Linked Surveillance[[1]](#footnote-2)

Examples of types of indicators that were reported at least once as part of climate surveillance but may or may not be repeated over time.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Other Indicator Types** | **# of States** | **% of States**  **N=20** | **# of Counties and Cities** | **% of Counties and Cities**  **N=11** |
| ***Chronic Diseases and Conditions***[[2]](#footnote-3) | | | | |
| Heart attack | 2 | 10% | 1 | 9% |
| Cancer incidence | 2 | 10% | 0 | 0% |
| Coronary heart disease or angina | 0 | 0% | 1 | 9% |
| Diabetes hospitalization | 0 | 0% | 1 | 9% |
| Diabetes prevalence | 0 | 0% | 1 | 9% |
| Kidney disease/dialysis | 0 | 0% | 1 | 9% |
| Obesity prevalence among adults | 0 | 0% | 1 | 9% |
| Obesity prevalence among high school students | 0 | 0% | 1 | 9% |
| Stroke | 0 | 0% | 1 | 9% |
| ***Maternal and Child Health*** | | | | |
| Birth defect | 2 | 10% | 0 | 0% |
| Childhood cancer | 1 | 5% | 0 | 0% |
| Early childhood mortality | 1 | 5% | 0 | 0% |
| Infant mortality | 1 | 5% | 0 | 0% |
| Low birth weight | 1 | 5% | 0 | 0% |
| Maternal and child vulnerability | 1 | 5% | 0 | 0% |
| Preterm birth | 1 | 5% | 0 | 0% |
| ***Environment*** | | | | |
| Childhood lead poisoning | 3 | 15% | 0 | 0% |
| Drought | 3 | 15% | 0 | 0% |
| Heavy precipitation | 3 | 15% | 0 | 0% |
| Carbon monoxide poisoning | 2 | 10% | 0 | 0% |
| Altrazine exposure and levels | 1 | 5% | 0 | 0% |
| Arsenic exposure and levels | 1 | 5% | 0 | 0% |
| Di(2-ethylhexyl)phthalate (DEHP) exposure and levels  exposure and levels | 1 | 5% | 0 | 0% |
| Environmental justice | 1 | 5% | 0 | 0% |
| Extreme precipitation | 1 | 5% | 0 | 0% |
| Fire hazard | 1 | 5% | 0 | 0% |
| Flood | 1 | 5% | 0 | 0% |
| Flood vulnerability | 1 | 5% | 0 | 0% |
| Future extreme precipitation projections | 1 | 5% | 0 | 0% |
| Projected sea level rise | 1 | 5% | 0 | 0% |
| Projected temperature changes | 1 | 5% | 0 | 0% |
| Rainfall | 1 | 5% | 0 | 0% |
| Relative increase in wildfire acreage | 1 | 5% | 0 | 0% |
| Snow pack (glaciers) | 1 | 5% | 0 | 0% |
| Environmental sustainability | 0 | 0% | 1 | 9% |
| Disaster risk index | 0 | 0% | 1 | 9% |
| Dissolved oxygen in waterways | 0 | 0% | 1 | 9% |
| Enterococci in waterways | 0 | 0% | 1 | 9% |
| Court-ordered evictions | 0 | 0% | 1 | 9% |
| Household crowding | 0 | 0% | 1 | 9% |
| Owner-occupied homes | 0 | 0% | 1 | 9% |
| Percent of adults with air conditioners | 0 | 0% | 1 | 9% |
| Percent of household air conditioning | 0 | 0% | 1 | 9% |
| Percent of household using electric medical equipment | 0 | 0% | 1 | 9% |
| Percent of older adults (age 65+) with air conditioners | 0 | 0% | 1 | 9% |
| Rent-burdened households | 0 | 0% | 1 | 9% |
| ***Injury*** | | | | |
| Extreme weather-related injury | 1 | 5% | 0 | 0% |
| Paid wage loss claims | 1 | 5% | 0 | 0% |
| Traumatic brain injury | 1 | 5% | 0 | 0% |
| Traumatic work related deaths | 1 | 5% | 0 | 0% |

### Table 8. Populations Of Concern Among States, Counties and Cities with Linked Surveillance

Populations mentioned as affected by climate change in website and report narratives:

* Low income
* Older adults
* People of color
* Children
* Linguistically disadvantaged
* Low educational attainment
* Occupational risk
* Women of childbearing age
* High social vulnerability index
* Immigrant
* Underlying medical conditions
* People living in climate hazard areas

# Appendix A: Local and State Health Department Sampling Framework Methodology

We developed separate sampling plans for LHDs and SHDs intentionally designed to capture health departments that were most likely to be engaged in climate change and health surveillance, including attention to population size, and/or engagement in organizations focused on climate action.

Eighteen counties and cities were selected using a multi-step process. First, we identified LHDs currently or previously funded by CDC’s CRSCI program. We then referenced the top ten largest US cities as of 2023 to identify additional localities. We also included US cities that are part of C40, a global organization that brings together cities taking action on climate change. Lastly, we included Baltimore, Maryland, as the home of Johns Hopkins University.

Thirty states were identified for our assessment (for the purposes of our sampling, the District of Columbia was considered with states). Similar to counties and cities, we identified states currently or previously funded by CDC’s CRSCI program. Next, we generated a random sample of states using the *Trust for America’s Health Climate Change and Health Report* vulnerability index (Table 1 of their report, pg. 8).1 The report stratified states into the three vulnerability categories from the report (Less, More, Most Vulnerable). Four states were randomly selected from each vulnerability category. Based on expert recommendations, we also included Washington state.

# Appendix B: Number of Indicator Types per Category in States, Counties, and Cities with Linked Surveillance

|  |  |  |
| --- | --- | --- |
| **Climate and Health Indicator Categories** | **# of Indicator Types per Category in SHDs** | **# of Indicator Types per Category in LHDs** |
| Temperature | 14 | 11 |
| Air Quality | 39 | 12 |
| Vector Borne Disease | 5 | 13 |
| Food Safety, Nutrition & Distribution | 6 | 13 |
| Mental Health and Well-Being | 6 | 1 |

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1. One LHD had an extensive list of indicators for tracking equity in their climate and health activities; these indicators are not included here for length, but they do measure individual, interpersonal, and structural factors that shape climate vulnerability, preparedness, adaptability, and resilience. [↑](#footnote-ref-2)
2. Mentioned in the health department’s narrative as related to climate, but not explicitly linked to specific hazard such as temperature or air quality. [↑](#footnote-ref-3)