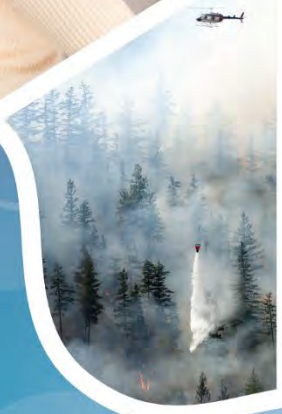
Environmental Health Disparities Map Report

Version 3.0



Washington State Department of HEALTH

WASHINGTON ENVIRONMENTAL HEALTH DISPARITIES MAP

This report was prepared by staff at the Washington State Department of Health (DOH). Staff at the Washington State Department of Ecology (ECY) and Washington State University (WSU) drafted and reviewed measure descriptions. Staff at the University of Washington (UW) provided input on additional content to include in this version.

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Acknowledgments

The creation of the Environmental Health Disparities Map (EHD) relies heavily on the communities and Tribes who directly fight for environmental justice. This map also relies on the contributions of people across the state who participated in community and Tribal listening sessions, collaboration, and consultation since 2017.

We acknowledge the over 1,900 forward-facing community members (representing 16 counties) and 79 non-contracted partners who attended our 2024- 2025 listening sessions and roundtables. These community members shared their lived experiences and serve as our consultants and advisors in this work. These contributions helped us make this tool more robust, comprehensive, and useful.

We recognize our contracted and community partners who made community engagement events a success over the past couple of years. These partners include:

- Asian Pacific Cultural Center
- Better Health Together Accountable Community of Health
- Elevate Health Accountable Community of Health
- Empowering Latina Leadership and Action (ELLA)
- Friends of Toppenish Creek
- Greater Health Now Accountable Community of Health
- Okanogan Coalition for Health Improvement (CHI)
- Shades of Motherhood Network
- Southwest Washington Accountable Community of Health
- Thriving Together (North Central Washington) Accountable Community of Health
- Tribal participants

We also acknowledge the partners involved in the development of the first 2 versions of the map. These partners include:

- Front and Centered
- Puget Sound Clean Air Agency
- University of Washington Department of Environmental & Occupational Health Sciences
- Washington State Department of Ecology
- Washington State Department of Health (DOH)

We developed Version 3.0 of the Washington Environmental Health Disparities Map through a collaborative effort. This collaboration included:

- California Office of Environmental Health Hazard Assessment

- DOH
- Environmental Protection Agency (EPA)
- Front and Centered
- Neighborcare Health
- Surge Reproductive Justice
- University of Washington Department of Environmental & Occupational Health Sciences
- Washington State Department of Ecology
- Washington State University

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Executive Summary

The land where we live, work, and play affects our health. Characteristics of the land and the people living on the land overlap and interact. Pollution, cost of living, and other social conditions don't happen on their own. They combine with the ongoing impacts of racism, colonization, and other injustices to affect community health. These factors add up and create greater impacts in some communities. The way factors add up is a community's **"cumulative risk."**

Not all communities are affected equally. Long-standing social, economic, and environmental injustices lead to significant differences across Washington. Communities with fewer economic opportunities or histories of marginalization face unfair and large impacts. So do Indigenous people.

People in affected communities have been concerned for a long time about the stressors they face. People in these communities do not have the same health, well-being, and opportunities as others because of these stressors. Communities urged the government to study these issues and take action. Their advocacy drove the creation of an innovative cross-sector collaboration. Researchers, government agencies, and groups representing impacted communities and underrepresented people worked together to create the **Environmental Health Disparities (EHD)** map.

The EHD map is an interactive tool that shows areas where communities face the most environmental health burdens or environmental injustice. The map uses data about communities and the environment to show where people are most likely to be at risk.

The map ranks Washington communities based on their risks. The rankings can help prioritize action, funding, and resources to reduce burdens in impacted communities. Purposely directed resources can help reduce inequities in environmental health across the state. The rankings are a cumulative risk and may not capture where all environmental justice is happening. But it is a good starting place.

Tribal census tracts are a priority to invest in for addressing environmental inequities. This is demonstrated by the definition of "overburdened communities" in Washington's Healthy Environment for All (HEAL) Act and Climate Commitment Act (CCA). Tribes are longstanding environmental justice advocates. Tribes are often most impacted by environmental injustice in ways represented and not represented on the EHD map. The Tribal census tracts layer may not fully represent the Tribe's definition

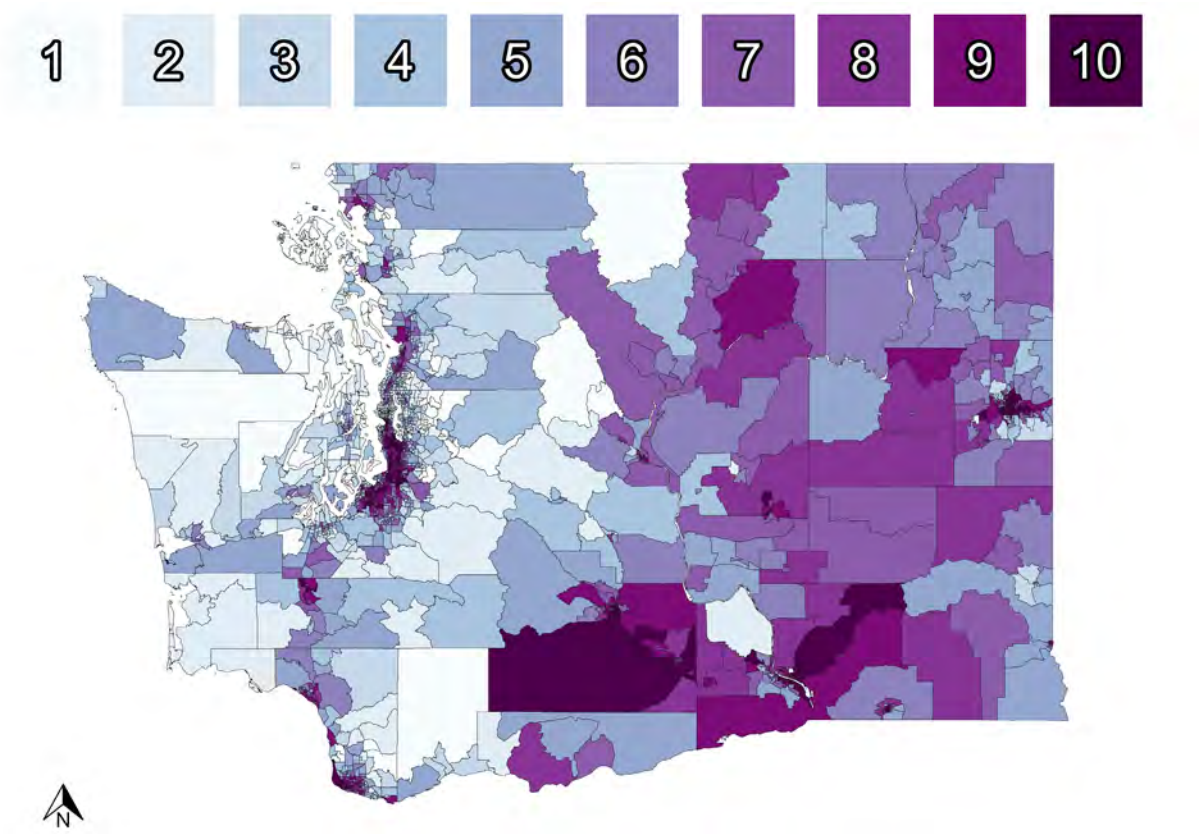
of their land based on historical injustices. We should prioritize Tribal engagement to fully understand the environmental health impacts on their community.

The EHD map uses 25 measures of community and environmental health. The data are combined into an overall score based on environmental and socioeconomic risk factors. 1,772 census tracts in Washington get a score. The result is a statewide view of the cumulative risks for each community.

Cumulative risks help compare communities to see which are facing the most challenges. These are the places that are most at risk for health inequities. The EHD map is a good starting point for policymakers and the public. It helps us understand where in Washington people's health is threatened by environmental pollution. This is where support is needed most.

This updated version of the map incorporates feedback from communities and Tribal Nations. We plan to engage more and develop the map further. This helps the map more accurately represent the lived experiences and priorities of people in Washington.

Washington Environmental Health Disparities Map
Version 3.0 Cumulative Rank
Ranks range from 1 (least impacted) to 10 (most impacted)



Introduction

Washington state has a long history of efforts to document and reduce environmental health inequalities. Tribal Nations, community-based organizations and groups, policymakers, federal and local governments, and state agencies lead these efforts.

We track these efforts and provide decision-makers, state agency staff, and advocates with clear and current data. This data includes environmental hazards, pollution exposure, and vulnerable populations. This is essential for guiding state policies and budget decisions that best address environmental justice issues.

The primary goal for the EHD map is to identify areas where communities are most affected by cumulative environmental health risks. The tool ranks these risks by census tract, highlighting communities most burdened by the cumulative impacts of pollution. The tool also identifies environmental health measures by census tract. This provides useful, data-driven insights for communities, policymakers, government leaders and staff, and others.

The EHD map ranks cumulative health impacts on a scale from 1 to 10, with 10 showing the highest risk. The rank reflects the risks each community faces from environmental hazards and social and economic conditions.

The ranks represent environmental health "risk." This is the likelihood of harm resulting from a combination of environmental hazards and community vulnerabilities. The tool takes some health outcomes into account as a vulnerability factor under the "sensitive populations" theme. This is because communities with higher rates of certain chronic diseases may face greater risks. This happens as exposure to environmental hazards could lead to more severe health impacts.

We recognize that there are limitations to the EHD map. Users should consider these limitations when using the map. **We recommend using this tool in combination with additional tools, datasets, and local knowledge when identifying overburdened communities and vulnerable populations.** The data in this map comes from a variety of sources. Sources include other state agencies, projects from universities, and federal data sets. We chose to use the data in the map, but we cannot edit or change much of the data used.

About the Washington Environmental Health Disparities Map

The Environmental Health Disparities (EHD) map shows where in Washington people are at the greatest risk for environmental impacts on their health. The EHD map can help us determine where more attention and resources are needed.

The map is based on the idea that each risk factor does not exist alone. Instead, risk factors can combine to make bigger impacts. These are also called cumulative impacts. The EHD map combines pollution data and population vulnerabilities to create scores for each area in Washington. We use the scores and information from the map to help reduce environmental and health inequities. The map helps guide environmental policy, budgeting priorities, and regulation enforcement.

In 2021, the Washington state legislature passed the Healthy Environment for All (HEAL) Act. The goal of the HEAL Act is to address environmental health disparities across Washington. The HEAL Act requires 7 state agencies to integrate environmental justice into their decision-making. The agencies must identify and focus expenditures (or costs) on "overburdened" communities and vulnerable populations.

Overburdened communities in HEAL include and expand on "highly impacted communities" from the Clean Energy Transformation Act. These are deficit-based terms because we are addressing deficits. These are not the fault of the communities, but rather structural inequities. Our use of deficit terms is not meant to ignore the strengths of communities. We understand these terms may have negative associations for communities based on their experiences.

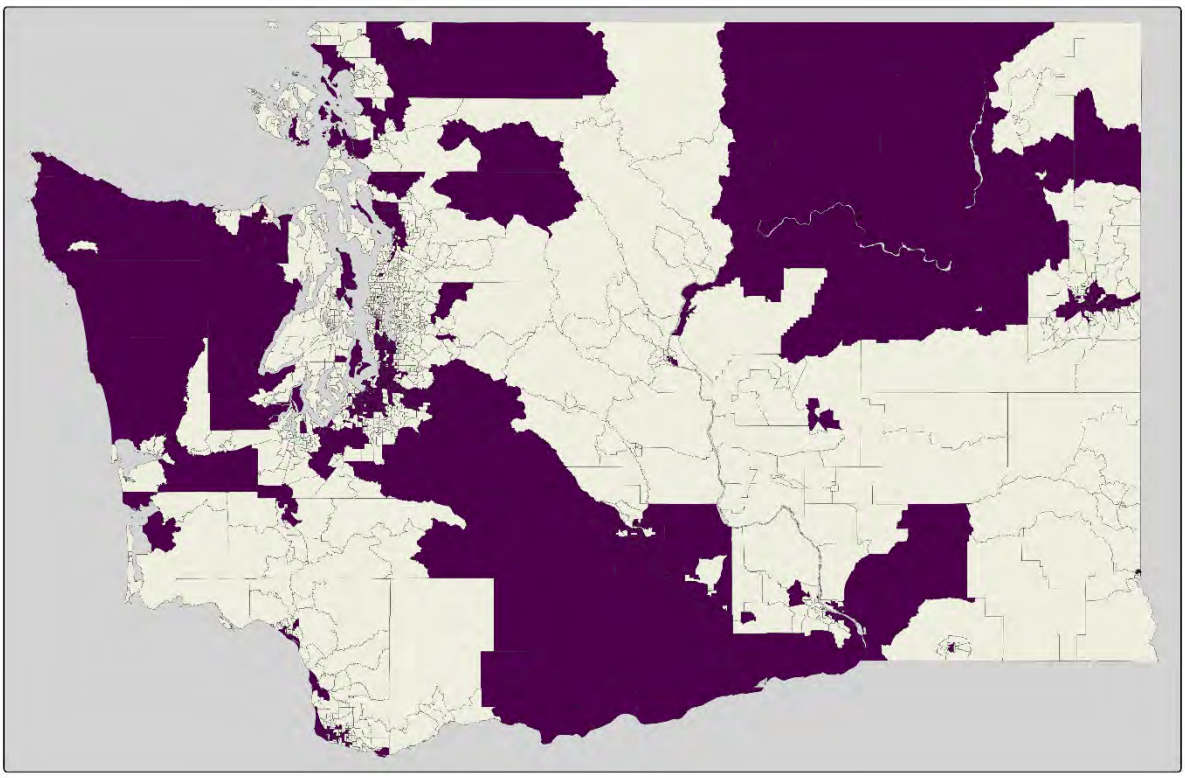
"Highly impacted communities" are defined as census tracts that either:

1. have an overall EHD rank of 9 or 10, or
2. are fully or partially in areas referred to as "Indian Country."

Figure 1 below shows census tracts that meet these criteria.

DOH recommends using the EHD map to look at "highly impacted communities." These communities are a starting point for identifying overburdened communities and vulnerable populations. DOH also recommends using the EHD map with additional tools, datasets, resources, and equitable community and Tribal engagement when making policy or programmatic decisions.

Figure 1. Census tracts that contain Tribal land or have an overall EHD ranking of 9 or 10



The HEAL Act and the Climate Commitment Act encourage agency staff to use the EHD map as a starting place for their work supporting overburdened communities.

You should not use the EHD map alone. Other data and community and Tribal engagement can provide important information beyond what the map has. Use a combination of sources when shaping environmental policies, priorities, and projects.

The HEAL Act requires DOH to continue developing the EHD map by:

- Engaging with communities, Tribes, researchers, and the Environmental Justice Council
- Tracking changes in health disparities over time
- Performing a comprehensive evaluation every 3 years
- Expanding online video trainings and guidance on how to use the EHD map
- Providing support and consultation to state agencies on how to use the EHD map

Key details about the map:

- The map is based on decades of advocacy and work on cumulative environmental impacts. This research shows that environmental hazards

and social conditions work together to have bigger impacts. It draws on a broad range of knowledge systems. These include Traditional Ecological Knowledge, community experiences, and environmental research.

- The map was modeled after CalEnviroScreen and tailored for Washington. It provides customizable views to identify where environmental health risks are highest. Users can explore the information in the ways that are most important to them.
- The data in the map comes from DOH, and other state and federal sources.
- The map has limitations. One limitation is that the map relies on available statewide data. This means we can't include topics that don't have comprehensive data. As a result, the map can't provide the full scope of environmental risks and health impacts people experience in Washington. Each measure also has its own limitations. These are described in each measure's section. There are additional limitations described in the limitations section.
- Version 1.0 of the EHD map was developed over a 2-year period. Communities directly shaped this version of the map by providing input during 11 statewide listening sessions. Participants included community groups representing communities of color, immigrants, Tribes, farmworkers, the elderly, and other groups disproportionately impacted by pollution. These groups have continued to shape later versions of the map.
- The EHD map is hosted by DOH's Washington Tracking Network (WTN). WTN is a DOH program that provides data to the public on over 300 environmental and public health measures across the state. WTN is supported by the U.S. Centers for Disease Control and Prevention's National Environmental Public Health Tracking Program. WTN also receives state funding from the HEAL Act, Climate Commitment Act, and the Model Toxics Control Act.

Timeline

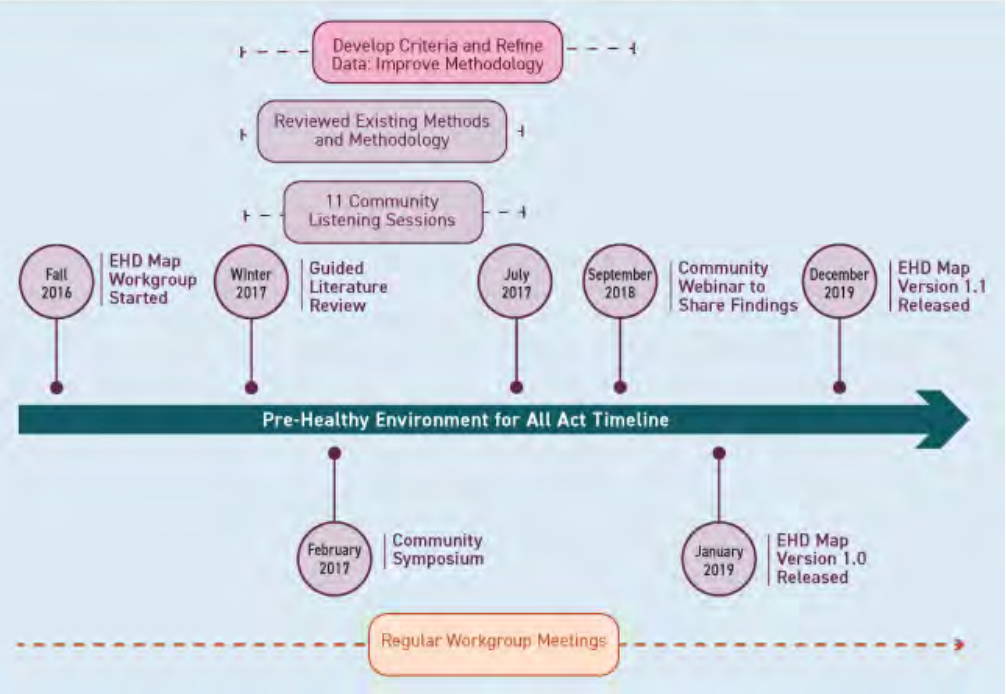
Communities and Tribes have been leading the fight for environmental justice before the EHD map began. In fall 2016, we created the Environmental Justice (EJ) Mapping workgroup. Front and Centered, an environmental justice coalition of organizations rooted in communities of color, teamed up with the University of Washington Department of Environmental & Occupational Health Sciences. They also worked with the Washington State Departments of Health and Ecology, and the Puget Sound Clean Air Agency. In 2017, the EJ Mapping Work Group started formal listening sessions for communities and talked with people interested in the project.

To develop the map, the EJ Mapping workgroup:

- Asked Washington residents about the biggest environmental concerns in their communities.
- Looked at other tools that modeled how environmental risks affect communities' health and create disparities. These tools included EPA's EJSCREEN and California's CalEnviroScreen.
- Read research about how proposed measures relate to environmental health.
- Explored possible data sources and evaluated their reliability and quality.
- Released Version 1.0 of the EHD map in January 2019.

Figure 2. Pre-Healthy Environment for All Act Timeline

	TIMELINE	EVENTS
1	Fall 2016	Environmental Health Disparities (EHD) Map Workgroup started
2	Winter 2017	Guided literature review for the EHD Map
3	Winter to July 2017	Completed 11 Community Listening Sessions
4	Winter to July 2017	Reviewed existing methods and methodology for the EHD Map
5	Winter 2017 to September 2018	Developed criteria and refined data to improve methodology for the EHD Map
6	February 2017	Community Symposium hosted
7	September 2018	Community Webinar to share findings hosted
8	January 2019	EHD Map Version 1.0 released
9	December 2019	EHD Map Version 1.1 released
10	Continuing Work	Regular EHD Map Technical Workgroup meetings



DOH updated Version 1.0 twice, both under the name Version 1.1. We updated the "sensitive populations" measures and the socioeconomic measures using American Community Survey data in December 2019. The second update, released in January 2022, fixed a few errors.

From July 2019 to Fall 2020, the legislature tasked the Environmental Justice Task Force to hold community meetings and draft recommendations. One of the recommendations was guidance for using the EHD map.

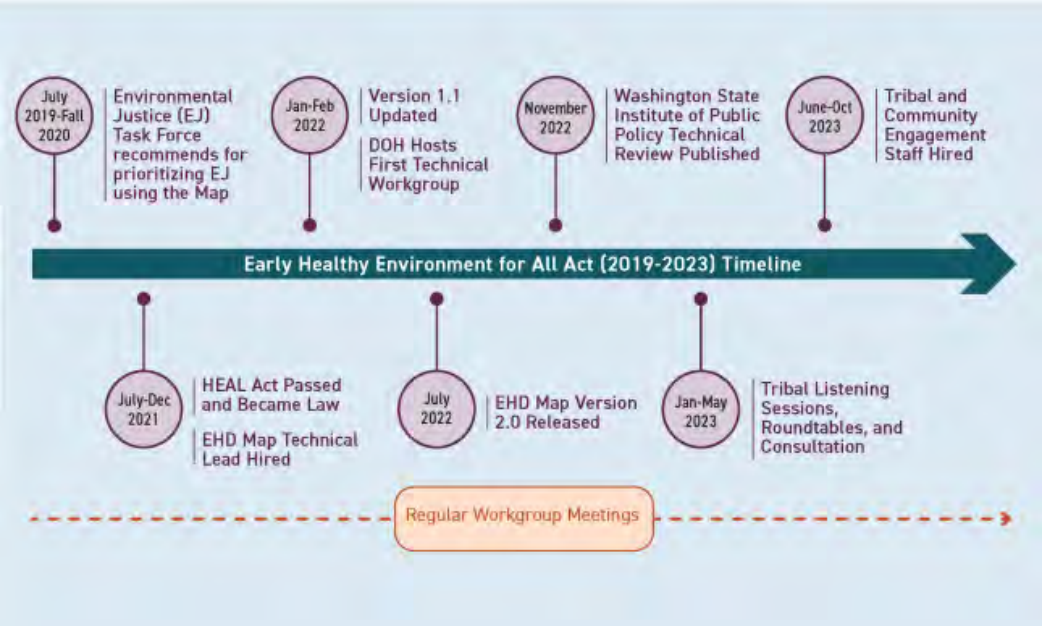
Based on these recommendations, the Healthy Environment for All (HEAL) Act (SB5141) was passed in 2021. This law gave DOH the job of maintaining and developing the EHD map. To help with this, DOH hired a technical lead in late 2021. Then, in early 2022, DOH started regular meetings with a technical workgroup. We released Version 2.0 in July 2022 with updated data and improved methods.

The HEAL Act also required a technical review of the map by the Washington State Institute for Public Policy. DOH supported the review by providing technical expertise. The report was published in November 2022.

Another part of the HEAL Act required that DOH offer consultation with federally recognized Indian Tribes to develop the EHD map. In early 2023, DOH held Tribal listening sessions, roundtables, and consultation. Together, we agreed on next steps, which included hiring a Tribal engagement specialist. DOH hired this staff in June 2023. In October 2023, DOH also hired a staff person to lead EHD map community engagement.

Figure 3. Early Healthy Environment for All Act (2019 to 2023) Timeline

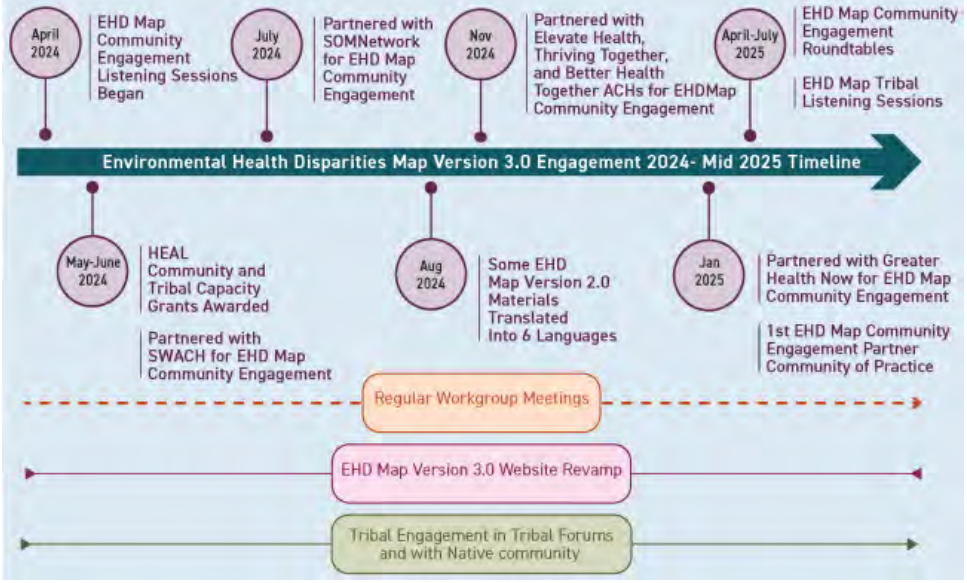
	TIMELINE	EVENTS
1	July 2019 to Fall 2020	Environmental Justice (EJ) Task Force recommends for prioritizing EJ using the Map
2	July to December 2021	The Healthy Environment for All (HEAL) Act became law
3	July to December 2021	EHD Map Technical Lead hired
4	January to February 2022	Version 1.1 of the EHD Map is updated
5	January to February 2022	DOH hosts first EHD Map Technical Workgroup
6	July 2022	EHD Map Version 2.0 released
7	November 2022	Washington State Institute of Public Policy Technical Review published
8	January to May 2023	Tribal Listening Sessions, Roundtables, and Consultation
9	June to October 2023	Tribal and Community Engagement staff hired
10	Continuing Work	Regular EHD Map Technical Workgroup meetings



The HEAL Act also says that DOH must get feedback from overburdened communities and vulnerable populations in all regions of the state. Our community and Tribal engagement staff have started that work.

Figure 4. Environment Health Disparities Map Version 3.0 Engagement (2024 to Mid-2025) Timeline

	TIMELINE	EVENTS
1	April 2024	EHD Map Community Engagement Listening Sessions began
2	May to June 2024	HEAL Community and Tribal Grants awarded
3	May to June 2024	Partnered with the Southwest Washington Accountable Community of Health (SWACH) for EHD Map Community Engagement
4	July 2024	Partnered with Shades of Motherhood Network (SOMNetwork) for EHD Map Community Engagement
5	August 2024	Translated specific EHD Map Version 2.0 materials into 6 languages
6	November 2024	Partnered with Elevate Health, Thriving Together, and Better Health Together Accountable Communities of Health (ACHs) for EHD Map Community Engagement
7	January 2025	Partnered with Greater Health Now Accountable Community of Health (ACH) for EHD Map Community Engagement
8	January 2025	1st EHD Map Community Engagement Partner Community of Practice
9	April to July 2025	EHD Map Community Engagement Roundtables
10	April to July 2025	EHD Map Tribal Listening Sessions
11	Continuing Work	Regular EHD Map Technical Workgroup meetings
12	Continuing Work	EHD Map Version 3.0 website revamp
13	Continuing Work	Tribal Engagement in Tribal Forums and with Native communities



In November 2023, the EHD map community engagement lead contacted several communities across Washington. The lead gathered information about communities' past experiences with community engagement from state agencies.

Community members had clear expectations for thoughtful community engagement. By late November 2023, the community engagement lead contacted several Accountable Communities of Health (ACHs). The goal was to begin relationship-building to support

trust-building, data accountability, and regional EHD map community engagement. In April 2024, the EHD map community engagement staff also began hosting and co-supporting existing community engagement events with permission or an invitation from the communities.

Between June and October 2024, we created contracts with ACHs. This included Southwest Washington Accountable Community of Health (SWACH), Better Health Together (BHT) ACH, Thriving Together (NCW) ACH, and Elevate Health (Pierce) ACH. We also partnered with Shades of Motherhood Network (SOMNetwork) for their unique demographics that met the HEAL Act requirements. In January 2025, we signed our final partner, Greater Health Now ACH, for the EHD map Version 3.0 community engagement.

In January 2025, we introduced the first EHD map community engagement partner community of practice. This provided space for contracted partners to ask questions and share ways they were uniquely reaching communities in their region.

Contracted partners helped us work with 79 community-based organizations, holding over 69 listening sessions, and 8 roundtables across Washington. The EHD map community engagement specialist (non-Tribal) led an additional 20 community engagement listening sessions.

Overall, we reached over 1,973 Washington community members. The community members provided feedback on their lived experiences, needs, and elements of the EHD map. They did this with the support of contracted and non-contracted partners.

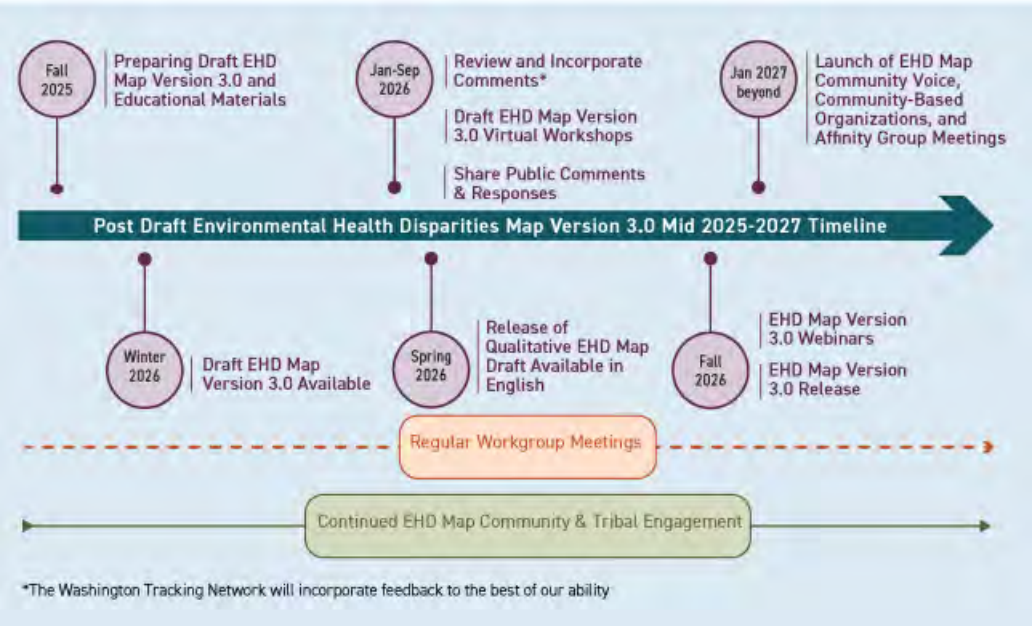
Based on feedback, we created, updated, or reviewed several EHD map materials to support the needs of community members and partners. These materials include the:

- EHD map Version 3.0 website update
- Translation of EHD map materials into 6 languages
- Creation and translation of the EHD map glossary
- EHD map forward-facing community engagement video (available in 9 languages)
- Overlay descriptions for the EHD map
- Updated EHD map timeline
- Completed guidance for state agencies using the EHD map.

Input from community engagement helped shape this report. Input included qualitative research on populations and how they are most affected for each measure description.

Figure 5. Post Draft Environmental Health Disparities Map Version 3.0 (Mid 2025 to 2027) Timeline

	TIMELINE	EVENTS
1	Fall 2025	Preparing Draft EHD Map Version 3.0 and Educational Materials
2	Winter 2026	Draft EHD Map Version 3.0 available
3	January to September 2026	Review and incorporate comments*
4	January to September 2026	Draft EHD Map Version 3.0 Virtual Workshops
5	January to September 2026	Share public comments and responses
6	Spring 2026	Release of Qualitative EHD Map Draft Available in English
7	Fall 2026	EHD Map Version 3.0 webinars
8	Fall 2026	EHD Map Version 3.0 Release
9	January 2027 and Beyond	Launch EHD Map Community Voice, Community-Based Organization, and Affinity Group meetings
10	Continuing Work	Regular EHD Map Technical Workgroup meetings
11	Continuing Work	Continued EHD Map Community and Tribal Engagement



In fall 2025, the EHD map team started working hard to prepare the draft EHD map Version 3.0 and update educational materials. **In winter 2026, the draft EHD map Version 3.0 will be available.** From March to September 2026, we will host virtual workshops to show community members and partners ways to use the new EHD map platform and provide a tour of measures. During that time, there will be an opportunity to provide public comments.

The EHD map team will review comments and incorporate feedback as much as possible. We will share feedback that can or cannot be incorporated with the public. After additional review and feedback, we will re-release the EHD map Version 3.0.

Based on a large amount of community feedback, DOH plans to launch the draft of the qualitative EHD map in English in spring 2026. While still in development, the qualitative EHD map plans to show community feedback by county. The qualitative EHD map will be a new addition and is a direct response to requests from community members across Washington.

In fall 2026, we plan to host several EHD map Version 3.0 webinars with the re-released 3.0 information. We hope these webinars support public usage. In January 2027 and beyond, we will launch the EHD map community voice. These will be meetings held for community-based organizations and affinity groups.

Throughout the timeline, continuous workgroup meetings, EHD map community, and Tribal engagement will take place. See the Future Versions and Measures Under Exploration section to learn more about future EHD map development and plans to develop additional tools, guidance, and resources.

EHD Map Changes for Version 3.0

One of the most significant improvements in this map update is the community center focus in our data measure notes. Additionally, we've created a glossary of definitions and a more detailed document describing the changes between Version 2.0 and 3.0 of the EHD map.

EHD map Version 3.0 changes from Version 2.0 include:

- Measures updated with the most recent available data
- Recalculated measures to align with the 2020 census tract boundaries
    - The 2010 census included 1,458 census tracts. Now, the 2020 census includes 1,772 tracts.
    - Some tracts were split into multiple tracts, while others were merged or newly created.
    - When census boundaries change, the people and places inside those boundaries can change too. That means measures might fluctuate. This is not because the measure has really changed, but because we're now counting a different mix of residents, neighborhoods, or environmental exposures.
- **New Tribal lands layer** that appears automatically when users open the map. We added this because Tribal lands are included in the "overburdened community" definition in the Healthy Environment for All (HEAL) Act and the Climate Commitment Acts (CCA). We want this to be clearly visible to users.
- **Map platform transition** from the Information by Location tool to ArcGIS
    - This transition will better support the functionality needs identified by community members, Tribes and partners as we continue to update the map. A few examples include having the map in languages other than English and the ability to easily generate a community report for each census tract.
- Improved methodology for some measures:
    - For **PM2.5 and Ozone Concentrations**, we adjusted how we ranked the data to align with current federal health standards.
    - The **Lead Risk from Housing** measure updated the proportion of houses built in each decade that contain lead, based on new research findings.
    - Diesel Exhaust PM2.5 Emissions and Toxic Releases from Facilities were combined into a measure called **Risks from Diesel and Other Air Toxics.** We used 2020 data from EPA's AirToxScreen. This data gives a better understanding of the full risk from air pollution in Washington.
    - The **Proximity to Hazardous Waste Sites** measure (formerly called the Proximity to Hazardous Waste Treatment, Storage, and Waste [TSDFs] Sites) is now made by the Washington State Department of Ecology using a broader definition than before.
    - The **Proximity to Superfund Sites** measure (formerly called Proximity to National Priority List [Superfund Sites]) is now developed by the Washington State

Department of Ecology to improve the transparency of sites. It also ensures continued access to these data.
    - We changed the **Low Birth Weight** measure to include premature births.
- New measures added based on community and Tribal engagement feedback:
    - **Wildfire Smoke Exposure** combines the number and intensity of smoky days using daily smoke plume data.
    - **Pesticide Exposure** estimates potential exposure by analyzing the amount of pesticides used on major crops.
    - **Water Quality** reflects the number of unique pollutants found in impaired waters across Washington.
    - **People with a Disability** represents the percentage of the population reporting at least one disability.
    - **Community Retail Food Environment** assesses access to nutritious food within each census tract. It compares the availability of fresh, nutrient-dense food options to stores primarily selling processed or fast foods.
    - **Digital Infrastructure** is the availability and speed of internet access. Rural communities identified this as a priority.
    - **Air Quality–Related Respiratory Disease** shows the rate of emergency department visits for respiratory illnesses linked to air pollution.

Definitions

The race and ethnicity group definitions listed below use language from the Department of Health's Equitable Language Guide, except when otherwise noted. The terms used in this report are based on the researcher's studies and federal data collection. However, these terms may not reflect an individual's identity.

American Indian, Alaska Native, or Native American refers to individuals with origins in any of the original peoples of North, Central, and South America. This includes, for example, the Navajo Nation, Blackfeet Tribe of the Blackfeet Indian Reservation of Montana, Native Village of Barrow Inupiat Traditional Government, Nome Eskimo Community, Aztec, and Maya.[1]

Asian refers to individuals with origins in and across Asia. In Washington, the most common ancestry includes Chinese, Asian Indian, Vietnamese, Korean, Japanese, Middle East, and Filipino. We recognize that this is a broad term that can hide the unique experiences, cultures, and histories of the many groups within them. Note: Those who originate from the former Soviet Union are also considered Asian. However, in the continental United States of America, they are assigned as white.

Black refers to anyone of African descent and who may or may not ascribe to the term African American based on visible characteristics. The Black population is diverse and includes people who are descendants of those who were enslaved, those original to this land (known as Freedmen), and immigrants from Africa and other countries. It also includes those who are Afro-Latiné (individuals of Latin America or Latin American descent who are also of African ancestry) and other distinct ethnic and racial backgrounds.

Burden refers to the magnitude of negative health outcomes within a community that is connected to the risk factors present.

Census tracts are areas designated for taking the United States Census Survey. Census tracts generally have a population size between 1,200 and 8,000 people. On the EHD map, we use census tracts to represent communities.

Communities are defined on the EHD map as census tracts.

Cumulative impact refers to the combined impact of multiple pollution, social, or

[1] OMB Statistical Policy Directive No. 15 on Race and Ethnicity Data Standards, The 2024 Statistical Policy Directive No. 15.

health measures on a population. This often reflects ongoing and past unjust histories rooted in racism or other forms of oppression.

An **environmental hazard or risk factor** refers to a specific source or concentration of pollution in the environment. Examples of hazards include polluted air, water, and soil.

Environmental health refers to the ways environmental conditions affect human health, which are likely to have impacts on other beings.

Environmental justice is defined differently by different groups. The Healthy Environment for All Act defines it as the fair treatment and meaningful involvement of all people, regardless of race, color, national origin, or income. This is with respect to the development, implementation, and enforcement of environmental laws, rules, and policies. Environmental justice includes addressing disproportionate environmental and health impacts in all laws, rules, and policies with environmental impacts. We do this by prioritizing vulnerable populations and overburdened communities, the equitable distribution of resources and benefits, and eliminating harm.

Environmental effect generally refers to negative environmental quality. This applies even when the population's contact with an environmental hazard is unknown or uncertain.

Environmental exposure refers to how a person encounters an environmental hazard. Examples of exposure include breathing air, eating food, drinking water, or living near where environmental hazards are released or are concentrated.

Environmental harm, as defined in the HEAL Act, means the individual or cumulative environmental health impacts and risks to communities. It is caused by historic, current, or projected:

a) Exposure to pollution, conventional or toxic pollutants, environmental hazards, or other contamination in the air, water, and land.
b) Adverse environmental effects, including exposure to contamination, hazardous substances, or pollution. These harms increase the risk of adverse environmental health outcomes or create vulnerabilities to the impacts of climate change.
c) Loss or impairment of ecosystem functions or traditional food resources, access to gather cultural resources, or harvest traditional foods.
d) Health and economic impacts from climate change.

Healthy Environment for All (HEAL) Act is a Washington state law that was passed in 2021. The purpose of the law is to reduce environmental and health disparities in Washington state and improve the health of all Washington state residents.

Highly Impacted Communities is a term used by the Clean Energy Transformation Act. It identifies communities currently experiencing a disproportionate share of environmental risk. The goal of this definition is to prioritize an equitable distribution of energy benefits during the transition to a clean energy economy. Highly impacted communities are defined as census tracts (or communities) with an overall EHD rank of 9 or 10 or that are fully or partially on what is referred to as "Indian Country."

Indian Tribes are defined in RCW 43.376.010 as any federally recognized Indian Tribe whose traditional lands and territories include parts of Washington. Tribal lands are defined in the HEAL Act as having the same meaning as "Indian country" as provided in 18 U.S.C. Sec. 1151. They also include sacred sites, traditional cultural properties, burial grounds, and other Tribal sites protected by federal or state law.

Latiné refers to individuals who are from or descended from Latin America. The term Latiné also includes those historically identified as Chicano/a Hispanic/Hispanx and Latino/a or Latinx. The term, as an ethnicity, has a complex history and evolution that cannot be properly summarized in a few sentences.

Measure refers to the numeric quantity of a condition that we are tracking or assessing. These conditions fall under the categories of sensitive populations, socioeconomic factors, environmental effects, or environmental exposures. Examples of measures include proximity to toxic waste, poverty, and unaffordable housing.

Morbidity is the occurrence of disease, injury, and/or disability.

Mortality is the occurrence of death in a defined population.

Multiracial people who identify with more than one race.

Overburdened Community is defined in the Healthy Environment for All (HEAL) Act. It is a geographic area where vulnerable populations face combined, multiple environmental harms and health impacts. It includes, but is not limited to, highly impacted communities as defined in the Clean Energy Transformation Act. We recognize the language "overburdened communities" may not be how communities describe themselves or identify. Some communities prefer different terms, such as "minoritized" or "invisiblized" to identify that they are affected by harms created by those with the most positional, social, and structural power.

Overlay is a data layer that users can add to the map for additional context and visual support. They do not contribute to a community's environmental health risk score.

Particulate Matter is called particle pollution. It refers to a mixture of solid particles and liquid droplets found in the air. Some particles are so small that they can only be seen

with an electron microscope and are measured in micrometers. Particulate matter$_{2.5}$ or PM$_{2.5}$ are fine particles generally 2.5 micrometers or smaller.

Pasifika refers to the peoples of the Pacific Islands and their descendants. It is a term used to represent their distinct cultures and identities. In Washington, the most common ancestry includes Melanesia, Micronesia, and Polynesia.

Population characteristics refer to qualities and attributes of various types of populations within a social or geographic group. This includes aspects such as demographics, health status, and socioeconomic factors. These are impacted by systems of oppression, including racism and colonization.

Risk refers to the chance of harmful effects to human health from encountering a stressor or concerning factor or irritant.

Susceptibility refers to a person's (or population's) inherent biology that affects their risk. Examples of susceptibility include youth or old age, or whether a person is already affected by a disease, such as asthma or heart disease. These diseases place them at increased risk when exposed to environmental hazards.

Sensitive populations are those at greater risk due to biological or intrinsic vulnerability related to environmental inequities or injustice.

Sensitivity analysis refers to calculating and interpreting statistical correlations (or relationships) in any model. For the EHD map, this is a process that helps us understand how measures in our model relate to each other. It also tells us how well our model reflects some of the impacts of environmental health disparities.

Threat is represented by measures that account for pollution burden. Pollution burden is a combination of environmental effects and exposures in communities.

Uncertainty may describe when the data is unclear or unreliable.

Tribal lands on the EHD map currently use a Tribal lands layer from the Department of Ecology. It includes federally recognized lands, disputed lands, and off-reservation lands. We understand this might not be how Tribes view their relationships to lands, and some ongoing developments may not be reflected.

Tribes refer to any federally recognized Indian Tribe whose traditional lands and territories include parts of Washington.[2]

[2] RCW 43.376.010

Vulnerability refers to people or communities most impacted due to their minoritized identities or where they live. This affects their ability to cope with risk. Some are more vulnerable due to characteristics such as age, gender and sexual identities, race, culture, religion, disability, pre-existing health status, socioeconomic status, or migration status.

Vulnerable populations are defined in the HEAL Act. It includes, but is not limited to, racial or ethnic minorities, low-income populations, populations disproportionately impacted by environmental harms, and populations of workers experiencing environmental harms.

White (in the continental United States of America) refers to individuals with origins in any of the peoples of Europe. This includes, for example, English, German, Irish, Italian, Polish, and Scottish.

Methodology

The Model

The Environmental Health Disparities (EHD) map's model recognizes that health disparities can come from a variety of risk factors. These can be environmental, social, systemic, and/or biological.

- Environmental elements can include things like chemicals, and air and water pollution.
- Social elements include factors like race, unemployment, and socioeconomic class.
- Systemic elements are things like quality of education, housing costs, and access to quality healthcare.
- Biological elements are health conditions that make people more susceptible to pollution. This includes factors like heart disease and asthma.

Impacts from all these factors can build up over time and can lead to negative health outcomes. These result from ongoing or past histories that are inequitable or unjust, such as redlining or the invasion of the Americas.

The EHD map is based on the idea that **risk factors do not exist alone but can add up with others to make bigger impacts**. In real life, people and communities often deal with many stressors at the same time. Higher numbers of stressors lead to larger health impacts. Black, Indigenous, and other communities of color often carry a heavier health burden because they face more of these combined stressors. This is the result of ongoing racism and discriminatory laws, policies, and societal practices.

Looking at how all these stressors work together is called **cumulative impact analysis**. The EHD map uses this approach by combining pollution data with population vulnerabilities. Every census tract in Washington gets a score that shows the total burden of these combined risks.

The model behind the EHD map is based on a tool from California called CalEnviroScreen. It uses the formula:

Threat × Vulnerability = Risk

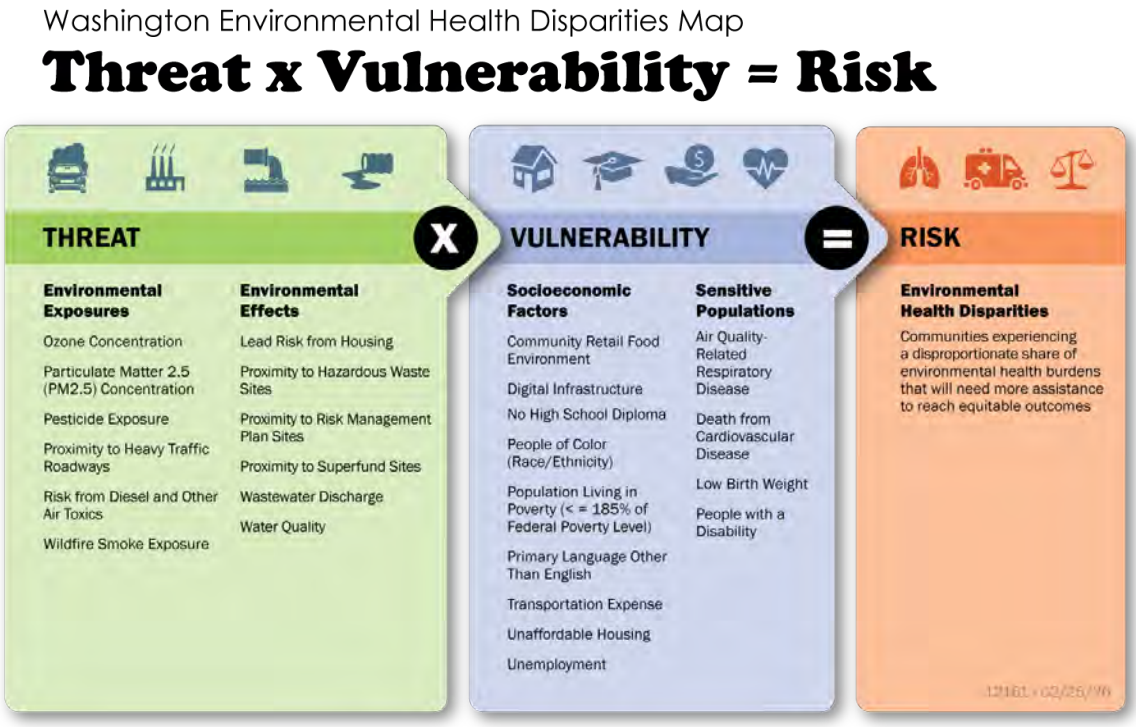
- **Threat** includes:
    - **Environmental exposures** – How much pollution people are exposed to.
    - **Environmental effects** – Nearby hazards, like waste sites or polluting industries.

- **Vulnerability** includes:
    - **Socioeconomic factors** – Things like education, income, or access to healthy food. These can make pollution harder to avoid or deal with. This category includes both social and systemic risk factors.
    - **Sensitive populations** – People who are more at risk because of their health or

biology. This includes people with asthma, disabilities, or other health conditions.

Vulnerabilities act as multipliers. This means they can make pollution threats more harmful. When we look at both threats and vulnerabilities, we get a more accurate picture of the burdens that communities face.

Figure 6. Model for EHD Map



Pollution, cost of living, and other social conditions don't happen on their own. They combine with the ongoing impacts of racism, colonization, and other injustices to affect community health.

Rankings

For each EHD map measure, every census tract (or community) has a raw data value. Each census tract is then assigned a rank from 1 to 10 that shows how the tract compares to other tracts on each measure.

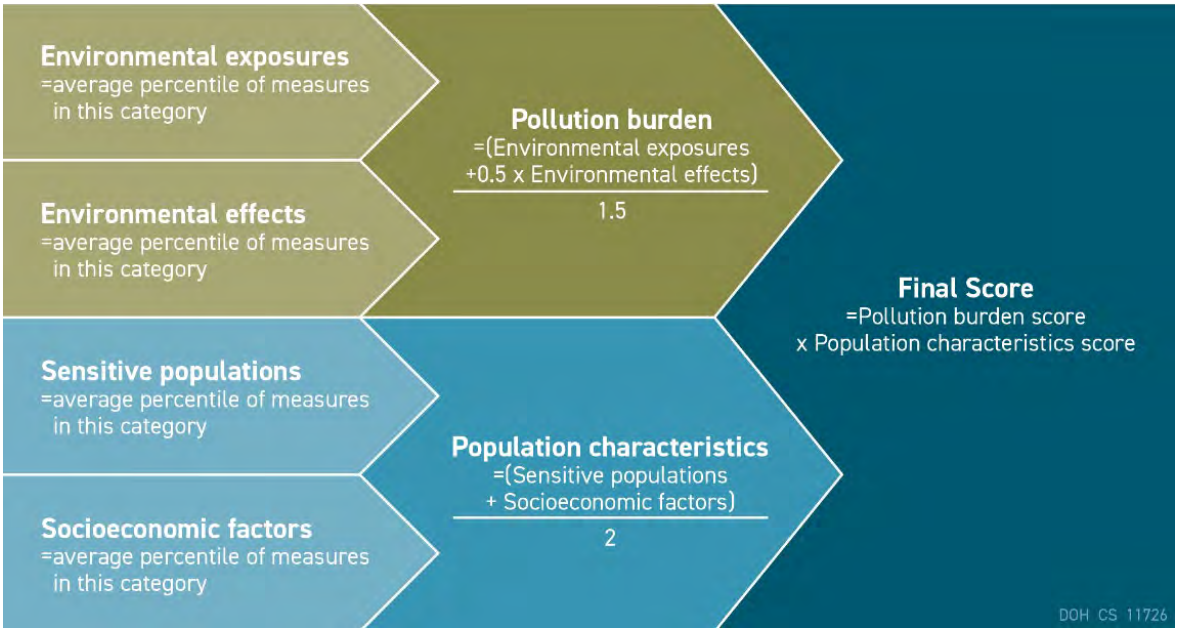
The decile ranks for all measures are averaged within each theme. We calculate the final composite score by multiplying the pollution burden and population characteristics scores. The final theme and composite scores are then normalized (adjusted to a common scale) using the decile ranking system to ensure the final score is between 1 and 10.

Each decile represents about 10 percent of the census tracts in the dataset. There are 1,772 census tracts in Washington as of 2020. This is approximately 177 census tracts in each rank.

For measures where at least 1 census tract is missing a raw value, we calculate the rankings based on the number of census tracts with data. No rank is assigned to census tracts with a missing raw value. These missing ranks are not included when averaging measures to calculate theme ranks.

Census tracts with a low population are more likely to have missing or unreliable socioeconomic and health data. This may lead to them having a lower cumulative EHD rank, even if there are important environmental concerns.

Figure 7. How Themes and Final Score Are Calculated



How to Interpret the Map

The ranking provides a common scale to compare issues at the community level and to assess the cumulative impact across communities. Rankings also allow health information to be displayed for each community, while protecting confidentiality in communities with small numbers.

The EHD map does not show numeric differences between each rank. The ranks show that there is a difference, not how much. The final composite scores are approximately equally distributed across 10 ranks. This means the result rankings on the map range from 1 (least impacted) to 10 (most impacted).

We can interpret rankings as the cumulative burden of environmental risk factors in communities relative to other Washington communities. For example, if a community has a rank of 8 for the lead risk from housing measures, it means about 10 percent of communities are similarly impacted by lead paint in homes. It also means approximately 70 percent are less impacted, and 20 percent are more impacted.

Figure 8. Explanation of EHD Map Rankings

The overall EHD ranking for each community reflects the cumulative impact of environmental, social, and health factors included in the map. It does not reflect every burden on communities. It also does not show resilience or environmental health asset-based measures.

A community's ranking does not reflect the likelihood that it will experience an increased amount of health outcomes like cancer or lung disease. Therefore, rankings should not be used to diagnose a community health issue, label a community, or assign risk factors and exposures for specific individuals. Additional analysis is needed to identify health outcomes that may be linked with environmental risk factors.

This map is intended to be a dynamic and informative tool. You should not base decisions on the cumulative impact of environmental risk on this map alone.

Measure Selection

This version of the map reflects identified priorities and feedback from community engagement efforts since 2017 and formal Tribal consultation in 2023. At the time development began, DOH's EHD map community and Tribal engagement staff had not yet started their engagement work. We prioritized relevance to rural communities since feedback expressed that the map had too much urban focus.

The Future Map Versions, Measures Under Exploration, and Additional Tools section outlines our anticipated approach to incorporate feedback and add measures in future EHD map updates. For information on the measures added to Version 3.0 of the EHD map, please refer to the EHD Map Changes for Version 3.0 section.

The overall EHD map ranking is informed by measures grouped within 4 themes. The following outlines the process used to select and incorporate measures into the EHD map.

Overview of the Measure Selection Process

- **Community and Tribal Engagement** – Input is gathered through engagement with both Tribal and non-Tribal communities. Residents identify topics of concern based on lived experience and local context.
- **Data Exploration** – The EHD map team works with partners to identify available datasets that could represent one or more aspects of the highlighted concern. (See Criteria for Measure Selection below).
- **Preliminary Research** – A high-level, informal review of existing research and practices to determine appropriate methods for creating a meaningful measure.
- **Technical Review** – Develop draft visualizations and supporting materials. We share these with the EHD map workgroup, data partners, and other subject matter experts to gather feedback and improve the measure.
- **Model Testing** – A sensitivity analysis is performed to assess the measure's contribution and ensure it meaningfully improves the overall model.

Criteria for Measure Selection

1. Measures must support identifying cumulative environmental health impacts and overburdened communities.
2. Measures should reflect common concerns related to environmental burden or population vulnerability across Washington.
3. Data must be available for most of the state at the census tract level.
4. Datasets must be reasonably complete, accurate, and up-to-date. A plan should exist to update the data in the future.
5. Data should provide information that isn't too similar to information already on the EHD map.

Limitations

The EHD map is based on a specific model for risk and cumulative environmental impact. It represents one of many ways to quantify these risks. The map also includes factors important to communities and Tribes and tries to represent their lived experiences. However, there is no one true value of environmental health risks that we can measure.

The map does not identify how pollutants get into the environment. It also does not show how pollutants and social factors interact with each other. Measuring, calculating, and summarizing data by census tract creates assumptions. There are important factors that we cannot include in the map because we don't have the tools to measure them across the state.

Some measures serve as proxies or substitutes for larger concerns that we cannot measure directly. For example, many communities are concerned about the quality of drinking water that comes out of the tap at home. This is difficult to measure without collecting and studying water samples from households across the state.

Several measures in the map may impact drinking water. This includes wastewater discharge, proximity to hazardous waste sites, pesticide exposure, and surface water quality (pollutants in nearby water bodies). However, these factors do not directly use data collected by water systems. These measurements also don't consider individual-level factors. For example, using a private well or living in a house with old pipes that are more likely to release toxic heavy metals into the water.

Measures use different methods to calculate risk and vulnerability. Some represent a modeled risk to individuals based on how they are exposed to different pollutants. Other measures represent the amount of a pollutant present in the environment or the proximity to a potential hazard.

Measures are also based on census tract averages and are not necessarily representative of every person in that community. The ranks presented in the map should not be interpreted as the risk to each individual living in a community.

This map does not include all environmental risk factors. DOH plans to continue adding input from communities and Tribes to better reflect the experiences of all Washington residents.

In Spring 2026, we plan to release a qualitative EHD map, which will share community stories by county area. This addition recognizes that we cannot quickly incorporate

stories into the EHD map and provide a resource that reflects the community's current lived experience. Please see the "Future Map Versions, Measures Under Exploration and Additional Tools" section for more information.

The map only presents data that is available across the entire state at the census tract level. For many issues, local data may better capture community experience than state-level data. County and city data and maps, if they exist, can provide more information for local decisions.

Measures

Table 1. List of EHD map measures

Environmental Exposures

Measures	Description of Measure	Source of Data	Years
Ozone Concentration	4th-highest 8-hour average ozone value in parts per billion	NW-AIRQUEST Regional Background Design Values, AIRPACT	2022-2024
Particulate Matter 2.5 (PM2.5) Concentration	Highest concentration between the mean and 98th percentile daily PM2.5 concentrations in µg/m3	NW-AIRQUEST Regional Background Design Values, AIRPACT	2022-2024
Pesticide Exposure	The total amount of pesticides applied to all crops is summed and divided by the area of each census tract	United States Department of Agriculture's National Agricultural Statistics Service and the U.S. Geological Survey	2019
Proximity to Heavy Traffic Roadways	Maximum distance-weighted traffic along Washington highways for each census tract	Washington State Office of Financial Management's 2020 census boundaries highway traffic from WSDOT geodatabase	2019
Risk from Diesel and Other Air Toxics	Risk from exposure to hazardous air pollutants. Measured as the total cancer risk per million people	Air Toxics Screening Assessment	2020
Wildfire Smoke Exposure	The wildfire smoke exposure score is based on how many smoky days there were and the severity of smoke pollution	National Oceanic and Atmospheric Administration's Hazard Mapping System	June-Sep. 2017-2023, and Oct. for 2022

Socioeconomic Factors

Measures	Description of Measure	Source of Data	Years
Lead Risk from Housing	Percentage of estimated homes that are likely to have lead paint	American Community Survey 5-year, B25034 – Selected Housing Characteristics	2019-2023
Proximity to Hazardous Waste Sites	Count of hazardous waste sites within 10 km, each divided by distance in km.	Washington Department of Ecology	2022-2023

Proximity to Risk Management Plan Sites	Count of risk management plan (potential chemical accident management plan) sites within 10 km, each divided by distance in km	EJSCREEN	2024
Proximity to Superfund Sites	Count of Superfund sites within 10 km, each divided by distance in km.	Washington Department of Ecology	2024
Wastewater Discharge	Toxicity-weighted stream concentrations instream segments within 500 meters, divided by distance in km	EPA's Risk-Screening Environmental Indicators Water Releases	2024
Water Quality	Summed number of unique pollutants detected in waters tested and classified as "impaired"	Washington Department of Ecology	2018

Socioeconomic Factors

Measures	Description of Measure	Source of Data	Years
Community Retail Food Environment	Percentage of stores offering fresh, nutrient-dense foods to those primarily selling processed or fast food	Data Axle via ESRI's ArcMap v10.8 Business Analyst	2023
Digital Infrastructure	Summary of the availability and speed of internet access	Purdue University 's Infrastructure and Adoption Component of Digital Divide Index	2023
No High School Diploma	Percentage of people without a high school diploma over the age of 25 per household	American Community Survey 5-year, DP02 - Selected Social Characteristics	2019-2023
People of Color	Summary of communities of color, specific race/ethnicity makeup for census tracts	Office of Financial Management	2024
Population Living in Poverty	Percentage of the total population whose income was less than or equal to 185% of the federal poverty level in the past 12 months	American Community Survey 5-year, S1701 - Poverty Status in the Past 12 Months	2019-2023
Primary Language Other Than English	Percentage of limited English-speaking households	American Community Survey 5-year, B16004 - Age by Language Spoken at Home by Ability to Speak English	2019-2023
Transportation Expense	Transportation costs based on the percentage of income for the regional moderate household	Center for Neighborhood Technology	2019

Unaffordable Housing	Percentage of people who spend over 30% of their income on housing-related costs	American Community Survey 5-year, DP04 - Selected Housing Characteristics	2019-2023
Unemployment	The population of people 16 years and older who are in the labor force and registered as unemployed	American Community Survey 5-year, DP03 - Selected Economic Characteristics	2019-2023

Socioeconomic Factors

Measures	Description of Measure	Source of Data	Years
Air Quality-Related Respiratory Disease	Age-adjusted rate of emergency department visits for "air quality-related respiratory illness" per 1,000 people	Rapid Health Information Network syndromic surveillance data for emergency department visits	2023
Death from Cardiovascular Disease	Age-adjusted death rate due to cardiovascular disease per 100,000 people	Washington State DOH Center for Health Statistics, Death certificates	2020-2024
Low birth weight	The number of live-born singleton (one baby) infants born with a birth weight of less than 2,500 grams (~5.5 pounds)	Washington State DOH Center for Health Statistics, Birth certificates	2020-2024
People with a Disability	Percentage of the population that reports having at least one disability	American Community Survey 5-year, S1810-Selected Disability Characteristics	2019-2023
Air Quality-Related Respiratory Disease	Age-adjusted rate of emergency department visits for "air quality-related respiratory illness" per 1,000 people	Rapid Health Information Network syndromic surveillance data for emergency department visits	2023
Death from Cardiovascular Disease	Age-adjusted death rate due to cardiovascular disease per 100,000 people	Washington State DOH Center for Health Statistics, Death certificates	2020-2024

Pollution Burden - Environmental Exposures Theme

This theme measures pollution in the environment. Exposure occurs when pollution sources get into the environment and affect individuals or populations. Direct contact or prolonged contact with an environmental exposure could lead to poor health outcomes.

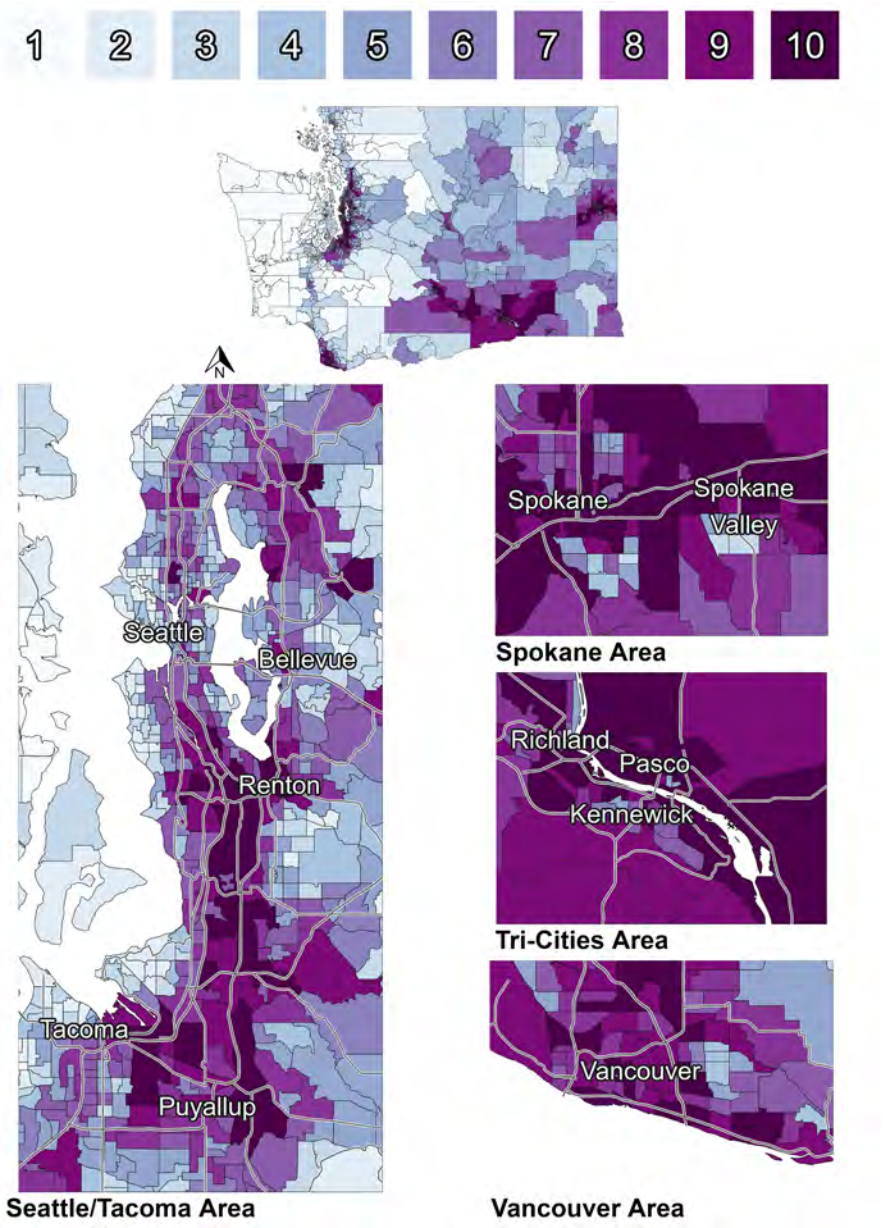
This theme captures common environmental exposures and the risk of developing poor health outcomes associated with those exposures. Environmental exposures include pollutants like:

- Ozone
- Particulate matter 2.5 (PM2.5)
- Pesticide exposure
- Proximity to heavy traffic roadways
- Risk from diesel and other air toxics
- Wildfire smoke exposure

Environmental Exposure Theme

This map shows the decile rankings for the combination of all measures in the Environmental Exposures theme

Ranks range from 1 (least impacted) to 10 (most impacted)



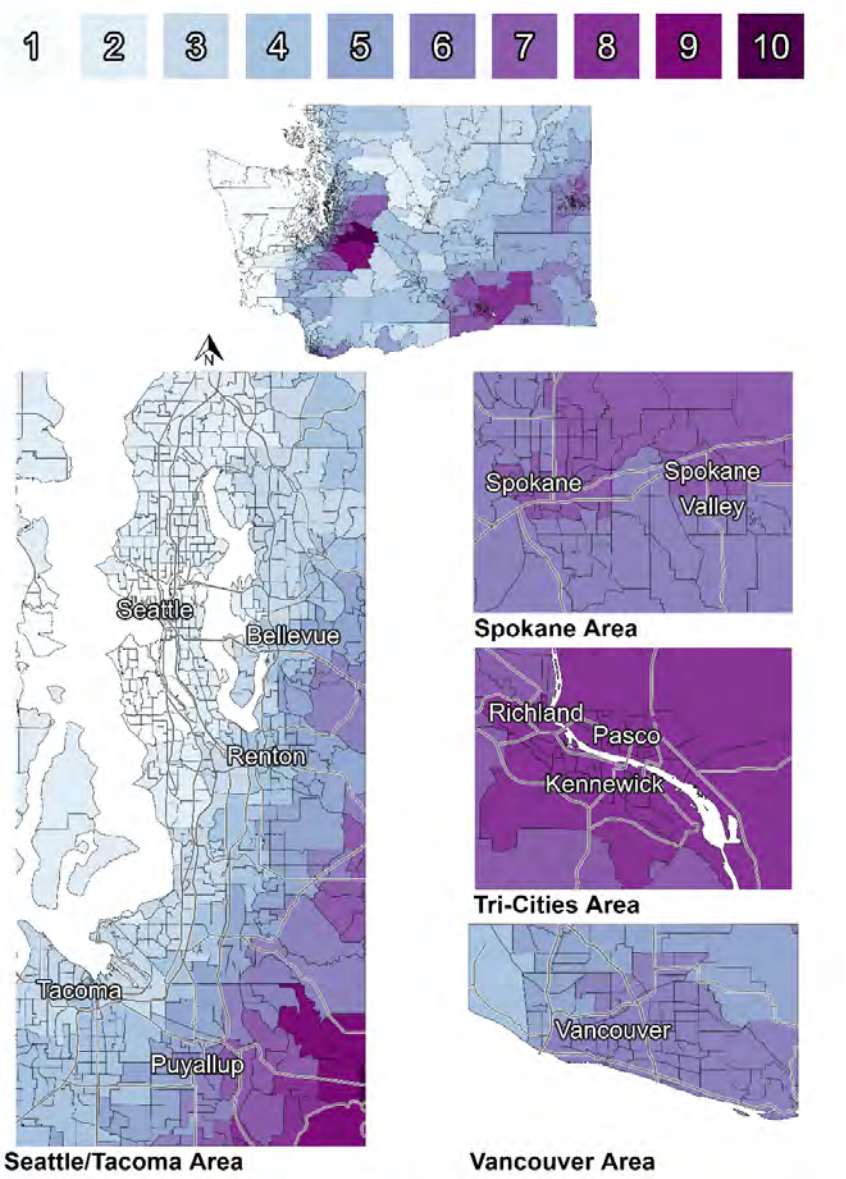
Ozone Concentration

Overview

Breathing ozone can harm the lungs, especially for people with asthma or other lung conditions. People living downwind from large cities are often exposed to more ozone. This puts them at higher risk for health problems. This measure estimates how ozone levels vary across Washington.

Ozone Concentration

This map shows decile rankings for the 4th highest 8-hour average ozone value, 2022-2024
Ranks range from 1 (least impacted) to 10 (most impacted)



Background

Ozone is a gas in the upper atmosphere that helps us by absorbing harmful sunlight. However, when ozone forms closer to the ground, it becomes a harmful pollutant. Ground-level ozone is created by chemical reactions between pollutants like volatile organic compounds (VOCs) and nitrogen oxides (NOx), which are released by vehicles, factories, wood burning, and gasoline. Ozone levels can change based on sunlight and emissions. Ozone levels are often higher on sunny days or in places with lots of traffic or factories.

Breathing in too much ozone can cause serious health problems, especially for people living with lung or heart conditions. It is linked to higher rates of asthma, more hospital visits, and even early death.

Ozone pollution also harms the environment. It can stunt plant growth, damage crops, and make it harder for plants to absorb carbon dioxide.

Evidence

Breathing in ozone can cause inflammation of the airways and increase the risk of early death. In children, it can lead to more hospitalizations for breathing trouble [1]. Factors like age, sex, and race can affect how vulnerable people are to ozone exposure [2, 3]. Dust and wildfires can increase ozone levels and lead to more emergency room visits [4]. Over 123 million people in the U.S. are exposed to harmful ozone levels, contributing to an estimated 30,000 to 64,000 early deaths. To fully understand ozone's effects, more research is needed on how factors like age, job, sex, and race play a role. The strongest evidence shows that the elderly, women, people who are unemployed, and people in blue-collar jobs are at higher risk. There is less evidence about differences based on education, income, or access to central air conditioning [5, 6].

Ozone pollution harms ecosystems too. It can stunt plant growth, damage crops, and reduce plants' ability to absorb carbon dioxide, which is important for fighting climate change. This harms food production and causes broader environmental damage [7].

Data Source

Ozone 2022-2024 estimates from the Washington State Department of Ecology

Methods

This measure looks at peak ozone concentrations from 2022-2024. These are estimated for 5km x 5km grid cells across Washington. Concentrations are estimated by combining expected levels from the National Oceanic and Atmospheric Administration (NOAA) forecast model with measured concentrations from the Washington Ambient Air Monitoring Network. The NOAA forecast model accounts for emissions, meteorology, and topography. The differences between the modeled and

measured concentrations are calculated across the grid. This is combined with the forecast model to produce daily maximum 8-hour ozone concentrations. The 4th highest annual daily ozone concentration (as is defined by the EPA to be used to compare to the federal standard) is then calculated for all points in the grid. Each census tract is assigned the ozone level of its most populated grid cell. Grid cell populations were estimated using 2020 census block groups.

The Department of Ecology created custom ranking which place the data into 3 ppb intervals: 43–45.9, 46–48.9, 49–51.9, 52–54.9, 55–57.9, 58–60.9, 61–63.9, 64–66.9, 67–69.9, and 70+. Areas not meeting federal health standards were given a rank of 10.
More information about federal ozone standards can be found at https://www.epa.gov/ground-level- ozone-pollution/timeline-ozone-national-ambient-air-quality-standards-naaqs
Ozone monitoring data are available from the Washington Department of Ecology at https://enviwa.ecology.wa.gov/mobile
The NOAA ozone forecasts are available at: https://airquality.weather.gov/

Caveats

This method assumes ozone levels are the same throughout each census tract. However, ozone can vary within smaller areas, especially in rural areas where census tracts are typically large. Because the same ozone level is used for the entire census tract, it might not reflect the true air quality in some communities. For more detailed data, 5km x 5km ozone data has been added as an overlay on the EHD map.

Sources

1. Fann, N., Lamson, A.D., Anenberg, S.C., Wesson, K., Risley, D., Hubbell, B.J. (2012). Estimating the national public health burden associated with exposure to ambient PM2.5 and ozone. Risk analysis: an official publication of the Society for Risk Analysis, 32(1), 81–95.
2. Bell, M.L., Dominici, F. (2008). Effect modification of the short-term effects of ozone on mortality in older adults. American Journal of Epidemiology, 167(6), 672-7.
3. Medina-Ramón, M., Schwartz, J. (2007). Temperature, temperature extremes, and mortality: a study of acclimatisation and effect modification in 50 US cities. Occupational and environmental medicine, 64(12), 827–33.
4. Kelly, F.J., Fussell, J.C. (2020). Global nature of airborne particle toxicity and health effects: a focus on megacities, wildfires, dust storms and residential biomass burning. Toxicology research, 9(4), 331-45.
5. Bell, M.L., Zanobetti, A., Dominici, F. (2014). Who is more affected by ozone pollution? A systematic review and meta-analysis. American journal of epidemiology, 180(1), 15–28.
6. Malley, C.S., Henze, D.K., Kuylenstierna, J.C.I., Vallack, H.W., Davila, Y., Anenberg, S.C., et al. (2017). Updated Global Estimates of Respiratory Mortality in Adults ≥30Years of Age Attributable to Long-Term Ozone Exposure. Environmental health perspectives, 125(8), 087021.

PM2.5 Concentration

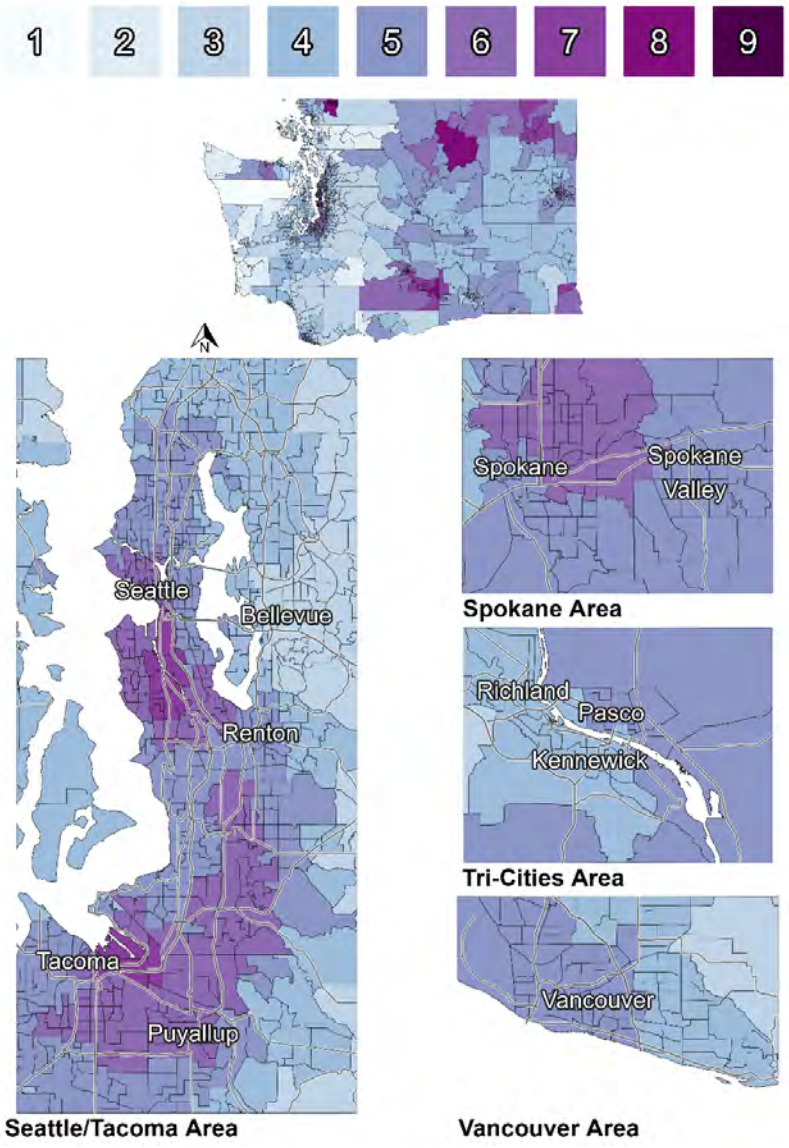
Overview

Long-term exposure to tiny particles in the air, known as particulate matter 2.5 (or PM2.5), can cause serious health problems like lung disease and heart issues. Communities of color and communities with less economic access are often more exposed to these particles. This is because affordable housing tends to be in areas with more pollution. This measure estimates how PM2.5 pollution varies across Washington.

PM 2.5 Concentration

This map shows decile rankings for the highest mean or 98th percentile daily PM2.5 concentrations, 2022-2024

Ranks range from 1 (least impacted) to 10 (most impacted)



Background

Particulate matter 2.5 (PM2.5), or fine particulate matter, are tiny particles that are 2.5 micrometers or smaller in size. These particles come from things like burning wood, dust, factories, commercial cooking, and vehicle exhaust. The particles can either come directly from a source or can form when chemicals like sulfur and nitrogen oxides react in the air. The makeup of PM2.5 can change depending on the season, location, and weather.
Historically minoritized people, older adults, children, and people with lung problems are more likely to experience significant health impacts from PM2.5. PM2.5 particles are small enough to get into the lungs and bloodstream, causing health problems. They can also harm nature by getting into the soil and water.

Evidence

PM2.5 is primarily released from wildfires, residential wood burning, industrial activities, and vehicle emissions [1]. PM2.5 particles can penetrate the lungs and bloodstream, where they trigger inflammation [2]. Prolonged exposure to PM2.5 is linked to lung and heart diseases, including lung cancer. Short-term exposure is linked to asthma attacks, hospitalizations, low birthweight babies, and fatal heart attacks [3, 4]. Urban areas and resource limited neighborhoods near factories or dense traffic often experience higher PM2.5 levels [5]. Black, Asian, and Latiné populations in the U.S. are consistently exposed to higher PM2.5 levels compared to white and Native American populations. These differences are getting worse over time [6]. Rural areas are exposed to PM2.5 from higher rates of wood heating and outdoor burning, as well as their proximity to wildfires. Limited health care access makes it harder for rural residents to manage pollution-related health issues [7]. PM2.5 also contributes to bad water quality and impacts aquatic life [8].

Data Source

PM2.5 2022-2024 estimates from the Washington State Department of Ecology

Methods

This measure looks at the average and 98th percentile daily PM2.5 levels from 2022-2024. These are estimated for 5km x 5km grid cells across Washington. Daily average PM2.5 concentrations are estimated by combining expected levels from the National Oceanic and Atmospheric Administration (NOAA) forecast model with measured concentrations from the Washington Ambient Air Monitoring Network. The NOAA forecast model accounts for emissions, meteorology, and topography. The differences between the modeled and measured concentrations are calculated across the grid. This is combined with the forecast model to produce daily average PM2.5 concentrations. The average and 98^{th} percentile concentrations are calculated for all points in the grid. Each census tract is assigned the PM2.5 levels of its most populated grid cell. Grid cell populations are estimated using 2020 census block groups.

In each census tract, the average and 98th percentile PM2.5 levels are combined into a single score. This score reflects both long-term (average) and peak (98th percentile) short-term (24-hour) PM2.5 levels.

Spikes in PM2.5 due to wildfire smoke are not included in these calculations, since wildfire smoke exposure is scored separately.

The Department of Ecology created custom rankings for the map which divide the data into equal intervals. All areas exceeding federal health standards receive a score of 10.
More information about federal PM2.5 standards can be found at: https://www.epa.gov/pm-pollution/timeline-particulate-matter-pm-national-ambient-air-quality-standards-naaqs
PM2.5 monitoring data are available from the Washington State Department of Ecology at https://enviwa.ecology.wa.gov/mobile.

The NOAA PM2.5 forecasts are available at:
https://airquality.weather.gov/?element=apm25h01_bc

Caveats

This method assumes that air quality is the same across an entire census tract. This isn't always accurate, especially in rural areas where census tracts are typically larger and air quality conditions more variable. Treating a whole census tract as having the same PM 2.5 level may miss pollution differences that could affect the health and the environment of smaller communities in that area. For more detailed data, 5km x 5km PM2.5 annual and daily data have been added as overlays on the EHD map.

Sources

1. Kampa, M., & Castanas, E. (2008). Human health effects of air pollution. Environmental Pollution, 151(2), 362-367.
2. Burnett, R.T., Pope, A.T., Ezzati, M., Olives, C., Lim, S.S., Mehta, S. (2018). An integrated risk function for estimating the global burden of disease attributable to ambient fine particulate matter exposure. Environmental Health Perspectives, 120(4), 572-580.
3. Dockery, D.W., Pope, C.A. (1994). Acute respiratory effects of particulate air pollution. Annual Review of Public Health, 15(1), 107-132.
4. Dominici, F., McDermott, A., Zeger, S.L., Samet, J.M. (2006). On the use of generalized additive models in time-series studies of air pollution and health. American Journal of Epidemiology, 164(3), 293-303.
5. Bell, M.L., Goldberg, R., Hogrefe, C., Kinney, P.L., Knowlton, K., Rosenthal, J.K., et al. (2007). Climate change, ambient ozone, and health in 50 U.S. cities. Climate Change, 82(1-2), 61-76.
6. Harvard T.H. Chan School of Public Health. "Racial and Ethnic Minorities Breathe More Hazardous Air Pollution Than White Americans." Harvard Public Health News, 2022.

7. Reid, C.E., Brauer, M., Johnston, F.H. (2016). Critical review of the health impacts of wildfire smoke exposure. Environmental Health Perspectives, 124(4), 423-31.
8. Pope, C.A., III, Ezzati, M., Dockery, D.W. (2013). Fine particulate air pollution and life expectancy in the United States. New England Journal of Medicine, 360(4), 376-86.

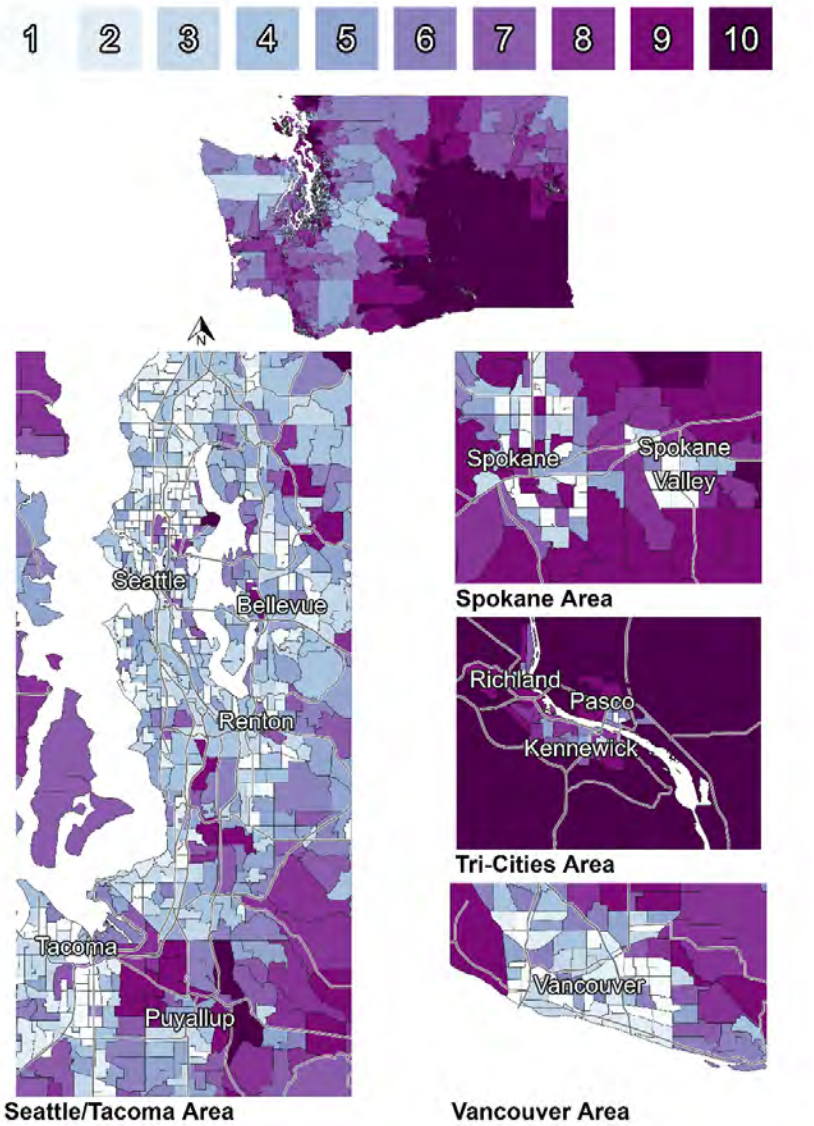
Pesticide Exposure

Overview

Exposure to pesticides can cause serious health problems, especially to the lungs and nervous system. People who work on farms, live in rural areas, or have fewer financial resources are more likely to be exposed. This measure estimates exposure by examining the amount of pesticide used on major crops.

Pesticide Exposure

This map shows decile rankings for the average amount of pesticides uses in a census tract, 2019
Ranks range from 1 (least impacted) to 10 (most impacted)



Background

"Pesticide" is a general term for chemicals used to control weeds, insects, and pests on crops. It includes insecticides, herbicides, fungicides, bactericides, and rodenticides. Nearly 90% of pesticides used in the United States are used in agriculture. As a result, farmworkers and people living near farms are more likely to be exposed to pesticides and suffer health problems caused by them. Those are often people of color or people who have fewer financial resources.

Pesticides can spread beyond where they are applied (called "pesticide drift"). This drift can contaminate nearby land and water, posing risk to both people and the environment. Exposure to pesticides can cause a range of health problems. Short-term effects include poisoning and breathing problems. Longer-term effects include cancer and damage to the nervous system.

Evidence

A recent study showed that Black, Indigenous, and people of color face higher pesticide exposure. So do communities with fewer financial resources. This is often because they work in agriculture, live near pesticide-treated areas, or live in substandard housing. People of color make up 63% of those living near pesticide manufacturing plants that break environmental laws [1]. Additionally, green spaces in communities of color are more often treated with pesticides. Most, if not all, Americans have pesticides in their blood. However, people of African descent, people of Mexican descent, farmworkers, and children have much higher levels [2].

Pesticides create ecological risks. Widespread use of pesticides can hurt important pollinators like bees [3]. These chemicals can also build up in the environment, contaminating soil and water. This buildup harms aquatic ecosystems and harms fish populations [4].

Pesticide exposure is linked to health issues like poisoning, breathing problems, increased risk of breast cancer, prostate cancer, preterm births, and shorter pregnancies [5, 6, 7]. Exposure to pesticides can increase the risk of anxiety and depression [8]. Exposure is also linked to an increased risk of developing and dying from Parkinson's disease [9, 10]. Prenatal pesticide exposure is associated with developmental issues, lower IQs, and higher risk of leukemia [11, 12, 13].

Data Sources

Cropland data. 2019 Georeferenced Cropland Data Layer dataset from the United States Department of Agriculture's National Agricultural Statistics Service.

Pesticide data. 2019 State- and county-level estimated annual agricultural pesticide from the United States Geological Survey.

Methods

Pesticide exposure was derived using these steps:

1. The area of major crops and crop groups in square meters (m^2) for each county was calculated by intersecting the cropland and county boundary shapefiles.
2. The percentage of each type of pesticide applied to each major crop and crop group was estimated using state-level EPest-high data. The major crops include alfalfa, corn, soybeans, and wheat. The crop groups are orchards and grapes, vegetables and fruit, pasture and hay, and other crops.
3. The amount of pesticides applied to each major crop and crop group in kg/m^2 was estimated by joining the state-level percentage of pesticides with county-level pesticide use and agricultural land area.
4. The area of major crops and crop groups in each census tract was calculated by intersecting the cropland shapefiles with the census tract boundary shapefiles.
5. The estimated county-level pesticide use in kg/m^2 was joined with census tract cropland data.
6. Census tract pesticide use for each major crop and crop group was calculated by multiplying the county-level pesticide use in kg/m^2 by the area of each major crop and crop group within the census tract.
7. The total amount of pesticides applied to all crops was summed and divided by the area of each census tract. Pesticide exposure values were calculated in kg/m^2 and $lbs/mile^2$.

Caveats

This method estimates pesticide use at the county and state levels and then breaks it down to census tracts. This process can miss differences within tracts, especially if farming practices or pesticide use vary. Factors like wind, runoff, or pesticide drift can also affect exposure. Since the estimate is the same for an entire census tract, it may not accurately reflect the real-world conditions. This may be particularly true closer to application sites.

This measure represents the entire census tract, not each individual community within the tract. These data should always be supplemented with local data and equitable engagement for more accurate insights.

Sources

1. Beyond Pesticides. (2022). Pesticide exposure disparities among people of color and low-income communities.
2. National Caucus of Environmental Legislators (NCEL). (2024). Pesticides and environmental justice.
3. Tudi, M., Ruan, H.D., Wang, L., Lyu, J., Sadler, R., Connell, D. Yu, Q. (2021). Pesticide pollution in agricultural systems and sustainable approaches for reducing its impact. Environmental Research, 195, 110829.
4. Farah, I.F., dos Santos, C.R., Pinto, M.C.F., Araújo, C.R., Amaral, M.C.S. (2024). Pesticides in aquatic environment: Occurrence, ecological implications and legal framework. *Journal of Environmental Chemical Engineering, 14*(2), 114072. https://doi.org/10.1016/j.jece.2024.114072.

5. Winchester, P.D., Huskins, J., Ying, J. (2016). Agrichemicals in surface water and birth defects in the United States. Acta Paediatrica, 105(3), e144-e154.
6. Panis, C., Mattos, R.T., da Silva, L.G., Takahashi, C.S. (2024). Pesticide exposure and adverse reproductive outcomes: A systematic review. Environmental Toxicology and Pharmacology, 96, 104345.
7. Koutros, S., Alavanja, M.C., Lubin, J.H., Sandler, D.P., Hoppin, J.A., Lynch, C.F., et al. (2013). An update of cancer incidence in the Agricultural Health Study. Journal of Occupational and Environmental Medicine, 55(7), 768-75.
8. Zanchi, A.C., Martins, A.F., Mesquita, C.S., Oliboni, C.G., Lemos, R.L., Pereira, C.H. (2023). Pesticide exposure and mental health: A review on anxiety and depression outcomes. Environmental Science and Health, 96, 125-37.
9. Baltazar, M.T., Dinis-Oliveira, R.J., de Lourdes Bastos, M., Tsatsakis, A.M., Duarte, J. A., Carvalho, F. (2012). Pesticides exposure as etiological factors of Parkinson's disease and other neurodegenerative diseases—A mechanistic approach. Toxicology Letters, 210(2), 119-130.
10. Freire, C., Koifman, S., Koifman, R. J. (2012). Pesticide exposure and Parkinson's disease: Epidemiological evidence of association. NeuroToxicology, 33(5), 947-71.
11. Rauh, V.A., Garfinkel, R., Perera, F.P., Andrews, H.F., Hoepner, L., Barr, D.B., et al. (2012). Impact of prenatal chlorpyrifos exposure on neurodevelopment in the first 3 years of life among inner-city children. Pediatrics, 118(6), e1845-59.
12. Gunier, R.B., Bradman, A., Harley, K.G., Kogut, K., Eskenazi, B. (2017). Prenatal residential proximity to agricultural pesticide use and IQ in 7-year-old children. Environmental Health Perspectives, 125(5), 057002.
13. Karalexi, M.A., Dessypris, N., Thomopoulos, T.P., Ntouvelis, E., Kantzanou, M., Diamantaras, A.A., et al. (2021). Association of maternal residential pesticide exposure with childhood leukemia risk: A systematic review and meta-analysis. Environmental Research, 197, 111009.

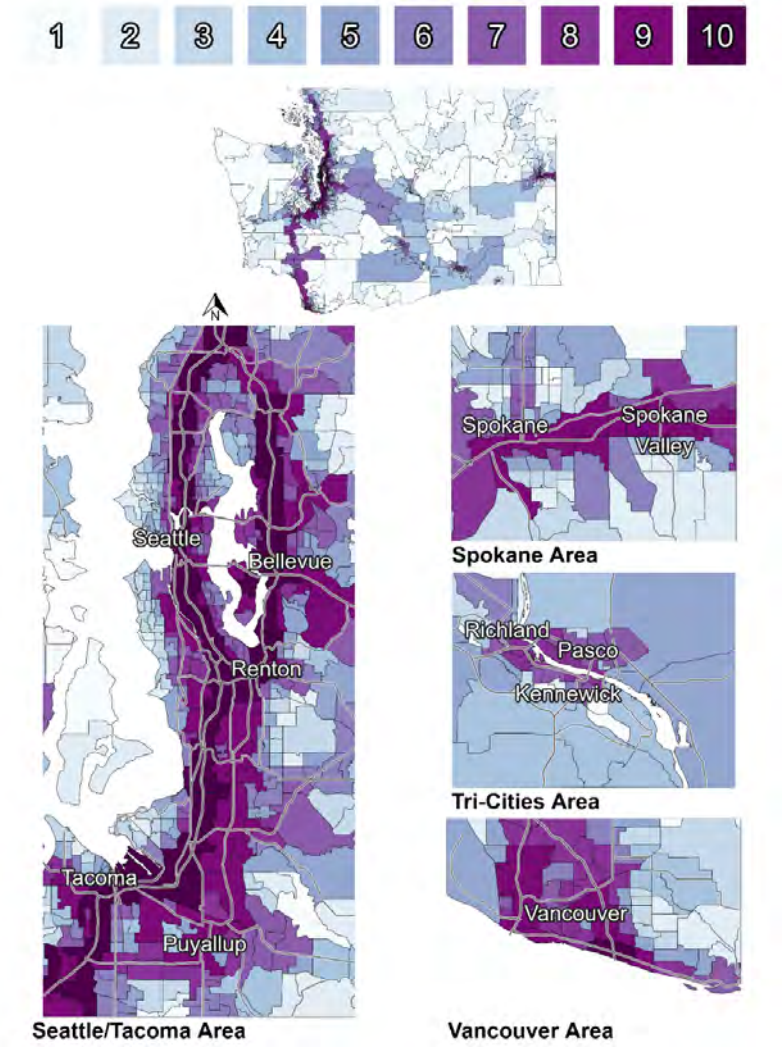
Proximity to Heavy Traffic Roadways

Overview

Living near busy roads can expose people to more air pollution. This can lead to health issues like asthma. Due to historical racism, marginalized communities and people with less economic access are often closer to these roads, putting them at greater risk. This measure estimates exposure to vehicle traffic by looking at highway length and traffic volume in a neighborhood.

Proximity to Heavy Traffic Roadways

This map shows decile rankings for the distance-weighted maximum traffic along highways, 2019
Ranks range from 1 (least impacted) to 10 (most impacted)



Background

Vehicle exhaust contains harmful chemicals that can seriously affect people's health. More traffic means more pollution in the air. The closer someone lives to busy roads, the more pollution they are exposed to. "Traffic density" is how much vehicle exhaust exposure there is, based on how much traffic there is in an area. Heavy traffic contributes to many health concerns, such as noise pollution, smog, and car accidents. It is associated with a range of health problems including infant death, negative birth outcomes, heart disease, and cancer.

Traffic-related pollution is especially harmful for specific groups. These include:

- People of color
- The elderly
- Children (especially those in childcare facilities)
- People with preexisting health conditions
- People with fewer financial resources
- People with limited access to cars
- Renters

People in these groups face increased exposure due to discriminatory practices, such as redlining and placing highways in historically minoritized communities.

While heavy traffic contributes to many health concerns, such as noise pollution, smog, and car accidents, one of the biggest concerns is that it worsens air quality both indoors and outdoors. Poor indoor air quality is particularly harmful to people's health. Pollution from traffic can enter homes, schools, and workplaces. Improving indoor air filtration can help reduce exposure to this harmful pollution.

Some communities are trying to address traffic pollution by creating green spaces or using electric buses.

Evidence

Dense traffic is a significant contributor to pollution. More traffic results in higher emissions of harmful air pollutants. These include particulate matter (PM2.5), nitrogen oxides (NOx), and volatile organic compounds (VOCs)[1]. Traffic also worsens indoor air quality. Facilities like schools and childcare centers are often located near busy roads. This puts the people inside, including children and childcare workers, at higher risk [2, 3]. Traffic-related air pollution is linked to multiple health concerns. These include increased risk of heart disease, respiratory issues, type 2 diabetes, lower rates of physical activity, and low birth weight [4, 5, 6, 7, 8, 9].

Living close to busy roads means breathing in higher levels of pollutants from vehicle exhaust [2][10]. This makes existing health problems worse. This is especially true for children, who are more sensitive to the effects of pollution. Children who are exposed to traffic pollution can develop chronic respiratory conditions and developmental delays [11].

The noise and disruptions from traffic can also cause stress and poor sleep quality. This increases

both physical and mental health challenges within these areas [12].

Data Source

Washington State Office of Financial Management's 2020 census boundaries (Census geographic files | Office of Financial Management (wa.gov), and 2019 roadway traffic from WSDOT map center.

Methods

This measure shows the maximum amount of traffic on highways divided by distance to each census tract. The highway with the highest number of vehicles is determined from Average Annual Daily Traffic (AADT) data. AADT data come from a network of highway traffic counters. Distance is the shortest distance from anywhere in the census tract to the heavily traveled highway. For very short distances, a minimum of 1 km was used. The units for this measure are maximum highway AADT (vehicles per day) / distance to highway (km), or vehicles/day/km. Depending on the levels of traffic, the highway used in the calculation may not be the closest highway to the census tract.

Caveats

This measure does not calculate exposure to emissions. It calculates proximity to heavy traffic as a proxy.

Factors such as wind direction, local geography, and weather conditions can change how pollution spreads. As a result, people living near busy roads may not always experience the same level of pollution.

This measure represents the entire census tract, not individual areas within it. These data should always be supplemented with local data and equitable engagement for more accurate insights.

Sources

1. Gauderman, W.J., Vora, H., McConnell, R., Berhane, K., Gilliland, F., Thomas, D., et al. (2004). Effect of exposure to traffic on lung development from 10 to 18 years of age: a cohort study. The Lancet, 365(9461), 1849-56.
2. González-Martin, J., Kraakman, N.J., Pérez, C., Lebrero, R., Muñoz, R. (2021). A state–of–the-art review on indoor air pollution and strategies for indoor air pollution control. Chemosphere, 262, 128376.
3. U.S. Environmental Protection Agency. (2021). *Best practices for reducing near-road pollution exposure at schools*. U.S. Environmental Protection Agency. https://nepis.epa.gov/Exe/tiff2png.cgi/P1013GDE.PNG?-r+75+-g+7+D%3A%5CZYFILES%5CINDEX%20DATA%5C16THRU20%5CTIFF%5C00001207%5CP1013GDE.TIF.
4. Berglind, N., Bellander, T., Forastiere, F., von Klot, S., Aalto, P., Elosua, R., et al. (2009). Ambient air pollution and daily mortality among survivors of myocardial infarction. Epidemiology, 20(1), 110-8.

5. Ghosh, R., Causey, K., Burkart, K., Wozniak, S., Cohen, A., Brauer, M., et al. (2012). Ambient and household air pollution in pregnancy and adverse perinatal outcomes: a systematic review and meta-analysis. Pediatrics, 130(5), 944-55.
6. Habermann, M., Gouveia, N. (2014). Socioeconomic position and low birth weight among mothers exposed to traffic-related air pollution. PLOS One, 9(11), e113900.
7. von Klot, S., Peters, A., Aalto, P., Bellander, T., Berglind, N., D'Ippoliti, D., et al. Health Effects of Particles on Susceptible Subpopulations (HEAPSS) Study Group (2005). Ambient air pollution is associated with increased risk of hospital cardiac readmissions of myocardial infarction survivors in five European cities. Circulation, 112(20), 3073–9.
8. Pyko, A., Andersson, N., Eriksson, C., de Faire, U., Lind, T., Mitkovskaya, N., et al. (2019). Long-term transportation noise exposure and incidence of ischaemic heart disease and stroke: a cohort study. Occupational and Environmental Medicine, 76(4), 201–7.
9. Roswall, N., Raaschou-Nielsen, O., Ketzel, M., Overvad, K., Olsen, A., & Sørensen, M. (2017). Long-term exposure to residential railway and road traffic noise and risk for diabetes in a Danish cohort. Environmental Research, 160, 292-7.
10. Boehmer, T.K., Foster, S.L., Henry, J.R., Woghiren-Akinnifesi, E L., Yip, F. Y. (2013). Residential proximity to major highways — United States, 2010. Morbidity and Mortality Weekly Report (MMWR), 62(3), 46-50.
11. Gunier, R.B., Hertz, A., Von Behren, J., Reynolds, P. (2003). Traffic density in California: Socioeconomic and ethnic differences among potentially exposed children. Journal of Exposure Analysis and Environmental Epidemiology, 13(3), 240-6.
12. Eze, I.C., Schaffner, E., Fischer, E., Schikowski, T., Adam, M., Imboden, M., et al. (2017). Long-term air pollution exposure and diabetes in a population-based Swiss cohort. Environment International, 108, 191-200.

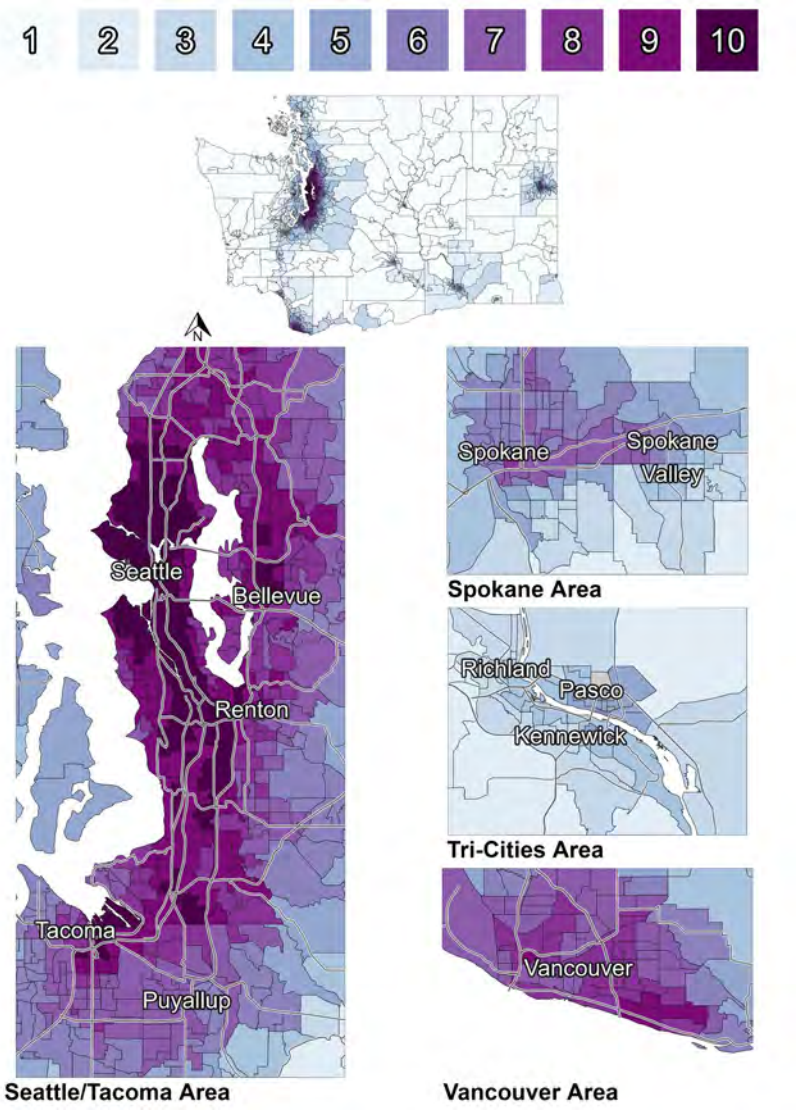
Risk from Diesel and Other Air Toxics

Overview

Some harmful gases and particles in the air can increase a person's risk of cancer. Communities with less economic access and historically minoritized communities are more likely to have high levels of these dangerous pollutants. Vehicle traffic, especially diesel emissions, makes up most of the cancer risk in Washington. This measure shows cancer risk from hazardous air pollution across Washington State.

Risk from Diesel and Other Air Toxics

This map shows decile rankings for the cancer risk from diesel and other air toxics, 2020
Ranks range from 1 (least impacted) to 10 (most impacted)



Background

Some air pollutants can raise the risk of cancer if people breathe them over many years. These pollutants, called air toxics, can come from many sources including cars, trucks, factories, and wood burning. Breathing in even low levels for a long time can lead to cancer and other serious health problems. Busy roads and polluting industries are frequently built in communities of color and neighborhoods with fewer financial resources, causing these communities to face higher health risks.

The EPA's Air Toxics Screening Assessment estimates how outdoor air pollution increases cancer risk. It looks at how much pollution is in the air, where it comes from, and how harmful it is. The analysis assumes people are exposed to the current level of pollution for a 70-year lifespan to estimate the lifetime impact on cancer risk.

For more information on the cancer risk from all emissions tracked, visit: AirToxScreen Mapping Tool (2020).

Evidence

The cancer risk from air toxics is not distributed evenly. Studies have found Black communities have 16% higher cancer risk than White communities. Communities with less economic access have 12% higher cancer risk than higher income communities [1]. Other analyses have found that racial residential segregation amplifies this risk. Individuals living in extremely segregated areas, regardless of race, have a 32% higher cancer risk than less segregated areas. This effect is the strongest for Hispanic communities, who experience 74% higher cancer risk in extremely segregated areas [2].

Industrial facilities that release pollution are more often built near communities with less economic access and communities of color [3]. Black Americans are 75% more likely to live near pollution producing sites compared to whites [4]. There is ten times as much toxic metal in the air in racially segregated communities [5]. People of color bear 56% of the burden of pollution from refineries [6].

It is important to note that these air toxics cause other health impacts in addition to cancer. Both acute and chronic exposure to diesel emissions can cause a wide range of health effects, including increasing rates of heart disease, blood pressure, and infant mortality rates [7]. Long-term effects of other air toxics include asthma, cardiovascular disease, and diabetes [8].

Data Source

EPA Air Toxics Screening Assessment, 2020

Methods

The risk from diesel and other air toxics score is the total cancer risk per million people from diesel and all air toxics captured in AirToxScreen 2020, except wildfire smoke.

Description of pollutant categories included in cancer risk analysis

Category	Examples of specific pollutants/sources
On Road	Vehicles on roads, including cars, trucks, and buses
Non-Road	Marine traffic, airplanes, agricultural equipment, and construction equipment
Facilities	Air pollution released by industrial facilities
Biogenics and Background	Emissions from vegetation and sources outside the state
Secondary	Pollutants formed due to interactions in the atmosphere between other pollutants
Area	Wide variety of pollutants that don't come from particular sources, including commercial cooking, commercial solvents, residential wood combustion, agricultural activity, and chemical storage/transport
Diesel	All vehicles and equipment that use diesel fuel, separated out of the other categories to emphasize the impact of diesel pollution

The cancer risk from diesel was calculated by multiplying the census block diesel PM10 exposure by CalEPA's estimated diesel cancer risk, 300 cases of cancer per million people per microgram of diesel exhaust particulate in a cubic meter of air exposure over a 70-year lifetime [9]. The total cancer risk from other sources was calculated by adding the total cancer risk for all air toxics sources measured by AirToxScreen except fire-related sources, since a broader measure of wildfire smoke exposure is already used in the Environmental Health Disparities map.

Census block level risks were summarized to census tract level using a population-weighted average.

Caveats

The unit risk estimate used to calculate cancer risk represents the plausible upper limit to cancer risk from each pollutant assuming a 70-year lifetime of exposure, based on the current evidence available. The actual risk from any given pollutant may be lower or higher and may be influenced by interactions with other pollutants. Many of these pollutants also have non-cancer risks that are not accounted for in this analysis.

This measure represents the entire census tract, not individual areas within it. These data should always be supplemented with local data and equitable engagement for more accurate insights.

Sources

1. James, W., Jia, C., Kedia, S. (2012). Uneven Magnitude of Disparities in Cancer Risks from Air Toxics. International Journal of Environmental Research and Public Health, 9(12), 4365-85. https://doi.org/10.3390/ijerph9124365.
2. Morello-Frosch, R., Jesdale, B.M. (2006). Separate and Unequal: Residential Segregation and Estimated Cancer Risks Associated with Ambient Air Toxics in U.S. Metropolitan Areas, Environ Health Perspect, 114, 386–93. doi:10.1289/ehp.8500.

3. Agarwal, N., Banternghansa, C., Bui, L. (2010). Toxic exposure in America: estimating fetal and infant health outcomes from 14 years of TRI reporting. Journal of Health Economics, 29(4), 557-74.

4. Choi, H., Shim, Y., Kaye, W., Ryan, P. (2006). Potential residential exposure to toxics release inventory chemicals during pregnancy and childhood brain cancer. Environmental Health Perspectives, 114(7), 1113-8.

5. Hendryx, M., Luo, J., Chen, B-C. (2014). Total and cardiovascular mortality rates in relation to discharges from toxics release inventory sites in the United States. Environmental Research, 133, 36-41.

6. Szasz, A., Meuser, M. (1997). Environmental inequalities: literature review and proposals for new directions in research and theory. Current Sociology, 45(3), 99-120.
7. Clark, L.P., Millet, D.B., Marshall, J. D. (2014). National Patterns in Environmental Injustice and Inequality: Outdoor NO2 Air Pollution in the United States. PLoS ONE, 9(4): e94431.
8. Kodros, J.K., Bell, M.L., Dominici, F., L'Orange, C., Godri Pollitt, K.J., Weichenthal, S., et al. (2022). Unequal airborne exposure to toxic metals associated with race, ethnicity, and segregation in the USA. Nat Commun, 13, 6329. https://doi.org/10.1038/s41467-022-33372-z.
9. California Environmental Protection Agency. (1998). Proposed Identification of Diesel Exhaust as a Toxic Air Contaminant, Initial Statement for Reasons of Rulemaking, https://ww2.arb.ca.gov/sites/default/files/classic/toxics/dieseltac/staffrpt.pdf.

Wildfire Smoke Exposure

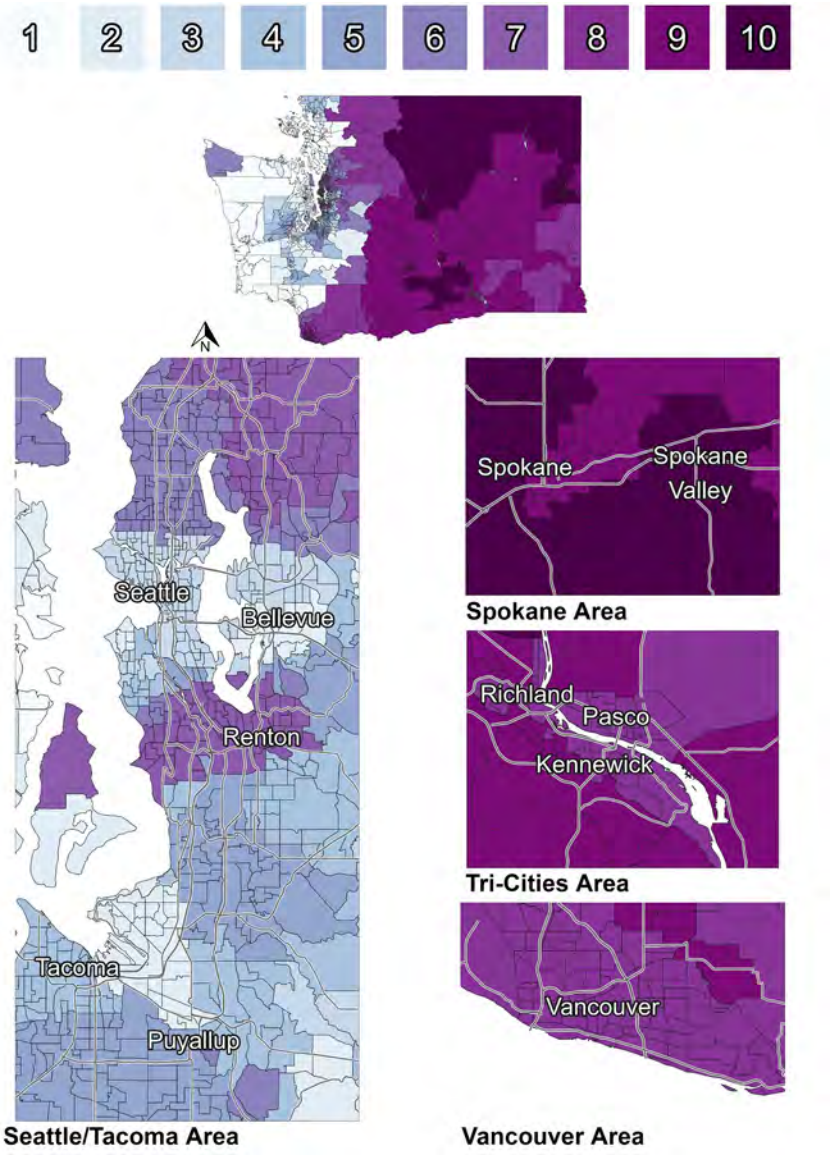
Overview

Wildfire smoke can cause breathing problems and make conditions like asthma or heart disease worse. People in rural or high-fire-risk areas are at higher risk of wildfire smoke exposure because they often live closer to wildfires. This measure looks at how many smoky days there were and how bad the smoke pollution was to create a score of wildfire smoke exposure.

Wildfire Smoke Exposure

This map shows decile rankings for the number of smoky days and severity of smoke pollution, 2017-2023

Ranks range from 1 (least impacted) to 10 (most impacted)



Background

Wildfires are happening more often and with more intensity due to climate change and past forest management practices. Wildfire smoke contributes significantly to fine particulate matter pollution (PM2.5). (Refer to our PM2.5 data note for more information.) PM2.5 is linked to a range of health issues, including lung and heart diseases, and increased rates of premature death. Short-term exposure to wildfire smoke can lead to hospitalizations for asthma and chronic obstructive pulmonary disease (COPD). Long-term exposure can increase the risk of heart disease, stroke, and lung cancer. Wildfire smoke disproportionately affects certain groups, including children and youth, older adults, pregnant people, people with chronic health conditions, people of color and Indigenous people, people with less economic access and/or higher social vulnerability, those with inadequate air filtration, outdoor workers, and unhoused people.

Evidence

In Washington, wildfire smoke is becoming more common and intense. Wildfires cause nearly half of all PM2.5 across parts of the Western U.S. [1]. Wildfire smoke can travel thousands of miles, exposing people in Washington to wildfire smoke from far away fires. Short-term exposure to wildfire smoke increases the risk of new or worsening health conditions [2]. These include lung and heart disease, asthma, and premature death [2]. Longer-term exposure to wildfire smoke may increase the risk of pre-term birth and low birthweight and mental health impacts [3,4]. Wildfire smoke exposure is also linked to higher risk of respiratory illness including influenza and COVID-19 [5].

Between 2011 and 2021, 87% of the U.S. population experienced increases in wildfire smoke exposure [6]. Children born in 2020 will face twice as many wildfires in their lifetime as those born in 1960 [7].

Wildfire smoke exposure affects some groups more than others. Communities facing disadvantages related to race, ethnicity, language, education, and housing are affected the most. As a result, these communities have higher risk of health problems such as lung and heart issues [6].

Non-Hispanic American Indians are disproportionately exposed to wildfire smoke in California [8]. In Washington, people with higher social vulnerability, as shown on the CDC's Social Vulnerability Index, are disproportionately exposed [9].

é communities are often overlooked in wildfire discussions. However, they face added challenges that make them more vulnerable. These include higher levels of air pollution exposure, preexisting health conditions, and outdoor employment. Systemic barriers like limited health insurance, gaps in emergency preparedness, and fears of immigration enforcement can make it harder for them to prepare and recover effectively [10].

Wildfire smoke can travel thousands of miles, depositing particles in ecosystems far from the fire.

It can change the soil and impact water sources like streams and lakes. This can affect drinking water as well as the plants and animals in the ecosystem [11]. Wildfire smoke may also impact biological processes of plants and animals by filtering sunlight.

Data Source
National Oceanic and Atmospheric Administration's (NOAA) Hazard Mapping System (HMS) daily smoke plume product and daily air quality concentration data for June-September, 2017-2023, and include October for 2022, due to major wildfire smoke events that month.

Methods
The wildfire smoke exposure score is based on the PM2.5 concentration on wildfire smoke days from June to September 2017-2023 (plus October, 2022). This score combines both the number of days with smoke and how bad the smoke was. The census tracts that experienced the most smoke have the highest scores.

We marked days as impacted by wildfire smoke based on "heavy" plumes from the NOAA HMS daily smoke plume product. Each impacted census tract was assigned the nearest air quality system monitor. For each smoke-impacted day, affected census tracts were assigned the PM2.5 concentration from the nearest monitor.

We calculated the median background PM2.5 level for each monitor each month to avoid double counting regular PM2.5 pollution. (Regular PM2.5 pollution is already captured in the PM2.5 measure of the EHD map.) We subtracted this median PM2.5 concentration from the PM2.5 concentration on smoky days to get a smoke PM2.5 concentration. The final score adds up the smoke-related PM2.5 levels over all the smoke-impacted days for each census tract, representing the historical smoke impacts across 2017-2023.

Additional Context
NOAA's Office of Satellite and Product Operations provides the daily HMS Fire and Smoke Product. The smoke product is the underlying data used in this map. Trained NOAA analysts create smoke polygons each day based on satellite imagery. The polygons are updated during the day as updated satellite imagery is available during daylight hours. The finalized smoke shapefile product is completed the following morning. Each smoke polygon is categorized as light, medium or heavy based on visual classification and apparent thickness of plumes from satellite imagery.

The PM2.5 data is derived from state and federal monitors, which are a part of the national Air Quality System. Washington State has over 70 federal reference, federal equivalent monitors, and nephelometers that serve as the gold standard for measuring PM2.5 concentration. We use daily PM2.5 concentration as a proxy for the intensity of wildfire smoke in an area, as is done in research settings.
For more information on real-time wildfire smoke impacts in Washington, visit the Washington Smoke Information blog or the EPA Fire and Smoke Map. Historical data from all air monitoring

sites is available from Department of Ecology's AirQualityWA - Site Map.

Caveats

The methods use NOAA's HMS smoke polygons, which are based on satellite imagery. While this provides a broad view of smoke exposure, it may not accurately capture localized variations in wildfire smoke or conditions at the ground level. The smoke polygons are updated based on satellite data available during daylight hours. This could potentially miss or underreport smoke events at night.

This measure represents the entire census tract, not each individual community within the tract. These data should always be supplemented with local data and equitable engagement for more accurate insights.

Sources

1. Burke, M., Driscoll, A., Heft-Neal, S., Xue, J., Burney, J., Wara, M. (2021). The changing risk and burden of wildfire in the United States. PNAS, 118(2).
2. Liu, J.C., Pereira, G., Uhl, S.A., Bravo, M.A., Bell, M.L. (2016). A systematic review of the physical health impacts from non-occupational exposure to wildfire smoke. Environ Res, 136.
3. Foo, D., Stewart, R., Heo, S., Dhamrait, G., Choi, H.M., Song, Y., Bell, M.L. (2024). Wildfire smoke exposure during pregnancy and perinatal, obstetric, and early childhood health outcomes: A systematic review and meta-analysis. Environ Res, 241.
4. Mirabelli, M.C., Vaidyanathan, A., Pennington, A.F., Ye, D., Trenga, C.A.. (2022). Wildfire smoke and symptoms affecting mental health among adults in the U.S. state of Oregon. Prev Med, 164, 107333. 10.1016/j.ypmed.2022.107333
5. Landguth, E.L., Holden, Z.A., Graham, J., Stark, B., Mokhtari, E.B., Kaleczyc, E., et al. (2020). The delayed effect of wildfire season particulate matter on subsequent influenza season in a mountain west region of the USA. Environ Int, 139.
6. Vargo, J., Lappe, B., Mirabelli, M.C., Conlon, K.C. (2023). Social vulnerability in US communities affected by wildfire smoke, 2011 to 2021. Am J Public Health, 113(7), 759–67.
7. Casey, J., Morello-Frosch, R. (2024). How researchers measure wildfire smoke exposure doesn't capture long-term health effects—and hides racial disparities. PreventionWeb.
8. Casey, J., Kioumourtzoglou, M-A., Padula, A., González, D.J.X., Elser, H., Aguilera, R., et al. (2024). Measuring long-term exposure to wildfire $PM_{2.5}$ in California: Time-varying inequities in environmental burden. PNAS, 121(8). https://doi.org/10.1073/pnas.2306729121
9. Rad, A.M., Abatzoglou, J.T., Fleishman, E., Mockrin, M.H., Radeloff, V.C., Pourmohamad, Y., et al. (2023). Social vulnerability of the people exposed to wildfires in U.S. West Coast states. Science Advances, 9(38). DOI: 10.1126/sciadv.adh4615
10. UCLA Latino Policy & Politics Institute. (2025). Wildfires and Latino communities: Health, economic, and preparedness challenges. UCLA Latino Policy & Politics Institute.
11. Farruggia, M.J., Brahney, J., Tanentzap, A.J., Brentrup, J.A., Brighenti, L.S., Chandra, S., et al. (2024). Wildfire smoke impacts lake ecosystems. Global Change Biology. https://doi.org/10.1111/gcb.17367

Pollution Burden – Environmental Effects Theme

This theme looks at potential sources of pollution that cause negative health conditions. This pollution can harm the environment and wildlife living there, use up resources, and cause health issues for people living or working nearby. Environmental effects can be immediate or have a delayed impact. It can also affect the well-being and access of nearby communities.

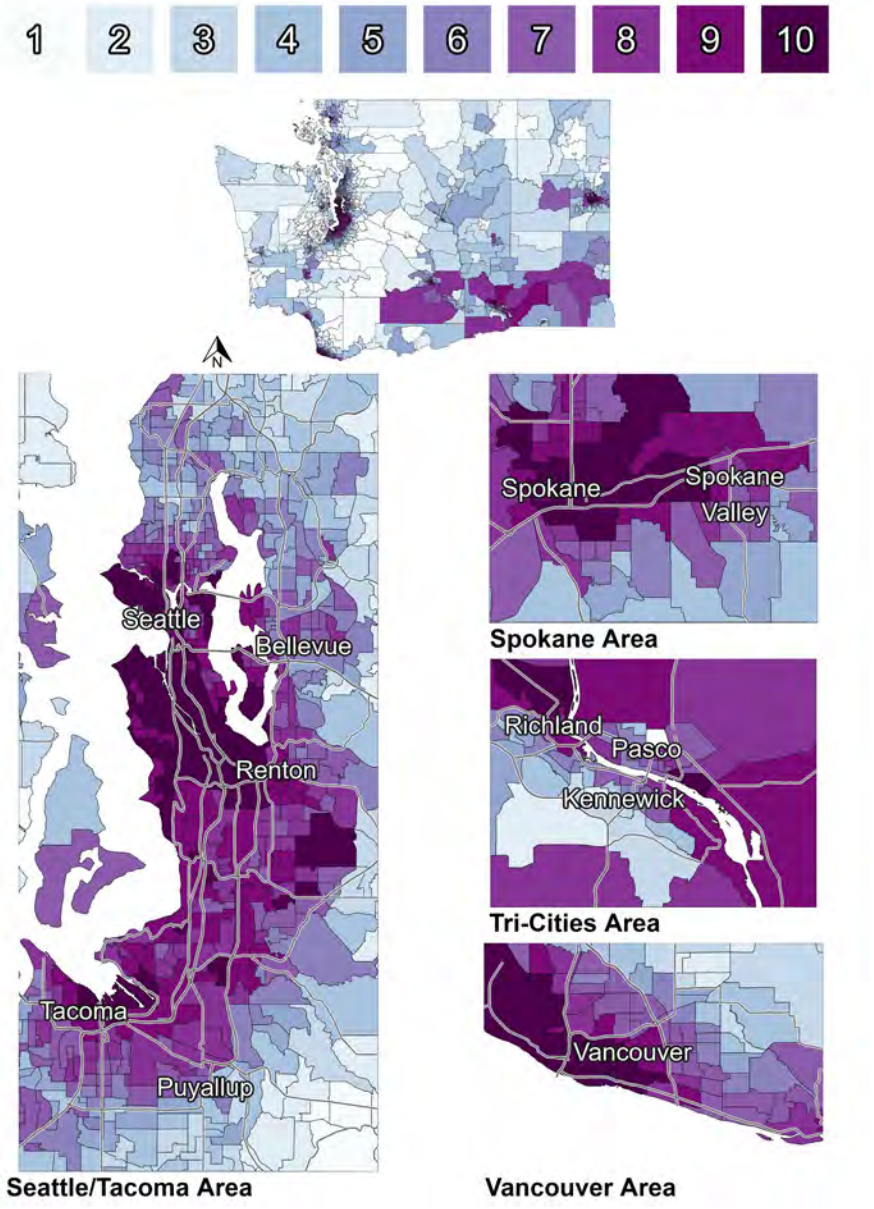
Environmental effect measures include:

- Lead risk from housing
- Proximity to hazardous waste sites
- Proximity to Superfund sites
- Proximity to risk management plan sites with highly toxic substances
- Wastewater discharge
- Water quality

Environmental Effects Theme

This map shows decile rankings for the combination of all measures in the Environmental Effects theme

Ranks range from 1 (least impacted) to 10 (most impacted)



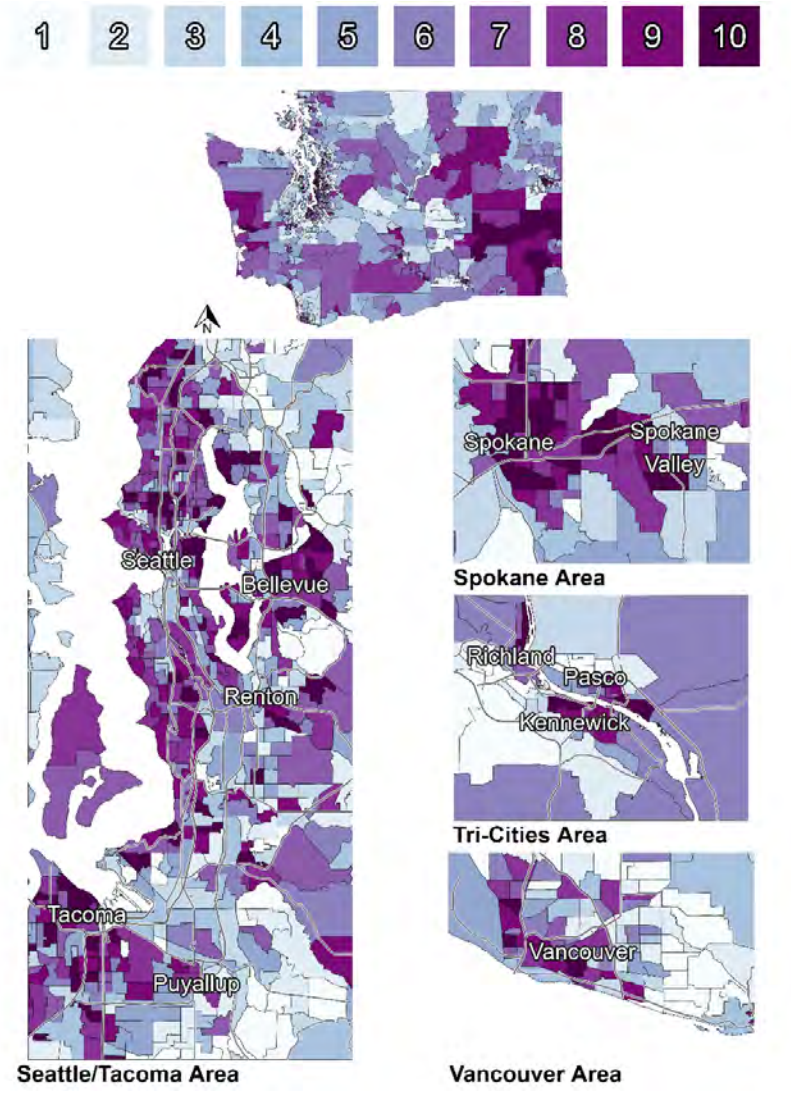
Lead Risk from Housing

Overview

Any level of lead exposure is dangerous, especially for children. Lead exposure risk is unequal due to systemic inequities in housing and environmental conditions. Identifying areas with higher exposure risk is a step toward addressing these disparities. This measure gives an estimated percentage of homes that are likely to have lead paint. This is based on the year the homes were built.

Lead Risk from Housing

This map shows decile rankings for the percent of houses likely to have lead paint, 2019-2023
Ranks range from 1 (least impacted) to 10 (most impacted)



Background

Lead poisoning is a serious but preventable public health issue. There are no safe levels of lead exposure. Even small amounts can lead to significant health implications. Exposure to lead can increase risk for chronic health conditions, neurological defects, and nervous system damage. Children six years old and younger are the most affected by lead exposure. Their growing bodies absorb more lead than adults do, and their brains and nervous systems are more sensitive to its damaging effects. Much of the lead found in human environments is due to the use of lead in products such as water pipes and house paint. Paint typically contained high levels of lead before 1980. Therefore, home age is a marker of the presence of lead paint. In the early 1970s the paint industry issued voluntary standards limiting lead content in paint, and in 1978 lead was banned from use in the manufacture of residential paint.

Structural racism and historical discriminatory policies, such as redlining, have contributed to disparities in lead exposure. Non-Hispanic Black children consistently have higher median blood lead levels compared to non-Hispanic white children. Areas with high lead exposure also experience more racial segregation and lower academic test scores. These lower test scores serve as a health measure, reflecting the neurological impact of lead exposure.

People with fewer financial resources are more likely to live in older homes where lead paint is deteriorating, increasing their lead exposure. While full removal of lead paint may not always be possible, strategies like maintaining cracking paint and washing children's toys or bottles can reduce the risks. Testing children for lead poisoning is important when there is a potential risk of lead exposure.

Evidence

Lead exposure can cause learning disabilities, behavior problems, stunted physical growth, and delayed mental development [1] Racial segregation caused by discriminatory housing policies causes disparities in lead exposure. Non-Hispanic Black children are more likely to be exposed to lead than non-Hispanic white children [2].

Lead paint in older homes can raise indoor lead levels. In combination with poor housing conditions, this can increase the risk of lead exposure [3, 4].

Data Source

American Community Survey 5-year estimates 2018-2022, B25034 - Selected Housing Estimates

American Housing Survey II - presence of lead in housing based on era of construction [5].

Methods

The U.S. Census's American Community Survey (ACS) 5-year roll-up provides the total number of houses in each census tract and the proportion of houses by year of construction. We adjust each era of construction based on the proportionate risk for that era. The adjustment factors come from the American Housing Survey II. The adjustments are for housing built:

- Before 1940 = 0.619.
- 1940-1959= 0.309.
- 1960-1977= 0.075.

Caveats

This measure models potential lead exposure based on the age of housing. The age of a building by itself does not reflect the actual exposure to lead. Some older homes have had lead paint removed through a process called *remediation*.

Additionally, the age of housing is an individual-level risk factor. This measure represents the whole census tract, which is not the actual risk for a specific house or community within the tract. Not all houses within a census tract were built at the same time, so not all homes within a census tract actually have the same risk. To find the risk for their home, people should consider checking its specific age and lead status. Conditions can vary widely.

For a map of lead exposure risk in WA state incorporating both housing and poverty factors, you can visit the Lead Exposure Risk Index on our Information by Location tool.

Sources

1. American Academy of Pediatrics. (n.d.). Lead Exposure in Children. Retrieved from https://www.aap.org/en/patient-care/lead-exposure/lead-exposure-in-children/
2. Bravo, M.A., Zephyr, D., Kowal, D., Ensor, K., Miranda, M.L. (2022). Racial residential segregation shapes the relationship between early childhood lead exposure and fourth-grade standardized test scores. Proc Natl Acad Sci. 119(34):e2117868119.
3. Jacobs, D.E., Nevin, R., Eaton, D. (2009). The relationship of housing and population health: A 30-year retrospective analysis. Environmental Health Perspectives, 117(4), 597–604.
4. Roberts, J.R., Hulsey, T.C., Curtis, G.B., Reigart, J.R. (2003). Using geographic information systems to assess risk for elevated blood lead levels in children. Public Health Reports, 118(3), 221–9.
5. U.S. Department of Housing and Urban Development, Office of Lead Hazard Control and Healthy Homes. American Healthy Homes Survey II: Lead Findings Report. October 29, 2021. https://archives.huduser.gov/portal/pdredge/pdr-edge-trending-030822.html.

Proximity to Hazardous Waste Sites

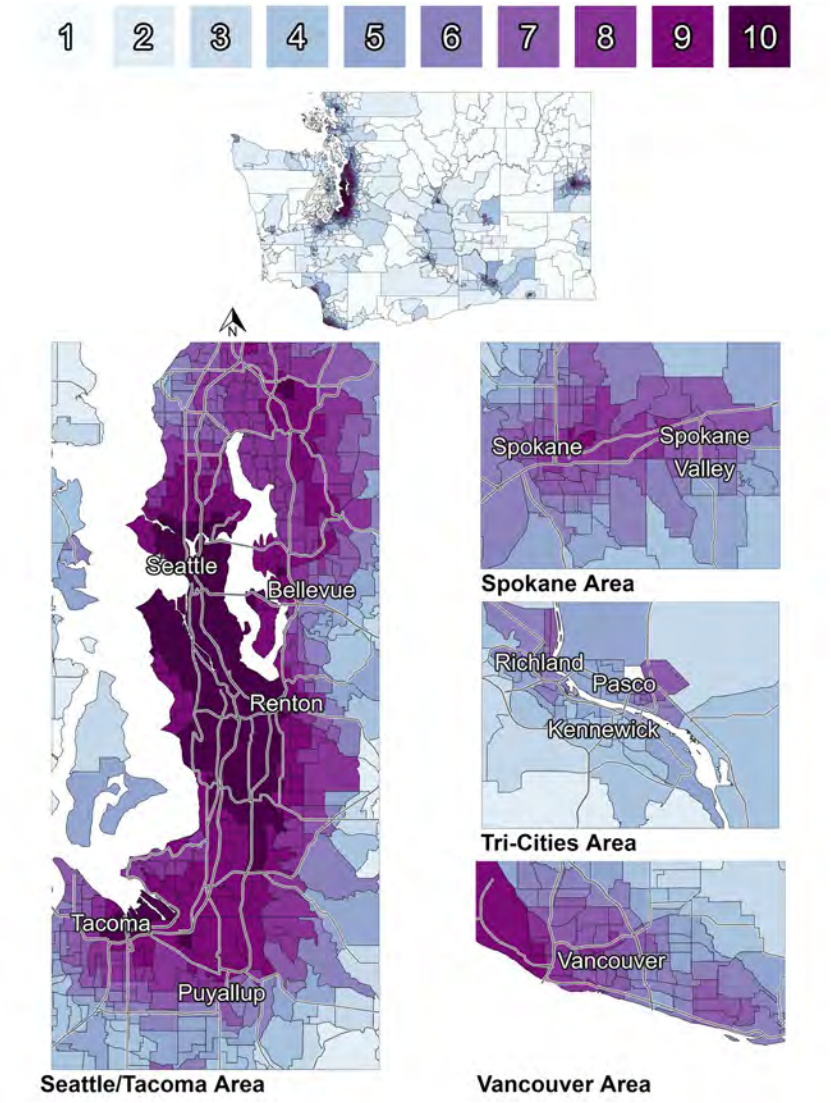
Overview

Hazardous waste sites can release toxic substances that are harmful to people and the environment. Marginalized communities and those with fewer financial resources are often located closer to these sites. This puts them at greater risk. This measure shows how close hazardous waste sites are by averaging the distance to nearby sites. The closer the community is to these waste sites, the higher the score it receives.

Proximity to Hazardous Waste Sites

This map shows decile rankings for the number of hazardous waste sites, adjusted by distance, 2022-2023

Ranks range from 1 (least impacted) to 10 (most impacted)



Background

Hazardous waste can be dangerous to health and the environment. It is mainly created through industrial processes and can be in the form of liquids, solids, gases, or sludges. Living near hazardous waste sites can lead to serious health problems. Black and Latiné communities, as well as those with fewer financial resources, are disproportionately affected. These communities are often located in areas with weaker environmental rules and less infrastructure investment, because of where housing is affordable. As a result, they face a double burden of exposure to dangerous chemicals as well as existing social and economic inequities.

If hazardous waste is not properly managed or disposed of, it can pollute nearby air, water, and soil. It can also contaminate essential resources, like drinking water or farmland. Contaminated food and water increase the risk of long-term exposure to toxic substances.

Living near these sites can lower property values, cause persistent mental distress, reduce lifespans and diminish overall quality of life. The health impacts can lead to increase medical costs, which can have an impact on family finances. This can make it harder for people to improve their living situations.

Evidence

Hazardous waste sites increase risks for nearby communities by producing toxic compounds that harm human health [1, 2]. People living near these sites are more likely to experience health issues. These include diabetes, heart disease, and lung problems [3, 4]. Hazardous waste sites are often located close to Black and Latiné communities and communities with less economic access due to discriminatory zoning [5, 6]. People in historically marginalized communities near hazardous waste sites also tend to not have adequate health care access [7]. Hazardous waste sites lower property values and diminish overall quality of life for people who live near them [1, 2].

Data Source

WA Department of Ecology Hazardous Waste Sites Database, 2022-2023

Methods

This measure estimates how close hazardous waste sites are to people living across Washington by calculating the distance between the sites and residents of various census tracts. First, all hazardous waste sites within 10 kilometers of each census block group were identified. Then, the individual blocks within each block group were evaluated, with each block receiving a score based on how close it was to nearby waste sites. The block scores were calculated using the sum of the inverse distances between the block's center and the location of nearby sites—so the closer a facility was to a block, the higher its contribution to the overall score. Blocks with no sites within 10 km of their block group received a score of zero. Finally, a population-weighted average was used to score census tracts based on their contained blocks.

Caveats

This method assumes the population-weighted centroid represents the entire area. This isn't always true. In large or oddly shaped tracts, most people may live far from the centroid. This could make the proximity score less accurate.

This method only measures straight-line distance from the centroid to the site. It does not consider important factors that can affect how pollutants spread, such as wind patterns, terrain, or transportation routes. As a result, the real exposure risks might not be fully representative.

This measure represents the entire census tract and does not represent each individual community within the tract. These data should always be supplemented with local data and equitable engagement for more accurate insights.

Sources

1. McGlinn, L. (2000). Spatial patterns of hazardous waste generation and management in the United States. The Professional Geographer, 52(1), 11-22.
2. Fazzo, L., Minichilli, F., Santoro, M., Ceccarini, A., Della Seta, M., Bianchi, F., et al. (2017). Hazardous waste and health impact: A systematic review of the scientific literature. Environmental Health: A Global Access Science Source, 16(1), 1-11.
3. Kouznetsova, M., Huang, X., Ma, J., Lessner, L., Carpenter, D. (2007). Increased rate of hospitalization for diabetes and residential proximity of hazardous waste sites. Environmental Health Perspectives, 115(1), 75-9.
4. Sergeev, A., Carpenter, D. (2005). Hospitalization rates for coronary heart disease in relation to residence near areas contaminated with persistent organic pollutants and other pollutants. Environmental Health Perspectives, 113(6), 756-61.
5. Aliyu, A., Kasim, R., Martin, D. (2011). Siting of hazardous waste dump sites and their correlation with the status of surrounding residential neighbourhoods in Los Angeles County. Property Management, 29(1), 87-102.
6. Boer, J., Pastor, M., Sadd, J., Snyder, L. (1996). Is there environmental racism? The demographics of hazardous waste in Los Angeles County. Abstracts with Programs - Geological Society of America, 28(7), 167.
7. Soliman, M.R., Derosa, C.T., Mielke, H.W., Bota, K. (1993). Hazardous wastes, hazardous materials and environmental health inequity. Toxicology and industrial health, 9(5), 901–12.

Proximity to Risk Management Plan Sites

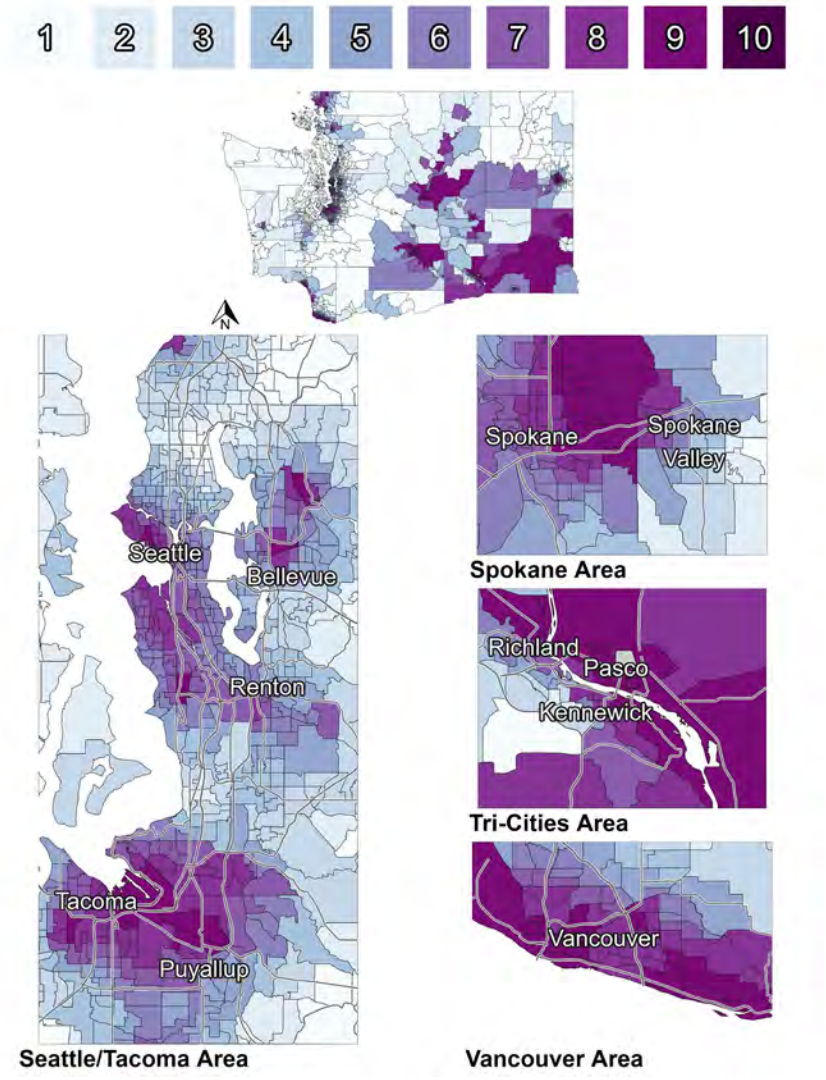
Overview

The dangerous chemicals used by Risk Management Plan sites could harm people living nearby. This is particularly true if an accident happens. These sites are often closer to underserved communities and those with less economic access, putting them at greater risk. This measure shows the number of Risk Management Plan sites within 10 km of a census tract. It considers both the distance and population.

Proximity to Risk Management Plan Sites

This map shows decile rankings for the number of risk management plan sites, adjusted by distance, 2024

Ranks range from 1 (least impacted) to 10 (most impacted)



Background

Many industrial sites use dangerous chemicals. When these chemicals get into the air or water, they can harm people's health. Workers and nearby residents face more exposure because of how close they are. Exposure may happen through accidents or unsafe handling of these substances. To reduce this risk, the chemicals need to be carefully managed. Reducing exposure to these substances is essential for preventing accidents and protecting health.

People living near sites that release toxic chemicals have a higher risk of health impacts. Communities with less financial means and historically minoritized communities are more likely to live near these sites due to redlining and environmental racism. This increases their risk of developing conditions such as heart disease, cancer, and in utero complications. People in these groups often also have less medical access. This can increase health risks because people may not be able to get timely care.

The Clean Air Act works to address these risks. It requires sites that use or store hazardous chemicals to create and update a Risk Management Plan every five years. These plans are crucial for ensuring proper safety measures are in place to prevent accidents. The plans also help first responders prepare for emergencies involving the chemicals.

Evidence

The EPA requires sites that handle highly toxic, flammable, or explosive substances to develop a Risk Management Plan. These plans are designed to mitigate potential hazards [1]. When an accident happens, surrounding communities can face elevated exposure to hazardous chemicals. This was seen during Hurricane Harvey. Several sites were damaged, resulting in health issues for nearby residents [2, 3]. Exposure to these chemicals is linked to a range of negative health outcomes, including reproductive and neurodevelopmental disorders, cognitive impairments, and adverse pregnancy outcomes such as preterm birth and fetal death [4].

Communities of color are more likely to live near risk management plan sites due to redlining, environmental racism, and zoning. This increases their exposure to environmental hazards such as poor air quality. As a result, historically minoritized communities face higher risk for health problems [5, 6]. These communities already face disproportionate exposure to pollution and its related health effects. An accidental release from an risk management plan site could further increase these impacts.

Data Source

EJSCREEN 2024 Proximity to Risk Management Plan estimates

Methods

This measure shows the number of risk management plan sites within 10 km of a census tract, weighted by distance and population. We downloaded the data from EJSCREEN at the census tract level. We used the EJSCREEN data as published, without any further calculations. For more

information about their methodology, please visit EJScreen Technical Documentation for Version 2.3.

Caveats

This measure was developed using nationwide databases. It may not reflect the risk of living or spending significant time near all risk management plan sites in Washington.

Census tracts are assigned "zero" scores if they are farther than 10 km from any risk management plan sites.

This measure represents the entire census tract and does not represent each individual community within the tract. These data should always be supplemented with local data and equitable engagement for more accurate insights.

Sources

1. Kleindorfer, P., Belke, J., Elliott, M., Lee, K., Lowe, R., & Feldman, H. (2003). Accident epidemiology and the U.S. chemical industry: Accident History and Worst-Case Data from RMP*Info. Risk Analysis, 23(5), 865-81.
2. Elliott, M., Wang, Y., Lowe, R., & Kleindorfer, P. (2004). Environmental justice: frequency and severity of US chemical industry accidents and the socioeconomic status of surrounding communities. Journal of Epidemiology and Community Health, 58(1), 24-30.
3. Han, I., Whitworth, K.W., Christensen, B., Afshar, M., Han, H.A., Rammah, A., et al. (2022). Heavy metal pollution of soils and risk assessment in Houston, Texas following Hurricane Harvey. Environmental Pollution, 296, 118717.
4. Kuehn, C.M., Mueller, B.A., Checkoway, H., Williams, M. (2007). Risk of malformations associated with residential proximity to hazardous waste sites in Washington State. Environmental research, 103(3), 405-12.
5. Nardone, A., Chiang, J., Corburn, J. (2020). Historic redlining and urban health today in US cities. Environmental Justice, 13(4), 109-19.
6. Taylor, D.E. (2014). Toxic Communities: Environmental Racism, Industrial Pollution, and Residential Mobility. NYU Press. http://www.jstor.org/stable/j.ctt9qg1v9

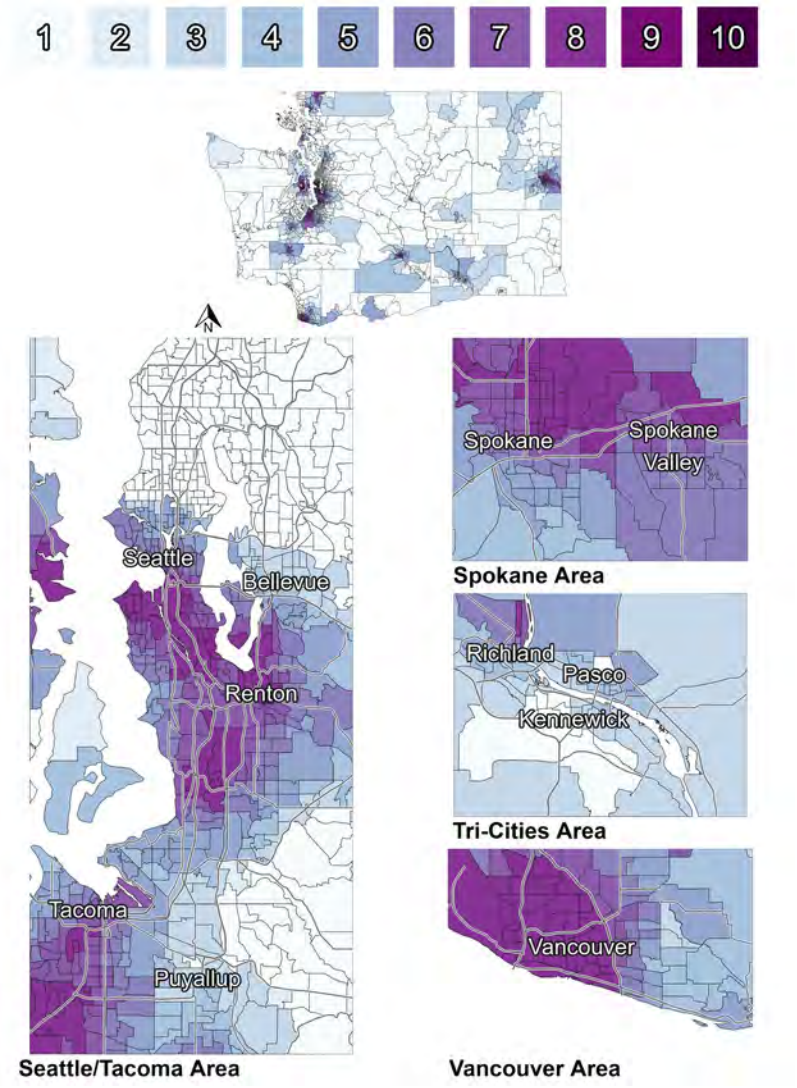
Proximity to Superfund Sites

Overview

Superfund sites may contain harmful chemicals that pose health and environmental risks. These sites are more likely to be near historically minoritized communities and communities with less economic access. This creates unjust exposure risk. This measure shows how close Superfund sites are by averaging the distance between communities and nearby sites. The closer the community is to these waste sites, the higher the score it receives.

Proximity to Superfund Sites

This map shows decile rankings for the number of superfund sites, adjusted by distance, 2024
Ranks range from 1 (least impacted) to 10 (most impacted)



Background

Superfund sites are areas where significant amounts of hazardous waste have been released. This is often a result of past industrial activities, such as manufacturing or mining. The chemicals from these sites can contaminate the soil, water, and air. This leads to significant environmental and public health risks. Sites that handle highly toxic substances are required by the EPA to follow Risk Management Plans with the EPA to prevent accidents. But, when contamination does happen, cleaning up these sites is slow, and the risks can last a long time. People who live near Superfund sites are frequently exposed to higher levels of harmful chemicals. New sites are often placed in communities with more people of color and Indigenous people, perpetuating environmental racism.

About 21 million Americans live within one mile of a Superfund site. Living near these sites increases the risk of health problems due to exposure to toxic chemicals. The health risks from Superfund sites are often made worse by socioeconomic challenges. Many Superfund sites are located in communities of color, communities with less economic access, or linguistically isolated communities. People living next to Superfund sites are more likely to be from historically minoritized groups, with race being a stronger predictor than income or homeownership. People without a high school education are also more likely to live near Superfund sites.

Evidence

Living near Superfund sites increases the risk of being exposed to dangerous chemicals in the soil, water, or air [1]. It is linked to health issues such as low birth weight, lung disease, cancer, and neurological damage [2, 3].

Superfund sites are often located near historically minoritized communities and those with less economic access that are already facing environmental burdens [4]. Studies suggest these communities are also more likely to be chosen for new Superfund sites. Therefore, extra care should be taken in deciding where to build federally funded housing projects [5, 6]. Indigenous people are more likely to live near toxic waste sites [7].

Gerrymandering is the practice of changing political boundaries for political gain. Gerrymandering has been found to help reduce pollution in certain areas but can also lead to fewer Black people living there [8].

Black women living near Superfund sites have been found to have higher levels of certain metals in their bodies than their white counterparts. This suggests higher exposure due to residential segregation and environmental disparities [9]. People who live closer to a Superfund site were also found to have higher levels of pesticides in their blood. This supports the theory that communities living near Superfund sites face a combination of environmental stressors [10].

Data Source

WA Department of Ecology Superfund Sites, 2024

Method

This measure estimates how close Superfund sites are to people living across Washington by calculating the distance between the sites and residents of various census tracts. First, all Superfund sites within 10 kilometers of each census block group were identified. Then, the individual blocks within each block group were evaluated, with each block receiving a score based on how close it was to nearby waste sites. The block scores were calculated using the sum of the inverse distances between the block's center and the location of nearby sites—so the closer a facility was to a block, the higher its contribution to the overall score. Blocks with no sites within 10 km of their block group received a score of zero. Finally, a population-weighted average was used to score census tracts based on their contained blocks.

Caveats

This method assumes the population-weighted centroid represents the entire area. This isn't always true. In large or oddly shaped tracts, most people may live far from the centroid. This could make the proximity score less accurate.

This method only measures straight-line distance from the centroid to the site. It does not include factors like wind patters, terrain, or transportation routes, which can affect how pollutants spread. As a result, the real exposure risks might not be fully reflected.

This measure represents the entire census tract and does not represent each individual community within the tract. These data should always be supplemented with local data and equitable engagement for more accurate insights.

Sources

1. Zota, A.R., Schaider, L.A., Ettinger, A.S., Wright, R.O., Shine, J.P., Spengler, J.D. (2011). Metal sources and exposures in the homes of young children living near a mining-impacted Superfund site. Journal of Exposure Science & Environmental Epidemiology, 21(5), 495–505.
2. Ala, A., Stanca, C. M., Bu-Ghanim, M., Ahmado, I., Branch, A. D., Schiano, T. D., & Odin, J. A. (2006). Increased prevalence of primary biliary cirrhosis near Superfund toxic waste sites. *Hepatology, 43*(3), 525–531.
3. Baibergenova, A., Kudyakov, R., Zdeb, M., & Carpenter, D.O. (2003). Low birth weight and residential proximity to PCB-contaminated waste sites. Environmental Health Perspectives, 111(10), 1352–57.
4. Kearney, G.D., Kiros, G.E. (2009). A spatial evaluation of socio demographics surrounding National Priorities List sites in Florida using a distance-based approach. International Journal of Health Geographics, 8, Article 33.
5. Mohai, P., Saha, R. (2015). Which came first, people or pollution? Assessing the disparate siting and post-siting demographic change hypotheses of environmental injustice. Environmental Research Letters, 10(11), 115008.
6. UAB Human Rights. (2021). People of color live disproportionately close to Superfund sites. University of Alabama at Birmingham. https://sites.uab.edu/humanrights/2021/01/15/people-of-color-live-disproportionately-close-to-superfund-sites/

7. Chong, K., Basu, N. (2024). Contaminated sites and Indigenous peoples in Canada and the United States: A scoping review. Integrated Environmental Assessment and Management, 20(5), 1306–29.
8. Kramar, D.E., Anderson, A., Hilfer, H., Branden, K., Gutrich, J. J. (2018). A spatially informed analysis of environmental justice: analyzing the effects of gerrymandering and the proximity of minority populations to US Superfund sites. Environmental Justice, 11(1), 29–39.
9. Christensen, K. (2023). The price of proximity: Black women disproportionately exposed to Superfund metals. Environmental Health Perspectives, 131(8), Article 084001.
10. Gaffney, S.H., Curriero, F.C., Strickland, P.T., Glass, G.E., Helzlsouer, K.J., Breysse, P.N. (2005). Influence of geographic location in modeling blood pesticide levels in a community surrounding a U.S. Environmental Protection Agency Superfund site. Environmental Health Perspectives, 113(12), 1712–16.

Wastewater Discharge

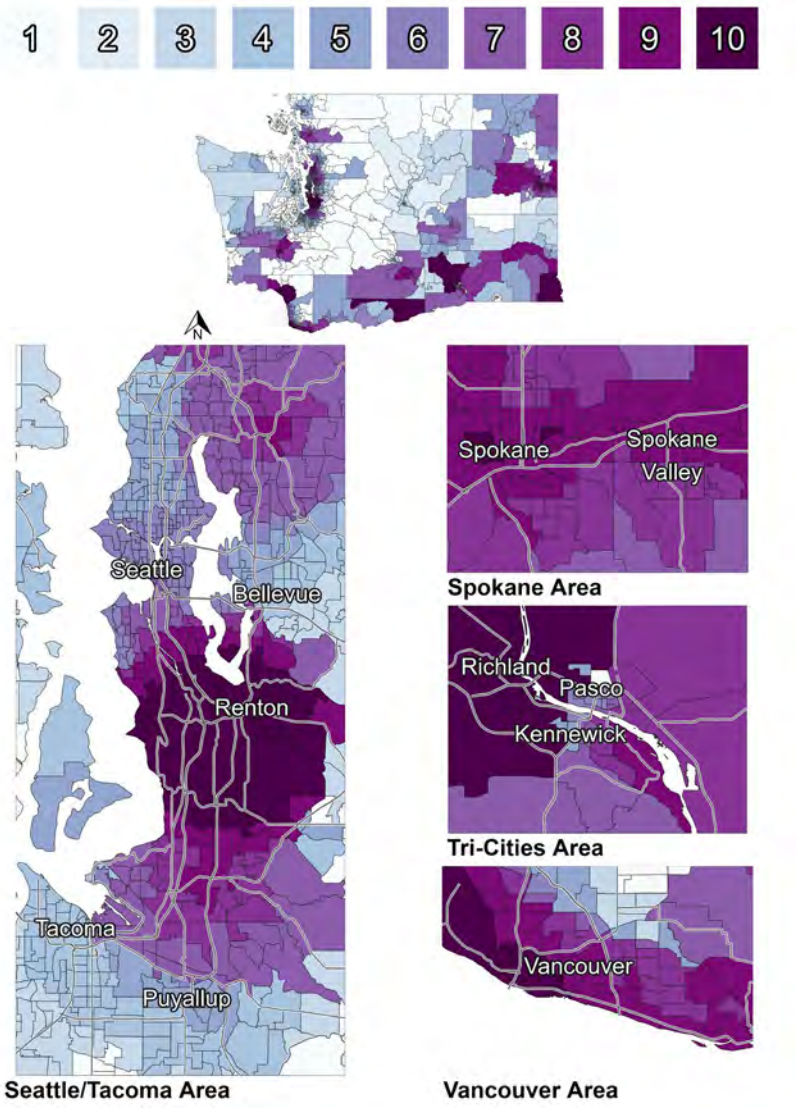
Overview

Wastewater discharges have the potential to cause ground and surface water pollution if not properly controlled. This pollution can cause health issues for nearby communities. Tribal Nations and communities that rely on fish and shellfish as major food sources have the greatest risk of exposure from wastewater pollution. This measure estimates the risk of exposure to chemicals due to sites releasing wastewater.

Wastewater Discharge

This map shows decile rankings for the toxicity-weighted concentration of chemicals from long-term wastewater exposure, 2024

Ranks range from 1 (least impacted) to 10 (most impacted)



Background

Wastewater is used water from households, businesses, and industries. It can contain contaminants that can be harmful to human health if not treated. Under the federal Clean Water Act (1948) and the Washington State Water Pollution Control Act (1945), facilities must treat wastewater to meet legal quality and safety standards before releasing it to surface water or groundwater. These facilities include industrial dischargers and wastewater treatment plants.

Water quality permits direct facilities to:

- reduce contaminant levels through prevention and treatment,
- comply with pollutant limits and permit conditions, and
- conduct regular monitoring and reporting of wastewater discharges.

These permits ensure the safe release of wastewater from these facilities into Washington's ground and surface waters, like the Spokane River and Puget Sound. The permitted discharge amounts account for higher fish and shellfish consumption rates in the calculations.

Heavy rain, aging infrastructure, and damaged or mismanaged systems can cause unpermitted spills. These releases may contaminate nearby water sources, harm aquatic ecosystems, and affect human health. Consuming untreated water, eating food grown with it, or eating fish with accumulated pollutants in their tissues can all pose public health risks.

Untreated wastewater may contain harmful substances such as bacteria, viruses, and chemicals that can cause illnesses. This ranges from gastrointestinal issues to life-threatening diseases like dysentery and cholera.

Tribes and community organizations across Washington are leading efforts to reduce wastewater pollution through clean-up and restoration projects. They also advocate for communities experiencing higher wastewater pollution.

Tribal populations and communities that consume more fish and shellfish may have a higher risk of some cancers and other health impacts from contaminated fish. Tribal fish commissions and organizations are longstanding advocates for addressing these environmental health concerns.

Drinking water systems may draw from state waterways. These systems treat water for safety in accordance with drinking water standards before the water is transported to people for consumption. Pollutants and pathogens from untreated wastewater spills can create challenges and increase the cost for drinking water treatment. Drinking water treatment failures and difficult-to-remove pollutants can ultimately lead to contamination of drinking water. Exposure to these pollutants can cause health issues. These include high blood pressure, cancer, and waterborne infections. People with fewer financial resources are often unable to afford health insurance or medical care. As a result, their health is more impacted by exposure to wastewater pollution.

Finally, these contaminants also have a strong impact on wildlife, shellfish, and fish populations. Chinook salmon, a culturally important species, experiences decreased growth rates and long-term reproduction impacts when exposed to untreated wastewater. Factors, such as warm waters,

the presence of dams, untreated storm water, and other factors impacting waterways, increase environmental stressors.

Evidence

People may be exposed to chemicals released into water in a variety of ways. The RSEI model focuses on potential chemical exposure in 2 ways:

1. from drinking contaminated tap water from a public water system whose drinking water intake was located in the path of a chemical release, or
2. from eating contaminated fish caught in a water body in the path of a chemical release.

Exposure to contaminated water can lead to serious health outcomes in humans. Chemicals used for wood preservation can increase high blood pressure [1]. Nitrates from fertilizer runoff can increase the risk of cancer, thyroid disease, and birth defects [2].

Impaired (polluted) source water, such as rivers, lakes, or aquifers, can also affect drinking water safety if not properly treated by the community water system. Poor source water quality also makes treatment more expensive and complex [3]. Untreated wastewater is one source of pollution that leads to contamination in fish. Eating contaminated fish or eating less traditional foods due to contamination can contribute to higher risks of diabetes, heart disease, and other health issues. This measure also may underestimate the risk to Tribal communities. Internal surveys have estimated that many Tribal members eat 10 to 100 times more fish than the EPA's average estimate [4].

Ultimately, unpermitted wastewater spills can enter the drinking water system through infrastructure damage and underinvestment. This is often connected to systemic racism. Across the United States, small community water systems that serve low-income and historically minoritized communities are the most likely to have health-based violations of drinking water standards due to a lack of staffing and resources [5].

Water systems serving Tribal populations are also more likely to be underfunded. This leads to a greater risk of exposure to pollution in drinking water [6]. These disparities come from racist housing and development policies. This causes communities with the highest pollution burden to have the least funding to support drinking water infrastructure [7].

Untreated wastewater can carry pathogens and pollutants that may impact the endocrine system, brain function, stress levels, and metabolism of Chinook salmon [8].

Data Source

Risk-Screening Environmental Indicators (RSEI) 2024 wastewater discharge estimates

Methods

This measure quantifies the impact of certain chemicals in wastewater discharge. It considers the risk of each chemical to human health and the concentration that humans could be exposed to. It was taken directly from EJSCREEN's 2024 wastewater discharge measure.

First, the measure calculates the toxicity-weighted concentration in each stream segment. This is the sum of each monitored chemical's concentration multiplied by its toxicity. The toxicity of each chemical is based on the chronic human health impacts it causes.

The chemicals and toxicities included in this analysis made available through section 313 of the Emergency Planning and Community Right-to-Know Act (EPCRA) in 1986. An estimated dose is calculated for each stream segment. This models how humans could be exposed to pollutants through drinking water or eating contaminated fish.

This was multiplied by the inverse distance to the center of the census block. The measure uses a maximum score of 10 for all distances under 0.1 km. This was then multiplied by the census block's population. Census blocks were added together for a census tract score.

Chemical data comes from Discharge Monitoring Reports and Toxic Release Measure data from sites that discharge wastewater. In Washington, many of these sites are:

- Municipal wastewater (sewage) treatment plants
- Stormwater treatment sites
- Industrial sites
- Fish hatcheries
- Super Fund sites
- Hydroelectric sites

For more information on the permit process and requirements, please refer to EPA's list of National Pollutant Discharge Elimination System permits.

For more information on how this measure was calculated, refer to RSEI's methodology.

Caveats

This measure does not include risk data for all contaminants. This measure includes only chemicals listed in the Toxics Release Inventory from section 313 of the EPCRA.

This measure uses wastewater discharge from sites required to report to national databases. This measure does not include water pollution from:

- Privately owned on-site septic systems
- Runoff from roads, agriculture, and industrial sites that directly enter streams and lakes

Therefore, this measure does not indicate risk of exposure from other sources of pollution in water.

The Risk-Screening Environmental Indicators (RSEI) model uses multiple assumptions to estimate the risk of exposure to chemicals in water bodies. The model uses the number of fishing licenses in an area to estimate the number of people exposed to wastewater discharge by eating fish. They assume that 5% of all families with a fishing license consume fish at a higher "subsistence fishing" level [4].

The methodology uses where people live, not where they fish.

This measure is aggregated or compiled across the census tract. It does not represent each community within the tract. These data should always be supplemented with local data and equitable engagement for more accurate insights.

This measure does not reflect the quality or safety of public drinking water supplies.

Sources

1. Karouna-Renier, N., Rao, K., Lanza, J., Davis, D., Wilson, P. (2007). Serum profiles of PCDDs and PCDFs, in individuals near the Escambia Wood Treating Company Superfund site in Pensacola, FL. Chemosphere, 69(8), 1312-9.
2. Ward, M.H., Jones, R.R., Brender, J.D., de Kok, T.M., Weyer, P.J., Nolan, B.T., et al. (2018). Drinking Water Nitrate and Human Health: An Updated Review. International Journal of Environmental Research and Public Health, 15(7):1557.
3. Price, J.I, Herberling, M.T. (2018). The Effects of Source Water Quality on Drinking Water Treatment Costs: A Review and Synthesis of Empirical Literature. Ecological Economics, 151, 195-209
4. O'Neill, C. (2007) Protecting the Tribal Harvest: The Right to Catch and Consume Fish, 22 J. ENVTL. L. & LITIG. 131. https://digitalcommons.law.seattleu.edu/faculty/542.
5. Fedinick, K., Taylor, S., Roberts, M., Moore, R., Olson, E. (2019). Watered down justice. Washington DC: Natural Resource Defense Council Report.
6. Levin, R., Villanueva, C.M., Beene, D., Cradock, A.L., Donat-Vargas, C., Lewis, J., et al. (2024). US drinking water quality: exposure risk profiles for seven legacy and emerging contaminants. J Expo Sci Environ Epidemiol, 34, 3–22. https://doi.org/10.1038/s41370-023-00597-z
7. Wakhungu, M., Abdel-Mottaleb, N., Wells, E., Zhang, Q. (2021). Geospatial Vulnerability Framework for Identifying Water Infrastructure Inequalities. Journal of Environmental Engineering, 147(9).
8. Ball, S.C., Meador, J.P., James, C. A., McIntyre, J. K., (2024): Exposure of juvenile Chinook salmon to effluent from a large urban wastewater treatment plant. Part 1. physiological responses. Aquaculture and Fisheries, 9(3), 355-66. https://doi.org/10.1016/j.aaf.2023.06.0

Water Quality

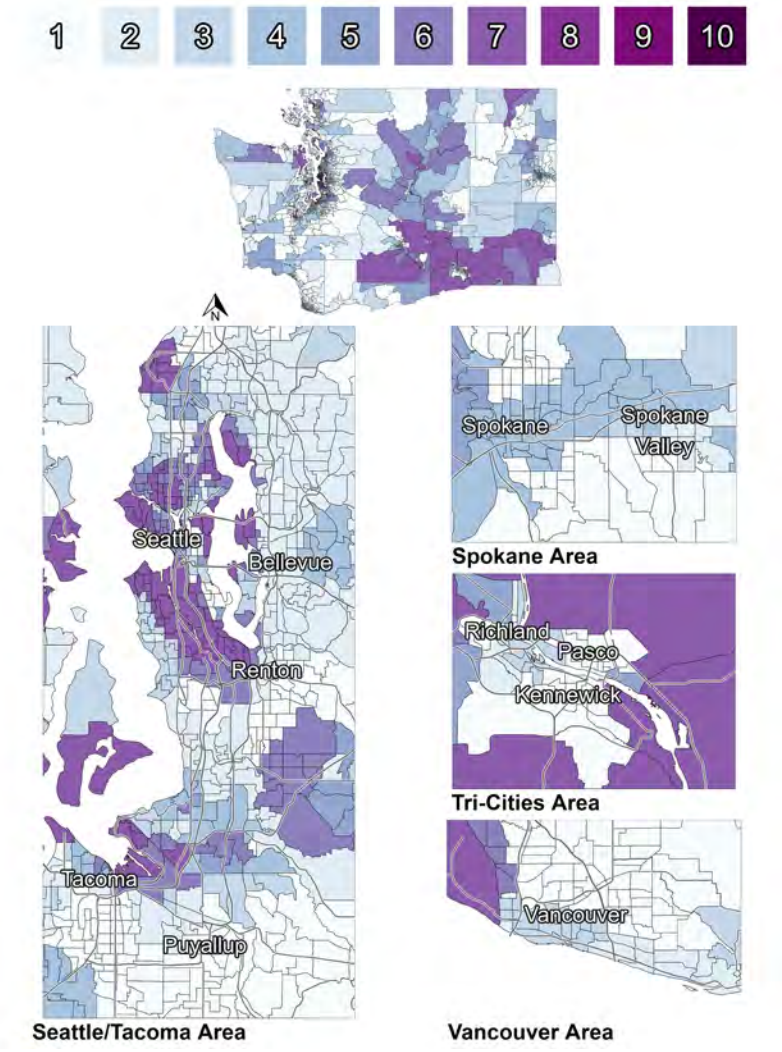
Overview

Waterbody cleanliness is important because it supports ecosystems and sustains agriculture. Tribal Nations and communities that rely on natural water sources, such as streams, rivers, lakes, and estuaries, are more likely to be exposed to water pollution. This can harm both their health and cultural practices. Because of this, these communities and Tribes have been, and continue to be, strong advocates for better water quality. This measure counts the number of different pollutants detected in waters, tested, and classified as impaired across Washington.

Water Quality

This map shows decile rankings for the number of unique pollutants in waters classified as impaired, 2018

Ranks range from 1 (least impacted) to 10 (most impacted)



Background

Water is vital for drinking, aquatic life, agriculture, and recreation. It is also crucial for ecosystems and has cultural significance. This measure assesses the quality of waterbodies, which can affect aquatic life and impact human and animal health. For example, pollutants like dioxins can impact the reproduction and development of both people and fish. People who use well water are more affected by environmental water quality because their water is not treated or regulated like water from municipal systems.

Water quality and health risk vary by location. This puts some communities at greater risk. These communities often have less economic access and more people of color.

Testing water quality is important for the health of humans, animals and aquatic life. Under the federal Clean Water Act, all states must keep a list of polluted waters. In Washington, the Department of Ecology (ECY) assesses waterbodies based on the credible data submitted to the agency. From the data that is submitted, Ecology determines which waters are polluted, which are clean, and which do not have enough data to make a determination. Assessing water quality helps find where water is most impacted by pollutants. This information guides water quality improvement plans.

Evidence

Polluted water is linked to sickness in both humans and animals, aquatic habitat damage, and bad smells [1, 2]. Communities with both less economic access and more of people of color often face more pollution in their waters [3]. Climate extremes, such as droughts, can impact water quality by concentrating pollutants and increasing water temperature. This can affect health and safety [4]. Heavy rain can also wash pollutants into waterways [5].

Data Source

Washington State Ecology Water Quality Atlas: Water Quality Atlas - Start Page, 2018

Washington State Ecology Water Quality Assessment: Assessment of state waters 303d - Washington State Department of Ecology

Method

This measure displays the total number of unique pollutants in each census tract, based on findings from all water bodies within that tract assessed by ECY as falling under categories 4a, 4b, or 5. This measure is modeled after CalEnviroScreen's Impaired Water Bodies Measure.

Caveats

This measure is not comprehensive. Areas that do not have the resources for a water assessment, or that capture their water quality by different metrics, are not included. This measure should be used as a starting point, and not as a sole basis for funding decisions.

Ecology uses Tribal water quality data in the Water Quality Assessment when the data meet

credible data requirements and are submitted to approved databases, such as the EIM database or the federal Water Quality Portal. Tribes often collect data both on their reservations and in nearby waterbodies, so Ecology looks at the exact location of each sample to determine whether it can be included. Data collected within reservation boundaries are excluded because those waters are not considered state waters and remain under Tribal jurisdiction. Data collected outside reservations, in state waters, are evaluated and included in the Assessment when they meet data requirements. As a result, the Assessment incorporates a significant amount of Tribal data, with the exception of data collected within reservation boundaries.

This measure represents the entire census tract, not individual areas within it. These data should always be supplemented with local data and equitable engagement for more accurate insights.

Additional Resources

California Office of Environmental Health Hazard Assessment CalEnviroScreen, Impaired Water Bodies

Northwest Indian Fisheries Commission, New home for Treaty Rights at Risk

Tribal Water Quality Resources: EPA Actions on Tribal Water Quality Standards and Contacts | US EPA, FAQs CWA TAS IR | US EPA ARCHIVE DOCUMENT

Washington State Department of Ecology, Water Quality

Water Quality Standards: Water quality standards - Washington State Department of Ecology

Ecology Data Credibility Standards: Water Quality Policy 1-11 Chapter 2. Ensuring Credible Data for Water Quality Management

Sources

1. Lin, L., Yang, H., Xu, X. (2022). Effects of water pollution on human health and disease heterogeneity: a review. Frontiers in environmental science, 10, 880246.
2. Haxton, T.J., Findlay, C. S. (2008). Meta-analysis of the impacts of water management on aquatic communities. Canadian Journal of Fisheries and Aquatic Sciences, 65(3), 437-447.
3. Liévanos, R.S. (2018). Impaired Water Hazard Zones: Mapping Intersecting Environmental Health Vulnerabilities and Polluter Disproportionality. ISPRS International Journal of Geo-Information, *7*(11), 433. https://doi.org/10.3390/ijgi7110433.
4. Centers for Disease Control and Prevention. (2024, March 28). Health impacts of drought. https://www.cdc.gov/drought-health/health-implications/index.html
5. USGCRP, (2023). Fifth National Climate Assessment. (2023). Crimmins, A.R., Avery, C.W., Easterling, D.R., Kunkel, K.E., Stewart, B.C, Maycock, T.K. Eds., U.S. Global Change Research Program, Washington, D. C. https://toolkit.climate.gov/sites/default/files/2025-07/NCA5_2023_FullReport.pdf

Population Characteristics - Socioeconomic Factors Theme

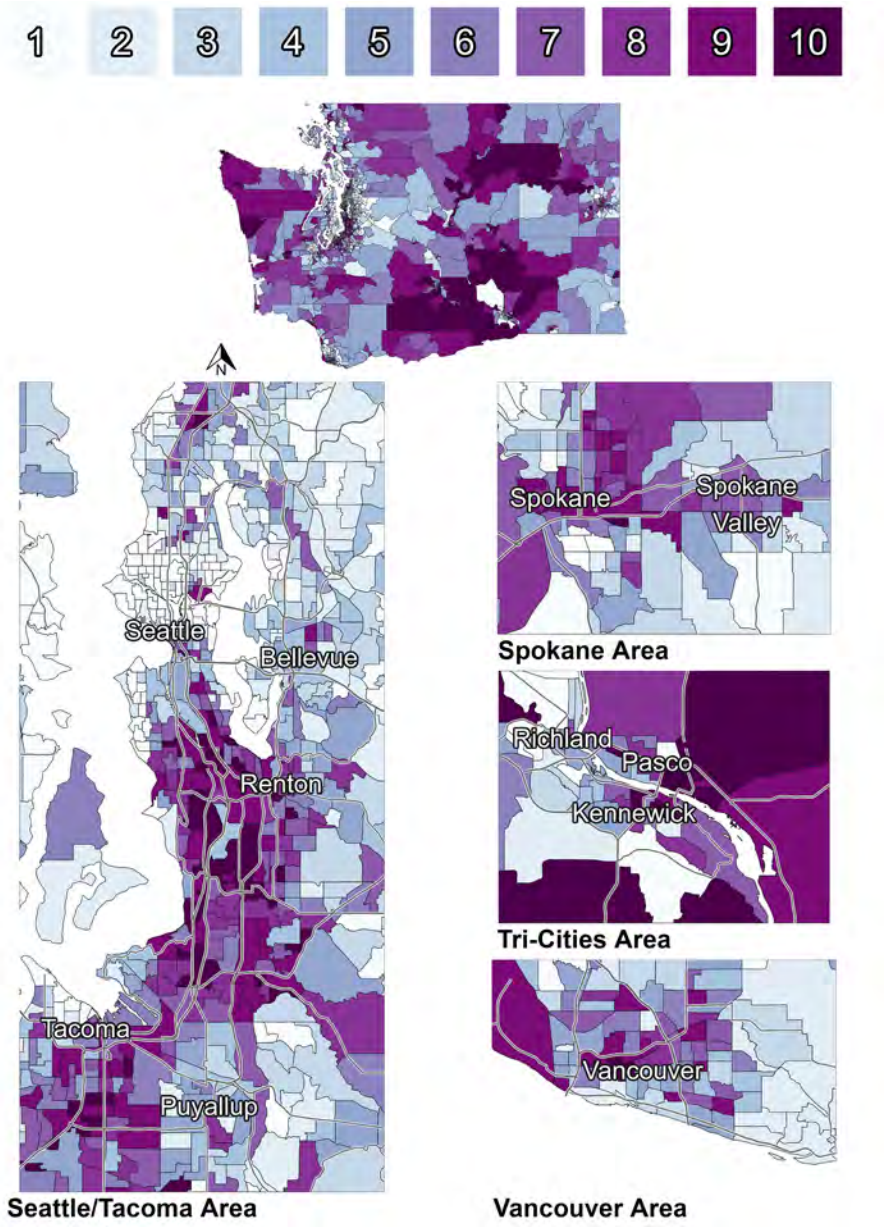
Socioeconomic factors refer to the social and economic conditions that influence the opportunities, resources, and well-being of individuals and communities. They impact historically minoritized populations' exposure to pollution. The socioeconomic factor theme includes:

- Linguistic isolation
- Income
- Unemployment
- Educational history
- Race and ethnicity
- Living expenses
- Access to nutritional food
- Access to digital infrastructure

Socioeconomic Factors Theme

This map shows decile rankings for the combination of all measures in the Socioeconomic Factors theme

Ranks range from 1 (least impacted) to 10 (most impacted)



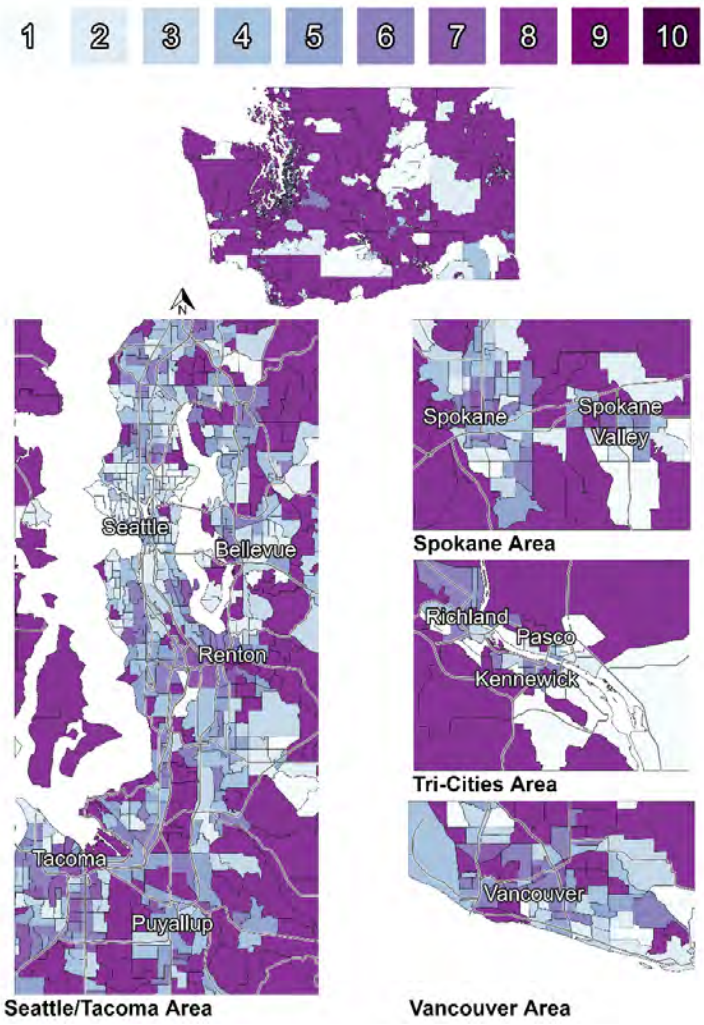
Community Retail Food Environment

Overview

The community retail food environment affects access to diverse and affordable food, which impacts overall health. Rural communities and communities with less economic access are less likely to have access to grocery stores. This results in fewer diverse and affordable food options nearby. This measure evaluates access to nutritious food within each census tract. It does this by comparing the number of stores that offer fresh, nutrient-dense options to those that primarily sell processed or fast food.

Community Retail Food Environment

This map shows decile rankings for the percent of stores offering fresh, nutrient-dense foods, 2023
Ranks range from 1 (least impacted) to 10 (most impacted)



Background

Unequal nutritional access causes a significant public health issue in the United States. Not all communities have the same access to nutritious food options. Systemic inequities and historical injustices shape access to nutritious food. Many communities have trouble getting fresh, nutritious food. Stores in neighborhoods with less economic access may not sell as many nutrient-dense food options as stores in wealthier areas. These areas are sometimes called ‘food deserts’ or ‘food swamps.’

In areas with fewer food options, people may eat fewer fruits and vegetables. Eating less nutrient-dense foods increases the risks of chronic conditions like type 2 diabetes, cancer, and heart disease. Communities that have been historically minoritized or have less economic access often have less access to foods that provide essential nutrients, especially produce. These same communities also face more environmental health burdens, like pollution, and have less access to health care.

Community-driven food systems offer local solutions that improve access to fresh, diverse, and affordable foods while empowering communities to shape their own food environments. Culturally relevant farmers’ markets are an example.

Evidence

Many people with less economic access and historically marginalized neighborhoods do not have grocery stores selling nutrient-dense options [1]. Neighborhoods with more obesity and less economic access often lack retailers selling nutritious food [2]. Food deserts or food swamps force people without transportation to rely on smaller stores with higher prices and fewer options. This increases the risk of food insecurity [3]. Community members often have to rely on convenience stores, fast food outlets, and other retailers with fewer healthy options. This can result in diets that exceed the USDA Guidelines for saturated fat, added sugars, and added sodium [4]. These kinds of diet can increase the risk of type 2 diabetes and heart disease [5, 6].

Communities with fewer financial resources have limited access to diverse food options. Stores in these areas offer fewer nutrient-dense choices like fruits, vegetables, and low-fat items [7]. People living near healthy food retailers eat more fruits and vegetables [8, 9]. The lack of diverse food options results from inequities in urban planning [10]. This highlights the need for policies that improve access to supermarkets and nutritious foods in underserved areas [7].

Communities with limited access to nutrient-dense food often also face environmental stressors, like air pollution. This further increases health risks. Exposure to these environmental hazards is linked to higher death rates. Socioeconomic and racial factors play a significant role in how severely these risks affect people [11].

Limited access to culturally relevant foods, combined with environmental stress, worsens health disparities. It also increases the risk of chronic conditions. Eating more whole food, plant-based foods can help reduce the health impacts of pollution [12].

Data Source

Food Outlet Location: Washington state healthy and non-healthy food outlets from the 2023 Data Axle via ESRI's ArcMap v10.8 Business Analyst
Census Data: 2020 Decennial Census; 2020 Census Geographies

Methods

The CDC's Modified Retail Food Environment Index (mRFEI) was used to measure food access in each census tract. The mRFEI calculates the ratio between healthy and less-healthy food retailers. The higher the mRFEI score, the more healthy food stores there are in an area. Healthy and less-healthy food retailers are defined by the typical foods they offer. Healthy foods include a variety of fruits, vegetables, lean meat products, and whole grains [13]. The data were cleaned to reflect current classification codes and ensure food retailers were accurately categorized.

This measure accounts for the number of healthy and less-healthy food stores within one mile of the population-weighted centroid of each census block group. Distance was based on the shortest road path, not a radius. We then combined census block groups into census tracts. The score for each census tract is the number of healthy food stores divided by the total number of food stores. Zero percent means a food desert (no food access). A low percentage indicates a food swamp (not enough healthy food access). A high percentage means a food oasis (enough access to healthy food).

Modified Retail Food Environment Index: https://stacks.cdc.gov/view/cdc/61367

Caveats

This method assumes that food access is uniformly distributed within a census tract. It does not include other factors that can affect access. These include cost, actual availability of food options, shopper experience, availability of transportation, and individual mobility.

Using a 1-mile distance to define food access may not reflect the real-world accessibility for everyone. This may be particularly true in areas with poor transportation infrastructure. People may also have different access based on factors like age, disability, or income.

This measure categorizes food outlets strictly as "healthy" or "less healthy." This oversimplifies the food choices available in different outlets. Additionally, communities may have their own definition of "healthy."

This measure uses the North American Industry Classification System (NAICS) codes to classify food outlets throughout the state. In some cases, businesses may be misclassified, misrepresenting the actual community food environment. Additionally, culturally specific food outlets are not included in this calculation. These outlets may be a primary source of food access for some communities.

This measure represents the entire census tract, not individual areas within it. These data should always be supplemented with local data and equitable engagement for more accurate insights.

Sources

1. Hallum, S.H., Hughey, S.M., Wende, M.E., Stowe, E.W., Kaczynski, A.T. (2020). Healthy and unhealthy food environments are linked with neighbourhood socio-economic disadvantage: an innovative geospatial approach to understanding food access inequities. Public Health Nutrition, 23(17), 3190.
2. Powell, L.M., Slater, S., Mirtcheva, D., Bao, Y., Chaloupka, F.J. (2006). Food store availability and neighborhood characteristics in the United States. Preventative Medicine, 44, 189–195.
3. Ver Ploeg, M. (2010). Access to affordable, nutritious food is limited in food deserts. U.S. Department of Agriculture, Economic Research Service. https://www.ers.usda.gov/amber-waves/2010/march/access-to-affordable-nutritious-food-is-limited-in-food-deserts.
4. U.S. Department of Agriculture and U.S. Department of Health and Human Services. (2020). Dietary Guidelines for Americans, 2020-2025, 9.
5. Lee, J.H., Duster, M., Roberts, T., Devinsky, O. (2022). United States Dietary Trends Since 1800: Lack of Association Between Saturated Fatty Acid Consumption and Non-communicable Diseases. Frontiers in Nutrition, 8.
6. Mozaffarian, D. (2016). Dietary and Policy Priorities for Cardiovascular Disease, Diabetes, and Obesity. In Circulation (Vol. 133, Issue 2, pp. 187–225). Lippincott Williams and Wilkins.
7. Yale News. (2008). Healthy foods scarce in poor neighborhoods, Yale researchers find. Yale News. https://news.yale.edu/2008/09/10/healthy-foods-scarce-poor-neighborhoods-yale-researchers-find.
8. Fiechtner, L., Kleinman, K., Melly, S. J., Sharifi, M., Marshall, R., Block, J., et al. (2016). Effects of proximity to supermarkets on a randomized trial studying interventions for obesity. American Journal of Public Health, 106(3), 557–562.
9. Laraia, B.A., Siega-Riz, A.M., Kaufman, J.S., Jones, S.J. (2004). Proximity of supermarkets is positively associated with diet quality index for pregnancy. Preventive Medicine, 39(5), 869–875.
10. Horowitz, C.R., Colson, K.A., Hebert, P.L., Lancaster, K. (2004). Barriers to Buying Healthy Foods for People With Diabetes: Evidence of Environmental Disparities. American Journal of Public Health, 94(9), 1549-54.
11. Bowe, B., Xie, Y., Yan, Y.Y., Al-Aly, Z. (2019). Burden of Cause-Specific Mortality Associated with PM2.5 Air Pollution in the United States. JAMA Network Open, *2*(11).
12. Lim, C.C., Hayes, R.B., Ahn, J., Shao, Y., Silverman, D.T., Jones, R.R., et al. (2019). Mediterranean Diet and the Association between Air Pollution and Cardiovascular Disease Mortality Risk. Circulation, 139(15), 1766–1775.
13. CDC. (2011a). Census Tract Level State Maps of the Modified Retail Food Environment Index (mRFEI). http://www.cdc.gov/obesity/downloads/2_16_mrfei_data_table.xls.

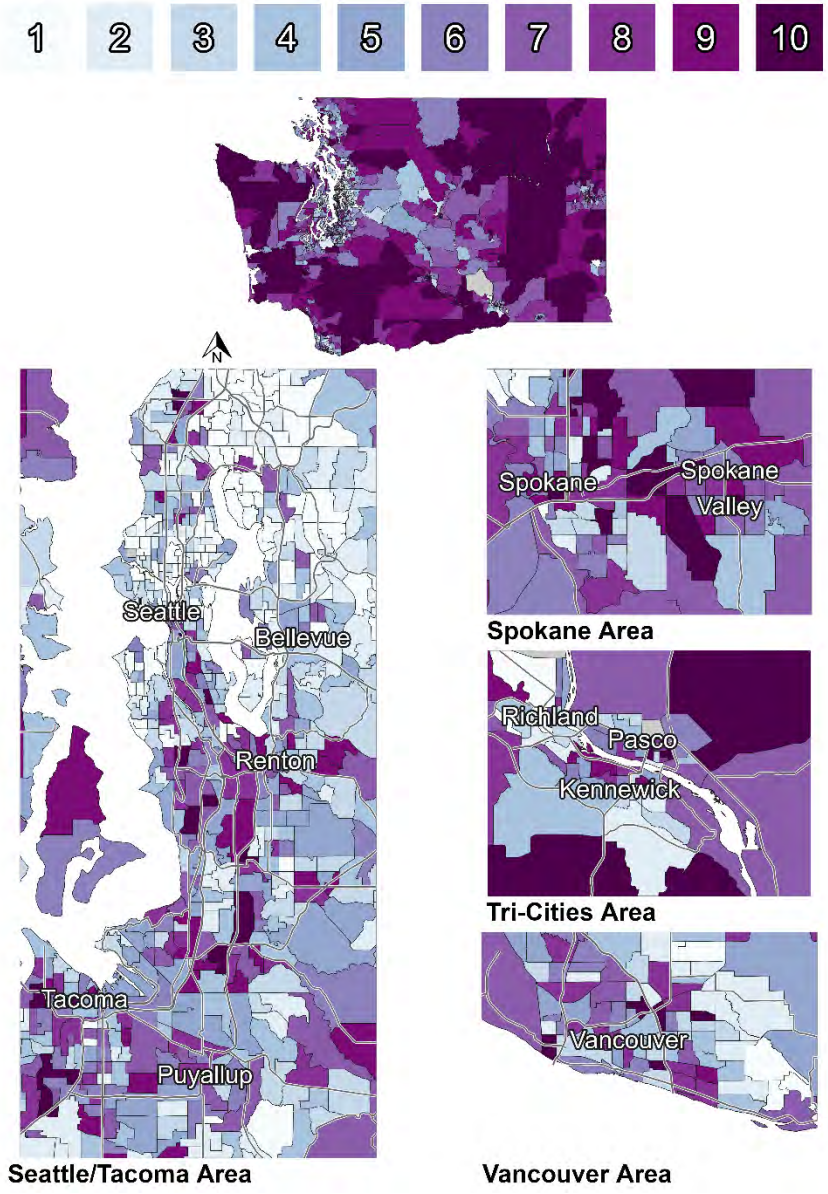
Digital Infrastructure

Overview

Digital infrastructure connects people to education, jobs, and health care services. Rural areas and communities with fewer financial resources often have limited access. This makes it harder for them to access services in an increasingly digital world. This measure shows the availability and speed of internet access.

Digital Infrastructure

This map shows decile rankings for the availability and speed of internet access, 2023
Ranks range from 1 (least impacted) to 10 (most impacted)



Background

Digital infrastructure plays a critical role in providing services. These include telehealth, emergency alerts, education, employment and social opportunities. Not having digital access to these services can harm people's health and well-being.

Unfortunately, connectivity presents challenges both in rural and urban areas.

In rural areas, the biggest problem is a lack of infrastructure. Bringing broadband networks to rural areas requires wiring long distances. Without this investment, internet availability is limited. As a result, many rural communities are left disconnected from digital services. This builds on other burdens rural communities may face. For example, telehealth could help offset rural doctor shortages, but only if people can get online.

In urban areas, the biggest problem is accessing the infrastructure that does exist. Minoritized communities face challenges such as limited digital literacy and affordability. People with limited financial resources often have other priorities for their spending. These factors create significant barriers for these communities in accessing digital services.

People who don't have access to the benefits of digital infrastructure often bear the costs of the industry. For example, data sites can create environmental and social inequalities. These are most likely to impact marginalized groups.

Lack of digital access increases health risk in both rural and urban communities. People may not be able to connect with health care providers or receive critical emergency information. Groups already burdened by environmental stressors are the most affected.

Evidence

Digital infrastructure is increasingly critical for delivering essential services like telehealth and staying socially connected. However, both rural and urban areas face significant challenges in digital connectivity [1, 2]. Rural regions often lack foundational infrastructure. This gets in the way of telemedicine making up for rural physician shortages [3]. Urban areas struggle with issues such as limited digital literacy and "digital redlining," where minoritized communities and communities with less economic access receive inferior internet services [2]. These connectivity gaps add to existing environmental burdens. In rural communities, lack of broadband access may require more travel to do work and activities that could otherwise be done online [4].

Data Source

2023 infrastructure/adoption (INFA) data was obtained here: 2023 Digital Divide Index (DDI) (arcgis.com), Purdue University

Methods

The Digital Divide Index includes an infrastructure/adoption (INFA) component and a socioeconomic component. This measure only uses the INFA component. The EHD map already accounts for socioeconomic factors separately.

The INFA score contains four variables related to broadband infrastructure and adoption:

(1) percent of homes without a computing device (desktops, laptops, smartphones, tablets, etc.).

(2) percent of homes with no internet access (including cellular data plans or dial-up).

(3) average download speed.

(4) average upload speed.

INFA measures speed in megabits per second, weighted by number of speed tests. These data come from the Ookla Speedtest® open dataset.

The Digital Divide Index weights the four INFA variables. Devices and access are weighted more heavily (0.35 each) than download and upload speeds (0.15 each). Without connection, speed does not matter. Therefore, devices and access are more fundamental to connectivity. Additionally, speeds are subject to extreme outliers. Lower weighting for download and upload speeds reduces the impact of these outliers.

You can learn more about how the INFA score is created on the Digital Divide Index website.

Caveats

The INFA score combines factors like access to computing devices, internet connectivity, and broadband speed into a single index. This may oversimplify the complexities of digital access.

This measure represents the entire census tract, not individual areas within it. These data should always be supplemented with local data and equitable engagement for more accurate insights.

Sources

1. American Heart Association. (2020). Expanding access to care through telehealth. https://www.heart.org/en/-/media/Files/About-Us/Policy-Research/Policy-Positions/Digital-Health/Expanding-Access-to-Care-Through-Telehealth-2020.pdf.
2. Community Tech Network. (2023). Digital redlining and its impact on low-income communities of color. https://communitytechnetwork.org/blog/digital-equity-for-black-americans-a-racial-justice-issue/#:~:text=Internet%20service%20providers%20have%20underinvested,infrastructure%20and%20slower%20internet%20speeds.
3. Drake, C., Zhang, Y., Chaiyachati, K.H., Polsky, D. (2019). The Limitations of Poor Broadband Internet Access for Telemedicine Use in Rural America: An Observational Study. *Annals of internal medicine*, *171*(5), 382–384.
4. Third Way. (2021). Rural communities need better transportation policy. rural-communities-need-better-transportation-policy.pdf.

No High School Diploma

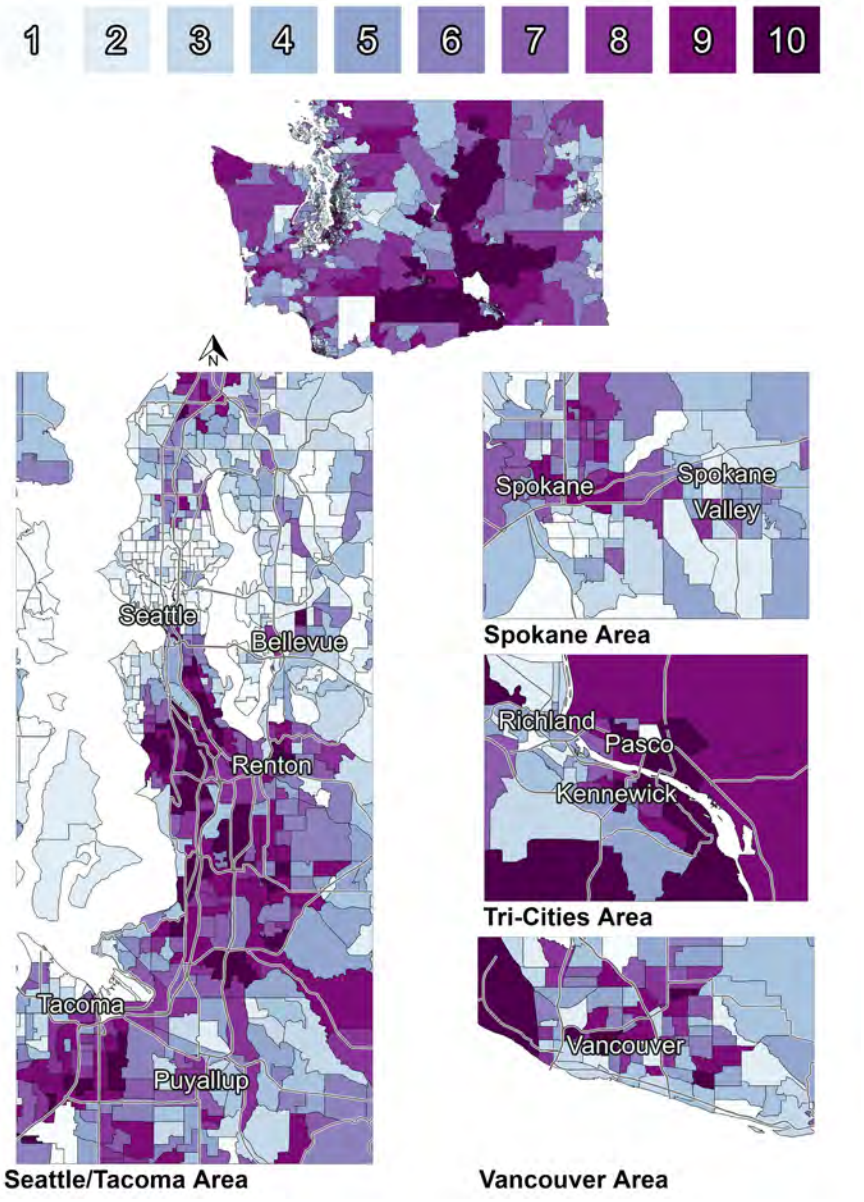
Overview

Education can reduce health disparities. Education empowers people to make informed decisions about their health and increases job opportunities. This measure shows the percentage of people over the age of 25 who do not have a high school diploma or equivalent.

No High School Diploma

This map shows decile rankings for percent of people over 25 years old with no high school diploma, 2019-2023

Ranks range from 1 (least impacted) to 10 (most impacted)



Background

Education is a primary predictor of the health of a community. Education comes in many forms. In the U.S., one of the most commonly tracked metrics is the completion of a formal high school education.

Education level can impact daily life and affect individual health in many ways. Lower formal education may lead to:

- Increased stress.
- Lack of social support.
- Limited occupational opportunities.
- Reduced access to nutritious food.
- Limited access to health care services.
- Increased risk of incarceration.
- Increased exposure to environmental pollutants.

Due to these impacts, people with less formal education face lower life expectancy and higher hospitalization rates during spikes in pollution levels than people with more formal education.

Schools often underserve marginalized communities. In Washington, Native students, students with disabilities, and students in foster care face the lowest graduation rates.

Evidence

Low educational attainment is a stressor that can lead to negative health outcomes. These include higher respiratory and heart-disease mortality rates [1] and an increased risk of asthma-related hospitalization during spikes in ozone levels [2]. Higher educational attainment is associated with higher life expectancy and a reduction of risks for diseases associated with aging [3, 4].

Communities with lower high school graduation rates have a higher risk of death from any cause due to exposure to sulfates [5]. They also have higher rates of respiratory disease-related hospitalizations due to air pollution levels [6].

The relationship between environment, health, and education goes in multiple directions. Exposure to pollution can disrupt education, leading to lower high school graduation rates. Children who attend schools downwind of heavy traffic pollution have lower test scores, higher absences from school, and higher behavioral incidences than children who live upwind [7]. Because people with less than a high school education are exposed to more pollution throughout their lives, this can lead to multi-generational impacts on education and health [8].

Washington graduation rates show additional disparities based on other socioeconomic factors as well. In 2022, 67.8% of American Indian/Alaska Native students graduated, compared to 82.8% of White students. Students in foster care had a graduation rate of 53.3%. Students with disabilities had a graduation rate of 65.3% [9].

Data Source

American Community Survey 5-year estimates, 2019-2023, S1501: Educational Attainment

Methods

The U.S. Census Bureau's American Community Survey (ACS) asks respondents a variety of detailed questions on social and economic topics. This measure was developed using census tract-level educational attainment data from the ACS's 5-year estimates.

This measure displays the percentage of the population 25 years and older that report not having a high school diploma or high school equivalency diploma.

For more information on how ACS data is collected and processed, refer to ACS General Data Users Handbooks.

Data Source	Variables Used	Calculations Performed*
ACS 5-year, S1501: Educational Attainment	DP02_0059, DP02_0060, DP02_0061	# No HS diploma = sum of (DP02_0060, DP02_0061) Population 25+ = DP02_0059 % No HS diploma = sum(DP02_0060, DP02_0061) / DP02_0059

* For margin of error (MOE) calculations, refer to U.S. Census Bureau, A Compass for Understanding and Using American Community Survey Data Appendix 1. For MOEs in which either the numerator or denominator of a proportion were derived from multiple ACS variables, see "Calculating MOEs for Aggregated Count Data;" for MOEs derived from proportions, see "Calculating MOEs for Derived Proportions." The data table shows the estimate for this variable minus the MOE (lower ME) and the estimate plus the MOE (upper ME).

Caveats

The margin of error shows how much uncertainty there is about whether the survey data accurately represents the full population. The confidence interval is the estimate plus or minus the margin of error. There is a 90 percent probability that the true population value is within the confidence interval, after accounting for sampling variability.

All survey data have some margin of error due to sampling variability. Results from smaller populations are less reliable because of their smaller sample sizes, leading to a larger margin of error. Counts for American Indian, Alaska Native, Native Hawaiian, and Pasifika populations are known to be less reliable. The survey design attempts to address these issues through increased sampling rates in smaller populations and on Tribal lands.

The data may also have non-sampling errors, which aren't shown in the tables. These can happen if there are problems with the survey questions, if there are issues with processing or weighting the data, or if certain groups of people don't respond [10]. Individuals with a distrust for government, more concerns about privacy, and who are very busy are less likely to respond to the survey.

This measure is aggregated across the census tract and does not represent each individual community within the tract. These data should always be supplemented with local data and equitable engagement for more accurate insights.

ACS bundles data in one-year, three-year, or five-year groups to get more reliable results. To have census tract data on all 39 counties in Washington, we use the ACS five-year grouping.

Sources

1. Lewis, A., Sax, S., Wason, S., Campleman, S. (2011). Non-chemical stressors and cumulative risk assessment: An overview of current initiatives and potential air pollutant Interactions. International Journal of Environmental Research and Public Health, 8(6), 2020-73.
2. Neidell, M. (2004). Air pollution, health, and socio-economic status: The effect of outdoor air quality on childhood asthma. Journal of Health Economics, 23(6), 1209-36.
3. Adler, N., Pantell, M.S., O'donovan, A., Blackburn, E., Cawthon, R., Koster, A., et al. (2013). Educational attainment and late life telomere length in the health, aging and body composition study. Brain Behavior and Immunity, 27(1), 15-21.
4. Hummer, R., Hernandez, E. (2013). The effect of educational attainment on adult mortality in the United States. Population Bulletin, 68(1), 1-16.
5. Krewski, D., Burnett, R., Goldberg, M., Hoover, B., Siemiatycki, J., Jerrett, M., et al. (2003). Overview of the reanalysis of the Harvard six cities study and American Cancer Society study of particulate air pollution and mortality. Journal of Toxicology and Environmental Health, Part A, 66(19), 1507-52.
6. Cakmak, S., Dales, R., Judek, S. (2006). Respiratory health effects of air pollution gases: modification by education and income. Archives of Environmental & Occupational Health, 61(1), 5-10.
7. Heissel, J.A., Persico, C., Simon, D. (2022). Does Pollution Drive Achievement? The Effect of Traffic Pollution on Academic Performance. Journal of Human Resources, 57(3), 747-76.
8. Zou, B., Peng, F., Wan, N., Mamady, K., Wilson, G.J. (2014). Spatial Cluster Detection of Air Pollution Exposure Inequities across the United States. PLoS ONE 9(3), e91917.
9. Kaundal, M. (Presenter). (2023, February 22). Disparities in high school graduation rates & student success [Public performance review]. Results Washington. https://results.wa.gov/sites/default/files/HighSchoolGraduationRatesPPR_022223.pdf.
10. Pickering, K. (2022). Nonresponse in census surveys. Federal Economic Statistics Advisory Committee. U.S. Bureau of Economic Analysis. https://apps.bea.gov/fesac/meetings/2022-12-09/Pickering-FESACNonresponse-in-Census-Surveys-12092022.pdf.

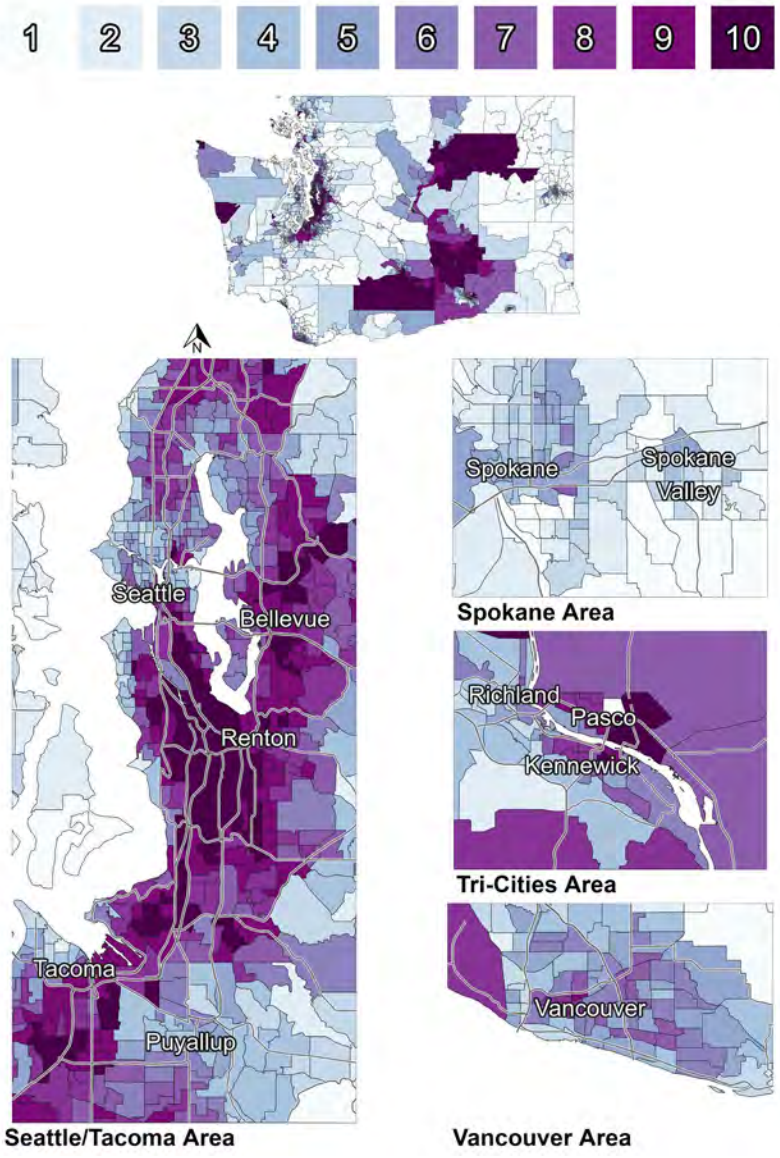
People of Color

Overview

Race and ethnicity are primary social determinants of health. This is due to the widespread, historical and ongoing effects of racism. These are reflected in discriminatory laws, practices and actions against people of color. This measure shows the percent of people who report their race or ethnicity as Hispanic, Black, American Indian/Alaska Native, Asian, Native Hawaiian/Pasifika, or two or more races.

People of Color

This map shows decile rankings for the percent of people of color, 2024
Ranks range from 1 (least impacted) to 10 (most impacted)



Background

Racial discrimination leads to differences in exposure to environmental hazards and air pollution. Historically minoritized communities of color and ethnic minorities are disproportionately exposed to environmental hazards. This is true regardless of income.

Potentially harmful sites are more likely to be built in communities of color. These include places like superfund sites, hazardous waste sites, landfills, and factories. People living near these places can be exposed to harmful things like toxic waste and pollution. Minoritized communities are also exposed to more air pollution, lead, and climate change impacts. More exposure leads to more health impacts for people in those communities.

Racism also affects things like access to healthy food, financial security, housing, and health care. These can directly and indirectly affect the health impacts of exposure to pollution. Children and women of color are especially at risk for health problems caused by pollution. These risks include negative birth outcomes, heart and lung diseases, and more hospitalizations due to chronic health conditions.

Evidence

Racial and ethnic groups are unequally affected by environmental risk factors. Historically minoritized communities are more likely to be exposed to air pollution [1]. Water systems serving Latiné communities are more likely to have high nitrate levels in drinking water [2]. Superfund sites and other hazardous sites are more likely to be built near communities of color [3].

Black communities have higher death rates after exposure to increased ozone levels [4]. Black and American Indian/Alaska Native adults are more likely to have asthma. This is made worse by air pollution [5].

Data Source

2022 population estimates from the Washington State Office of Financial Management

Methods

The data we used come from the Washington State Office of Financial Management (OFM). OFM uses mathematical models of births, deaths, and migration to make demographic estimates. They base these models on numbers obtained from the Census Bureau. OFM calls its numbers "estimates" because they are not an actual count of people.

We added together the OFM estimates for all race/ethnicity categories EXCEPT White and Non-Hispanic. This includes:

- Black.
- American Indian/Alaskan Native.
- Asian.
- Native Hawaiian-Other Pasifika.
- Two or more races.
- The ethnicity grouping of "Spanish/Hispanic/Latino".

We then calculated the percentage of people of color by dividing by the estimated total population.

Sources

1. Kravitz-Wirtz, N., Crowder, K., Hajat, A., Sass, V. (2016). The long-term dynamics of racial/ethnic inequality in neighborhood air pollution exposure, 1990-2009. Du Bois Review, 13(2), 237-59.
2. Schaider, L.A., Swetschinski, L., Campbell, C., Rudel, R.A. (2019). Environmental justice and drinking water quality: are there socioeconomic disparities in nitrate levels in U.S. drinking water? Environ Health, 18, 3.
3. Pollock, P., Vittas, M. (1995). Who bears the burdens of environmental pollution? Race, ethnicity, and environmental equity in Florida. Social Science Quarterly, 76(2), 294-310.
4. Bell, M., Dominici, F. (2008). Effect modification by community characteristics on the short term effects of ozone exposure and mortality in 98 US communities. American Journal of Epidemiology, 167(8), 986-97.
5. Washington State Department of Health (DOH). (2013). The burden of asthma in Washington state: 2013 update. https://www.doh.wa.gov/Portals/1/Documents/Pubs/345-240-AsthmaBurdenRept13.pdf.

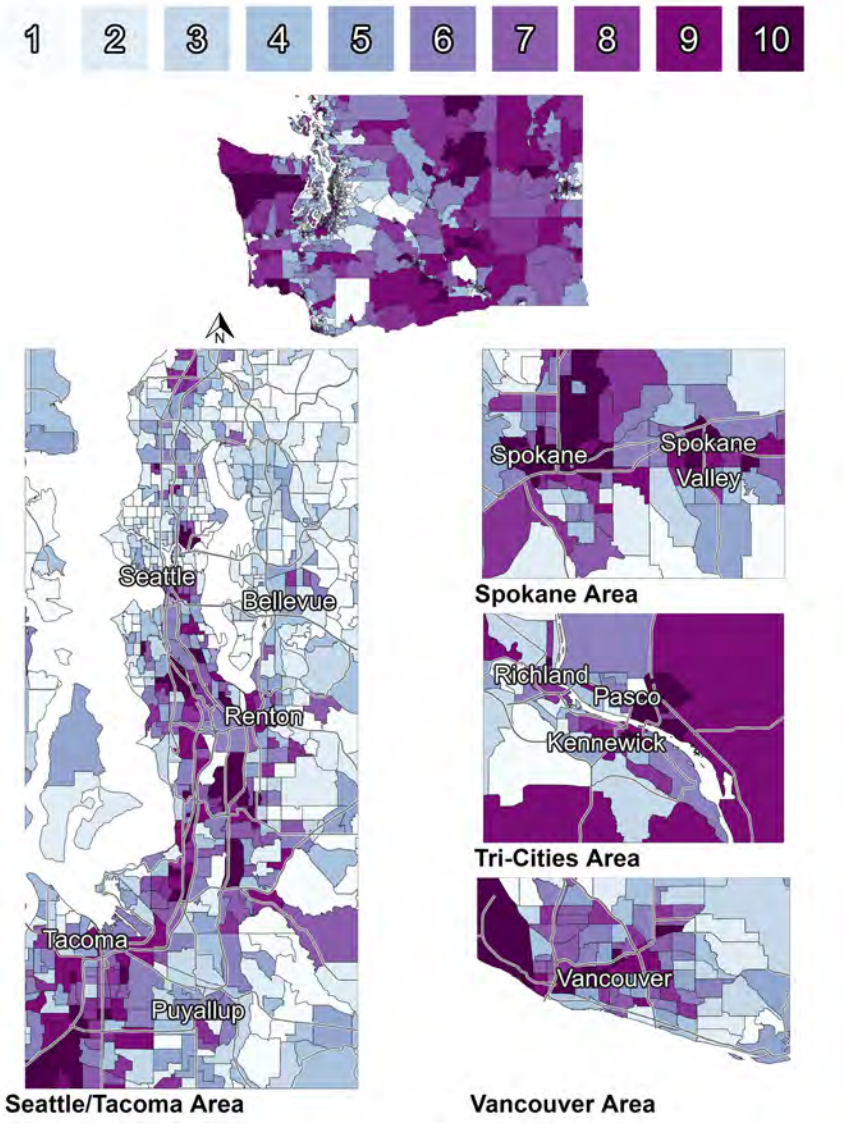
Population Living in Poverty (<= 185% of Federal Poverty Level)

Overview

Income impacts health by affecting access to nutrition, housing, and health care. This measure shows the percentage of people living in a household with an income under 185% of the federal poverty level, which is considered extremely low income.

Population Living in Poverty (<185% of Federal Poverty Level)

This map shows the decile rankings for the percent of people living in households with a total income under 185% of the Federal Poverty Level, 2019-2023
Ranks range from 1 (least impacted) to 10 (most impacted)



Background

Economic status affects many areas of life, including nutrition, jobs, housing, and access to health care. Due to social patterns and systems of inequity, people do not all have equal economic opportunities. This means the health risks associated with low income are disproportionately borne by groups already facing oppression and racism.

Stress from economic instability places people at increased risk of poor mental and physical health. People may also struggle to afford health care or may avoid seeking it due to cost. This can make existing health problems worse. People with less financial resources may also not have access to safe housing. This increases the risk of exposure to environmental hazards.

Communities with less access to financial resources are more likely to be exposed to pollution. Increased air pollution increases the risk of respiratory and cardiovascular issues such as asthma and heart attacks. Children are more sensitive to increased exposure due to their developing immune systems and organs.

Evidence

Due to structural racism and practices that favor those who already have wealth, income disparity disproportionately impacts historically minoritized communities [1].

Communities with fewer financial resources have higher rates of chronic diseases [2]. This increases the risk of health problems from pollution exposure for people with fewer financial resources [3]. For example, people in areas with fewer financial resources are at a higher risk of dying from short-term exposure to particulate matter in the air [4]. Children in these areas are also more likely to develop asthma due to traffic-related pollution [5].

Data Source

American Community Survey 5-year estimates, 2019-2023, S1701: Poverty Status in the Past 12 Months

Methods

The U.S. Census Bureau's American Community Survey (ACS) asks respondents detailed questions on social and economic topics. This measure was developed using census tract-level poverty data from the ACS's 5-year estimates.

This measure shows the percentage of the people living in household with an income at or below 185% of the federal poverty level over the past year. The federal poverty level varies depending on household size. Income is calculated before taxes. See How the Census Bureau Measures Poverty for more information on how poverty was measured.

For more information on how ACS data is collected and processed, refer to ACS General Data Users Handbooks.

Data Source	Variables Used	Calculations Performed*
ACS 5-year, S1701: Poverty Status in the Past 12 Months	S1701_C01_041, S1701_C01_001	# Individuals with Household Income Below 185% FPL: S1701_C01_041 # Individuals with known poverty status: S1701_C01_001 % Individuals with Household Income Below 185% FPL: S1701_C01_041 / S1701_C01_001

* For margin of error (MOE) calculations, refer to U.S. Census Bureau, A Compass for Understanding and Using American Community Survey Data Appendix 1. For MOEs in which we derived either the numerator or denominator of a proportion from multiple ACS variables, see "Calculating MOEs for Aggregated Count Data." For MOEs derived from proportions, see "Calculating MOEs for Derived Proportions." The data table shows the estimate for this variable minus the MOE (lower ME) and the estimate plus the MOE (upper ME).

Caveats

The ACS is known to undercount some populations. This includes young children who live with more than one parent or guardian, people without stable housing, and households that do not conform to the nuclear family structure. Populations that are undercounted in the ACS are more likely to have less financial opportunities.

The definition of income used for this measure does not reflect noncash benefits. These include food stamps, health care, and housing assistance. Because it only includes monetary income, it may not reflect how communities define their income, such as traditional Indigenous definitions of wealth.

The margin of error shows how much uncertainty there is about whether the survey data accurately represents the full population. The confidence interval is the estimate plus or minus the margin of error. There is a 90 percent probability that the true population value is within the confidence interval, after accounting for sampling variability.

All survey data have some margin of error due to sampling variability. Results from smaller populations are less reliable because of their smaller sample sizes, leading to a larger margin of error. Counts for American Indian, Alaska Native, Native Hawaiian, and Pasifika populations are known to be less reliable. The survey design attempts to address these issues through increased sampling rates in smaller populations and on Tribal lands.

The data may also have non-sampling errors, which aren't shown in the tables. These can happen if there are problems with the survey questions, if there are issues with processing or weighting the data, or if certain groups of people don't respond [6]. Individuals with a distrust for government, more concerns about privacy, and who are very busy are less likely to respond to the survey.

This measure is aggregated across the census tract and does not represent each individual community within the tract. These data should always be supplemented with local data and equitable engagement for more accurate insights.

ACS bundles data in one-year, three-year, or five-year groups to get more reliable results. To have census tract data on all 39 counties in Washington, we use the ACS five-year grouping.

Sources

1. Beech, B.M., Ford, C., Thorpe, R.J., Bruce, M.A., Norris, K.C. (2021). Poverty, racism, and the public health crisis in America. Frontiers in Public Health, 9.
2. Benavidez, G.A., Zahnd, W.E., Hung, P., Eberth, J.M. (2024) Chronic Disease Prevalence in the US: Sociodemographic and Geographic Variations by Zip Code Tabulation Area. Prev Chronic Dis, 21, 230267.
3. O'Neill, M., Jerrett, I., Kawachi, J., Levy, A., Cohen, N., Gouveia, P., et al. (2003). Health, wealth, and air pollution: Advancing theory and methods. Environmental Health Perspectives, 111(16), 1861-70.
4. Bell, M. L., Zanobetti, A., Dominici, F. (2013). Evidence on Vulnerability and Susceptibility to Health Risks Associated With Short-Term Exposure to Particulate Matter: A Systematic Review and Meta-Analysis. American Journal of Epidemiology, 178(6), 865–76.
5. Kravitz-Wirtz, N., Teixeira, S., Hajat, A., Woo, B., Crowder, K., Takeuchi, D. (2018). Early-Life Air Pollution Exposure, Neighborhood Poverty, and Childhood Asthma in the United States, 1990–2014. Int. J. Environ. Res. Public Health, 15, 1114.
6. Pickering, K. (2022). Nonresponse in census surveys. Federal Economic Statistics Advisory Committee. U.S. Bureau of Economic Analysis. https://apps.bea.gov/fesac/meetings/2022-12-09/Pickering-FESACNonresponse-in-Census-Surveys-12092022.pdf

Primary Language Other Than English

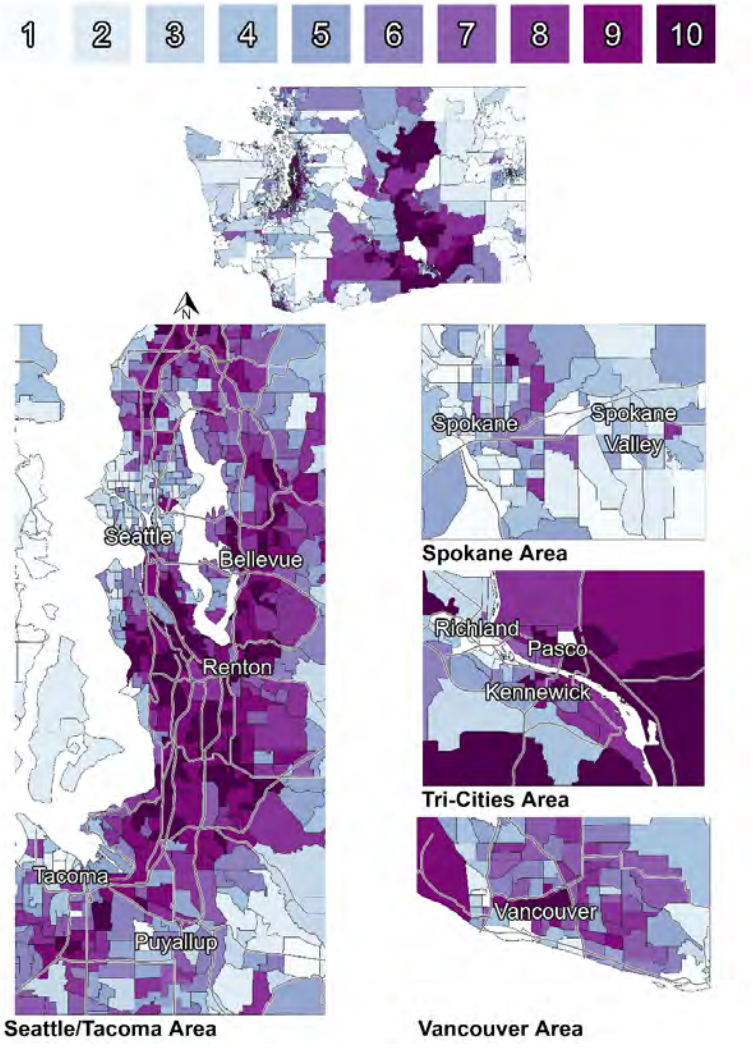
Overview

People who primarily speak a language other than English may be isolated from services and information. This includes health care. This contributes to health disparities and increased exposure to pollution. This measure looks at the language spoken at home for people ages 5 and older to estimate "linguistic isolation" in a community. Linguistic isolation is defined as those who report speaking a language other than English at home and speaking English "less than very well."

Primary Language other than English

This map shows decile rankings for the percent of people who report limited English proficiency, 2019-2023

Ranks range from 1 (least impacted) to 10 (most impacted)



Background

The U.S. Census Bureau measures “linguistic isolation” for people ages five and older using self-reported difficulties with speaking English. People who don’t primarily speak English experience more racial discrimination, social isolation, and exposure to pollution. Each of these can contribute to worse health outcomes.

Linguistic isolation can also prevent participation in community engagement, understanding important information, and accessing services. Linguistically isolated people may have trouble accessing health education and health services. Health information and emergency plans should be created in a culturally sensitive way to ensure everyone’s safety and well-being during a crisis. This means considering factors like language, cultural norms, and the specific needs of different groups.

Evidence

Linguistic isolation worsens existing racial and ethnic health inequalities. This is partly due to people lacking access to health care in their primary language [1]. Planning for language and cultural diversity is especially important during public health emergencies, when evacuating or taking safety precautions needs to be done quickly [2].

Places and initiatives that do not consider the needs of non-English speakers prevent participation in local decisions, such as environmental policies. This can lead to health issues related to pollution and environmental health disparities [3].

English proficiency is also linked to employment and income. People who don’t speak English as their first language have a harder time finding jobs because of negative perceptions around their capability or qualifications to do the job. This can lead to lower earnings over time [4]. The “Populations living in poverty” data note has information on how poverty can increase risk from environmental hazards.

Because of all these factors, children who speak a language other than English at home are more likely to be exposed to pollution, including industrial air pollution and lead [5].

Data Source

American Community Survey 5-year estimates, 2019-2023, B06007: Place of Birth by Language Spoken at Home and Ability to Speak English

Methods

The U.S. Census Bureau’s American Community Survey (ACS) asks detailed questions on social and economic topics. This measure uses data on the language spoken at home and ability to speak English from the ACS’s 5-year estimates.

This measure shows the percentage of people ages five and older who report both:

- speaking a language other than English at home AND
- speaking English “less than very well".

For more information on how ACS data is collected and processed, refer to ACS General Data Users Handbooks.

Data Source	Variables Used	Calculations Performed*
ACS 5-year, B06007: Place of Birth by Language Spoken at Home and Ability to Speak English	B06007_005, B06007_008, B06007_001	# Speaks English less than Very Well = sum (B06007_005, B06007_008) Population 5+ = B06007_001 % Speaks English less than Very Well = sum (B06007_005, B06007_008) / B06007_001

* For margin of error (MOE) calculations, refer to U.S. Census Bureau, A Compass for Understanding and Using American Community Survey Data Appendix 1. For MOEs in which we derived either the numerator or denominator of a proportion from multiple ACS variables, see "Calculating MOEs for Aggregated Count Data." For MOEs derived from proportions, see "Calculating MOEs for Derived Proportions." The data table shows the estimate for this variable minus the MOE (lower ME) and the estimate plus the MOE (upper ME).

Caveats

The data are based on how people feel about their own ability to speak English. This is often influenced by their interactions with others. In the United States, many interpret an accent as evidence that a person is not fluent in English. These assumptions can lead to negative interactions and lower self-ratings.

The ACS is known to undercount some populations. This includes young children who live with more than one parent or guardian, people without stable housing, and households that do not conform to the nuclear family structure. Populations that are undercounted in the ACS are more likely have less financial opportunity.

The margin of error shows how much uncertainty there is about whether the survey data accurately represents the full population. The confidence interval is the estimate plus or minus the margin of error. There is a 90 percent probability that the true population value is within the confidence interval, after accounting for sampling variability.

All survey data have some margin of error due to sampling variability. Results from smaller populations are less reliable because of their smaller sample sizes, leading to a larger margin of error. Counts for American Indian, Alaska Native, Native Hawaiian, and Pasifika populations are known to be less reliable. The survey design attempts to address these issues through increased sampling rates in smaller populations and on Tribal lands.

The data may also have non-sampling errors, which aren't shown in the tables. These can happen if there are problems with the survey questions, if there are issues with processing or weighting the data, or if certain groups of people don't respond [6]. Individuals with a distrust for government, more concerns about privacy, and who are very busy are less likely to respond to the survey.

This measure is aggregated across the census tract and does not represent each individual community within the tract. These data should always be supplemented with local data and equitable engagement for more accurate insights.

ACS bundles data in one-year, three-year, or five-year groups to get more reliable results. To have census tract data on all 39 counties in Washington, we use the ACS five-year grouping.

Sources

1. Nguyen D., Reardon L.J. (2013). The role of race and English proficiency on the health of older immigrants. Soc Work Health Care, 52(6):599-617.
2. Uekusa, S., Matthewman, S. (2023). Preparing multilingual disaster communication for the crises of tomorrow: A conceptual discussion. International Journal of Disaster Risk Reduction, 87, 2212-4209.
3. Pastor Jr., M., Morello-Frosch, R., Sadd., J. (2010). Air pollution and environmental justice: Integrating measures of cumulative impact and socio-economic vulnerability into regulatory decision-making. Final report. California Air Resources Board. https://ww2.arb.ca.gov/sites/default/files/classic/research/apr/past/04-308.pdf
4. Cheeseman Day, J. Shin H.B. (2005). How Does Ability to Speak English Affect Earnings? Annual Meetings of the Population Association of America. https://www.census.gov/content/dam/Census/library/working-papers/2005/demo/2005-Day-Shin.pdf
5. Payne-Sturges, D.C., Taiwo, T.K., Ellickson, K., Mullen, H., Tchangalova, N., Anderko, L., et al. (2023). Disparities in toxic chemical exposures and associated neurodevelopmental outcomes: A scoping review and systematic evidence map of the epidemiological literature. Environmental Health Perspectives, 131(9), 096001.
6. Pickering, K. (2022. Nonresponse in census surveys. Federal Economic Statistics Advisory Committee. U.S. Bureau of Economic Analysis. https://apps.bea.gov/fesac/meetings/2022-12-09/Pickering-FESACNonresponse-in-Census-Surveys-12092022.pdf

Transportation Expense

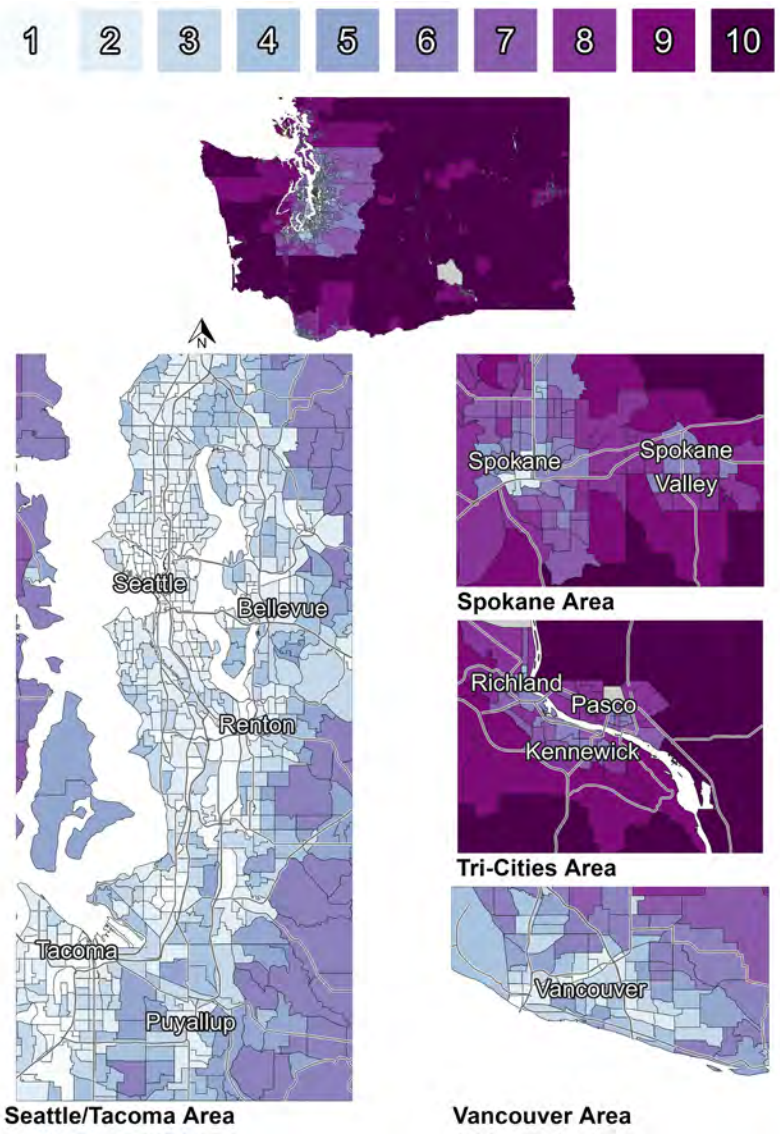
Overview

Transportation costs directly affect how much money households have for other essentials, such as food and health care. High costs can be a burden for people with fewer financial resources. Communities with limited access to transit, such as rural areas, may have higher transportation costs. This measure shows transportation costs as a percentage of a community's average income.

Transportation Expense

This map shows decile rankings for the average percent of income spent on transportation-related expenses, 2019

Ranks range from 1 (least impacted) to 10 (most impacted)



Background

Transportation expenses are a key social determinant of health. For many, transportation takes up a large part of their budget. This can make it harder for people to afford other important things, like housing, food, or services such as healthcare.

People in rural areas often face bigger challenges with transportation costs. These areas have longer distances and fewer public transportation options, so people rely more on private vehicles. Owning a car is more expensive than using public transportation and creates more pollution. Driving longer distances also costs more and produces more emissions. Rural areas may already have pollution from nearby highways and agricultural operations. Emissions from long drives add to this concern. Limited transportation options in rural areas also impacts safety. Transportation infrastructure gaps can make it harder to evacuate in emergencies like wildfires or floods. This puts people in rural areas at greater risk from environmental threats.

Less financially supported households may live farther away from cities because that's where they can find cheaper housing. But living farther away means they also spend more on transportation, even though they are less likely to have the means to afford it.

Transportation costs also affect health directly. When people can't afford transportation, they may not get the medical care they need or may delay it. This can lead to long-term health problems, like chronic conditions, stress, and depression.

Evidence

In the U.S., transportation is the second-largest household expense. People in rural areas spend more on transportation than those in cities [1]. Less financially supported households in rural areas tend to be located closer to highways, exposing residents to more air pollution [2]. High transportation costs can cause delays in medical care and worsen health problems [3, 4]. In rural areas, people may face more risk from things like wildfires, which can lead to respiratory problems and even death [5].

Data Source

This measure utilizes the transportation expense component, variable "T_80ami", of the Housing and Transportation Index from the 2022 data release from the Center for Neighborhood Technology (CNT).

Methods

The U.S. Census Bureau's American Community Survey (ACS) asks detailed questions on social and economic topics. This measure shows transportation costs as a percentage of income for a region's average household. It incorporates data on auto ownership, auto use, and transit use from the 2022 ACS. ACS data is collected and processed, refer to ACS General Data Users Handbooks.

For more information, refer to CNT Methodology documentation.

Caveats

The index is intended for use by researchers, developers, planners, and policymakers to enhance their understanding of the cost burden of transportation. Factors such as car ownership can change quickly, so this measure be less accurate than measures that change more slowly. Additionally, this measure relies on the median household income for the entire census tract, which makes it less likely to identify tracts with significant income disparities.

This measure uses data from the ACS. The ACS is known to undercount some populations, especially people who do not have stable housing.

This measure is aggregated across the census tract and does not represent each individual community within the tract. These data should always be supplemented with local data and equitable engagement for more accurate insights.

Sources

1. Bureau of Transportation Statistics. (2023). Transportation Economic Trends: Transportation expenditures by household income and geography. U.S. Department of Transportation. Retrieved from https://data.bts.gov/stories/s/ida7-k95k
2. American Lung Association. (2024). Who is at risk from air pollution? Retrieved from https://www.lung.org/clean-air/outdoors/who-is-at-risk
3. World Health Organization (WHO). (2012). Health and environmental impacts of transportation. WHO Regional Office for Europe.
4. Cristancho, S., Peters, R., Manderson, L. (2008). Transportation barriers to health care in rural areas: A case study. Journal of Rural Health, 24(4), 387-394.
5. Giving Compass. (2024). The physical and mental toll of wildfire smoke on rural communities. Giving Compass. https://givingcompass.org/article/the-physical-and-mental-toll-of-wildfire-smoke-on-rural-communities

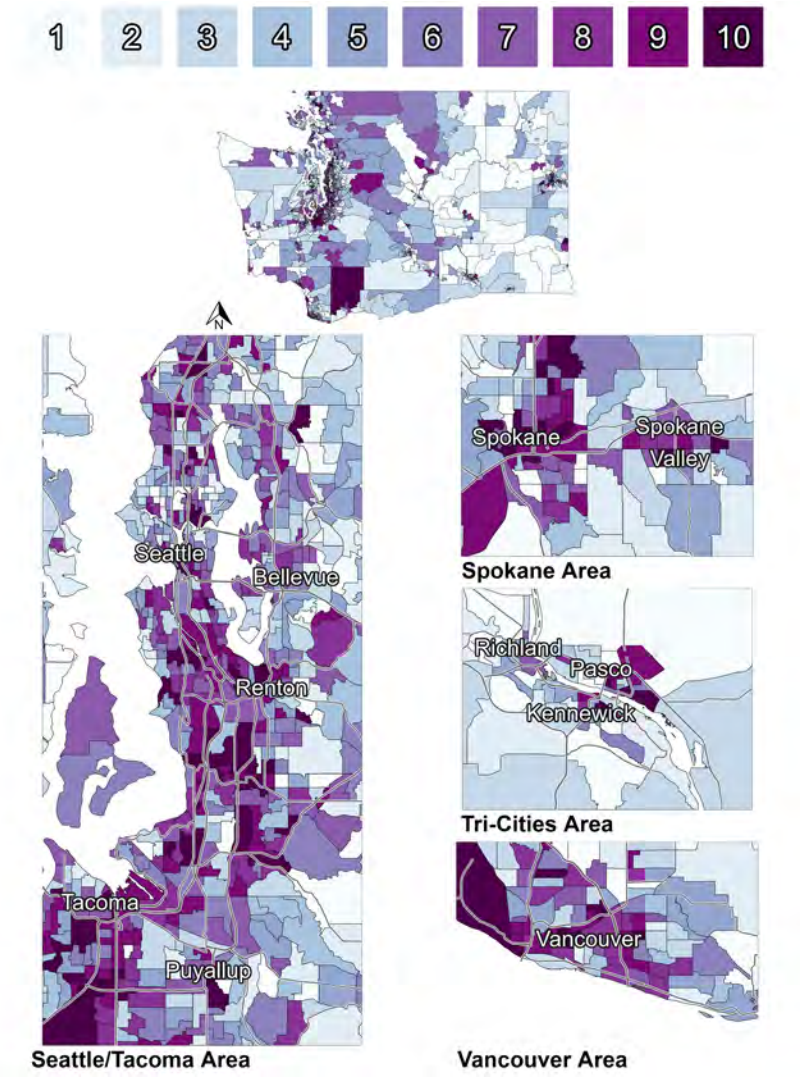
Unaffordable Housing (>30% of Income)

Overview

Housing costs affect how much money households have for other essentials, such as food and health care. Washington is in a housing affordability crisis. Low income and historically minoritized communities are the most affected. This measure shows the percentage of households that spend over 30 percent of their income on housing.

Unaffordable Housing

This map shows decile rankings for the percent of people who spend over 30% of their income on housing costs, 2019-2023
Ranks range from 1 (least impacted) to 10 (most impacted)



Background

The U.S. Department of Housing and Urban Development calls a household "cost-burdened" if they spend over 30 percent of their income on housing. Rising rent, lack of housing, and stagnant wages have led to a crisis in housing affordability. Without a financial safety net, emergency expenses or job loss can cause people to lose their homes.

Renters and households with less financial opportunity are the most impacted by the housing affordability crisis. Redlining, laws, and practices systematically excluded people of color from home ownership. This has resulted in the housing crisis disproportionately impacting historically minoritized communities.

Housing cost burden is related to many of the socioeconomic conditions that affect health and well-being. People trying to find affordable housing may be forced to live in areas with more pollution. As a result, people experiencing housing cost burden are at higher risk of exposure to air pollution and loss of life.

People experiencing housing cost burden may have to choose between paying for housing or other necessities. They may also delay medical care and services due to financial insecurity. This can lead to long-term health impacts. Chronic stress from worrying about the ability to pay for housing can also worsen physical and mental health.

Evidence

Housing cost burdens influence health in many ways. These include financial stress and the unaffordability of basic necessities such as healthy food or health care services [1, 2].

There is a strong link between housing burden and health disparities such as hypertension [3], mental health status [4], and cancer [5].

Increasing income inequality affects how burdened communities are by housing costs [6]. In Washington, 43 percent of all households, and 65 percent of households that are renting, are housing burdened.

Data Source

American Community Survey 5-year estimates, 2019-2023, DP04 - Selected Housing Characteristics

Methods

The U.S. Census Bureau's American Community Survey (ACS) asks respondents detailed questions on social and economic topics. This measure was developed using census tract-level housing data from the ACS's 2018-2022 5-year estimates.

This measure represents the percent of households that report spending over 30 percent of their gross income on housing in the past 12 months. Total housing costs include rent or mortgage, utilities, taxes, insurance, and other housing fees such as condo fees.

For more information on how ACS data is collected and processed, refer to ACS General Data Users Handbooks.

Data Source	Variables Used	Calculations Performed*
ACS 5-year average, DP04 - Selected Housing Characteristics	B25140_001, B25140_003, B25140_004, B25140_007, B25140_008, B25140_011, B25140_012	# Households spending >30% of income on housing: sum(B25140_003, B25140_004, B25140_007, B25140_008, B25140_011, B25140_012) # Housing units: B25140_001 % Households spending >30% of income on housing: sum (B25140_003, B25140_004, B25140_007, B25140_008, B25140_011, B25140_012) / B25140_001

* For margin of error (MOE) calculations, refer to U.S. Census Bureau, A Compass for Understanding and Using American Community Survey Data Appendix 1. For MOEs in which we derived either the numerator or denominator of a proportion from multiple ACS variables, see "Calculating MOEs for Aggregated Count Data." For MOEs derived from proportions, see "Calculating MOEs for Derived Proportions." The data table shows the estimate for this variable minus the MOE (lower ME) and the estimate plus the MOE (upper ME).

Caveats

The measurement of income used for this measure does not reflect noncash benefits such as food stamps, healthcare, and housing assistance. Additionally, studies have shown that non-wage income is typically underreported on the ACS.

The margin of error shows how much uncertainty there is about whether the survey data accurately represents the full population. The confidence interval is the estimate plus or minus the margin of error. There is a 90 percent probability that the true population value is within the confidence interval, after accounting for sampling variability.

All survey data have some margin of error due to sampling variability. Results from smaller populations are less reliable because of their smaller sample sizes, leading to a larger margin of error. Counts for American Indian, Alaska Native, Native Hawaiian, and Pasifika populations are known to be less reliable. The survey design attempts to address these issues through increased sampling rates in smaller populations and on Tribal lands.

The data may also have non-sampling errors, which aren't shown in the tables. These can happen if there are problems with the survey questions, if there are issues with processing or weighting the

data, or if certain groups of people don't respond [7]. Individuals with a distrust for government, more concerns about privacy, and who are very busy are less likely to respond to the survey.

This measure is aggregated across the census tract and does not represent each individual community within the tract. These data should always be supplemented with local data and equitable engagement for more accurate insights.

ACS bundles data in one-year, three-year, or five-year groups to get more reliable results. To have census tract data on all 39 counties in Washington, we use the ACS five-year grouping.

Sources

1. Harkness, J., Newman, S. (2005). Housing affordability and children's well-being: Evidence from the national survey of America's families. Housing Policy Debate, 16(2), 223-55.
2. Meltzer, R., Schwartz, A. (2015). Housing affordability and health: evidence from New York City. Housing Policy Debate, 26(1), 1-25.
3. Pollack, C., Griffin, B., Lynch, J. (2010). Housing affordability and health among homeowners and renters. American Journal of Preventive Medicine, 39(6), 515-21.
4. Baker, E., Lester, L., Mason, K., Bentley, R. (2020). Mental health and prolonged exposure to unaffordable housing: a longitudinal analysis. Social Psychiatry and Psychiatric Epidemiology, 55, 715–721.
5. Thompson, C., Nianogo, R., Leonard, T. (2024). Unaffordable housing and cancer: novel insights into a complex question. JNCI Cancer Spectrum. 8(3). 1-3.
6. Dunn, J. (2000). Housing and Health Inequalities: Review and Prospects for Research. Housing Studies, 15(3), 341-66.
7. Pickering, K. (2022, December 9). Nonresponse in census surveys [PDF]. Federal Economic Statistics Advisory Committee. U.S. Bureau of Economic Analysis. https://apps.bea.gov/fesac/meetings/2022-12-09/Pickering-FESACNonresponse-in-Census-Surveys-12092022.pdf

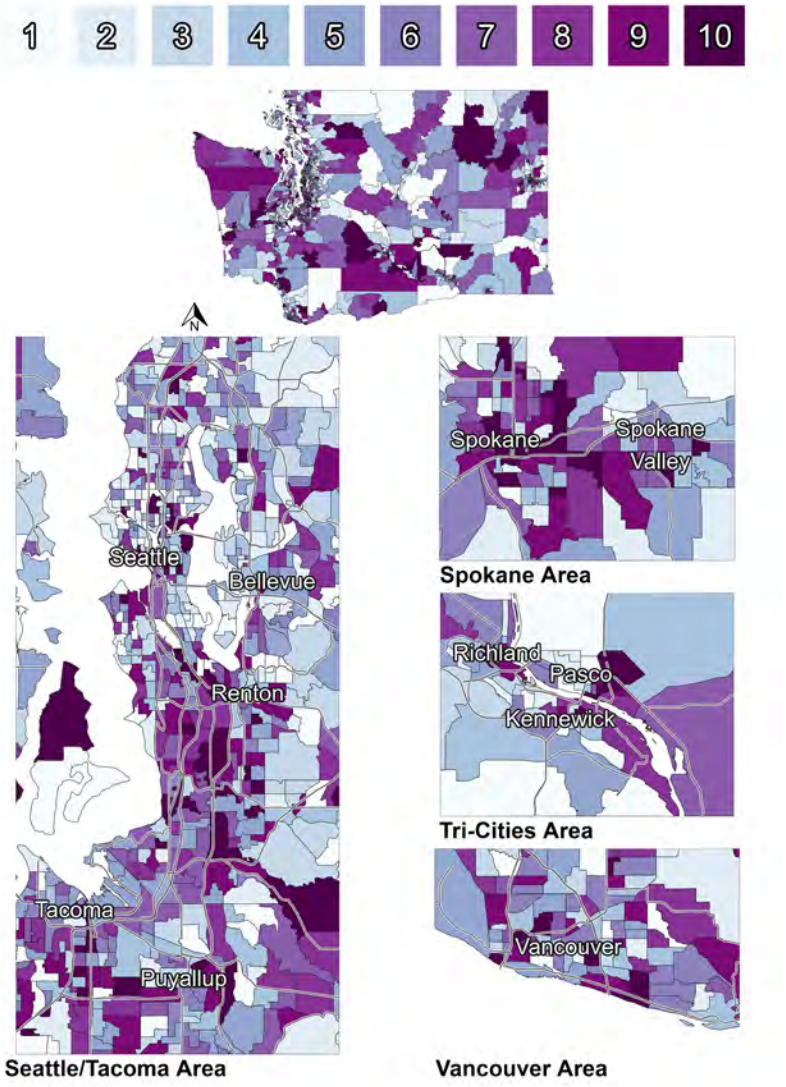
Unemployment

Overview

Jobs can provide access to health care, improve living conditions, and reduce financial stress. Not all people have equal access to stable, well-paying jobs. Barriers and discrimination contribute to disparities in employment. Historically minoritized communities, women, and people with disabilities are most affected. This measure shows the percentage of the civilian labor force that does not have a job and is searching for work.

Unemployment

This map shows decile rankings for the percent of people over 16 who are unemployed, 2019-2023
Ranks range from 1 (least impacted) to 10 (most impacted)



Background

Unemployment is a major factor in health and well-being. Employment opportunities vary across Washington state. Communities of color experience greater risk of higher levels of unemployment. This does not only stem from individual-level bias. It also comes from structural inequities in education, the justice system, business and government investment.

Being unemployed can increase financial and emotional stress. This, in turn, can significantly impact mental and physical health. Long-term unemployment may lead to increased sickness and death. For example, communities with high unemployment rates tend to also have higher rates of heart disease.

While unemployed, people may experience financial strain. As a result, they may have reduced access to healthcare, insurance, and nutritious food. This leads to an increased risk of adverse health outcomes. Unemployment may also lead people to seek housing in areas that are more affordable but are exposed to higher levels of pollution. Chronic stress from unemployment may also lead to an increased susceptibility to environmental pollutants.

Evidence

Community unemployment rates are correlated with pollution emissions [1] and vehicle-related particulate matter pollution [2].

Unemployment is also closely tied to negative health outcomes. Unemployed people report experiencing more physical and mental unhealthy days [3]. They experience higher levels of atherosclerosis that may lead to heart disease [4] and higher mortality rates [5]. Long-term unemployment may increase risk of developing aging-related diseases [6].

Data Source

American Community Survey 5-year estimates, 2019-2023, DP03 - Selected Economic Characteristics

Methods

The U.S. Census Bureau's American Community Survey (ACS) asks respondents detailed questions on social and economic topics. This measure was developed using census tract-level employment data from the ACS's 2018-2022 5-year estimates.

This measure represents the percent of the population in the civilian workforce over 16 years old that report being unemployed. The ACS counts people as "unemployed" if they did not work in the last week for reasons other than temporary absence (vacation, illness, etc.) AND were actively looking for work in the last 4 weeks AND were available to start a job. This number also includes individuals who are waiting to be recalled to a job they were laid off from.

For more information on how ACS data is collected and processed, refer to ACS General Data Users Handbooks.

Data Source	Variables Used	Calculations Performed*
ACS 5-year average, DP03 – Selected Economic Characteristics	DP03_0003, DP03_0005, DP03_0009P	# unemployed: DP03_0005 # in the civilian labor force: DP03_0003 % of civilian labor force unemployed: DP03_0009P

* For margin of error (MOE) calculations, refer to U.S. Census Bureau, A Compass for Understanding and Using American Community Survey Data Appendix 1. For MOEs in which we either derived the numerator or denominator of a proportion from multiple ACS variables, see "Calculating MOEs for Aggregated Count Data." For MOEs derived from proportions, see "Calculating MOEs for Derived Proportions." The data table shows the estimate for this variable minus the MOE (lower ME) and the estimate plus the MOE (upper ME).

Caveats

The margin of error shows how much uncertainty there is about whether the survey data accurately represents the full population. The confidence interval is the estimate plus or minus the margin of error. There is a 90 percent probability that the true population value is within the confidence interval, after accounting for sampling variability.

All survey data have some margin of error due to sampling variability. Results from smaller populations are less reliable because of their smaller sample sizes, leading to a larger margin of error. Counts for American Indian, Alaska Native, Native Hawaiian, and Pasifika populations are known to be less reliable. The survey design attempts to address these issues through increased sampling rates in smaller populations and on Tribal lands.

The data may also have non-sampling errors, which aren't shown in the tables. These can happen if there are problems with the survey questions, if there are issues with processing or weighting the data, or if certain groups of people don't respond [7]. Individuals with a distrust for government, more concerns about privacy, and who are very busy are less likely to respond to the survey.

This measure is aggregated across the census tract and does not represent each individual community within the tract. These data should always be supplemented with local data and equitable engagement for more accurate insights.

ACS bundles data in one-year, three-year, or five-year groups to get more reliable results. To have census tract data on all 39 counties in Washington, we use the ACS five-year grouping.

Sources

1. Premji, S., Bertrand, F., Smargiassi, A., Daniel, M. (2007). Socioeconomic correlates of municipal-level pollution emissions on Montreal Island. Canadian Journal of Public Health, 98(2), 138-42.

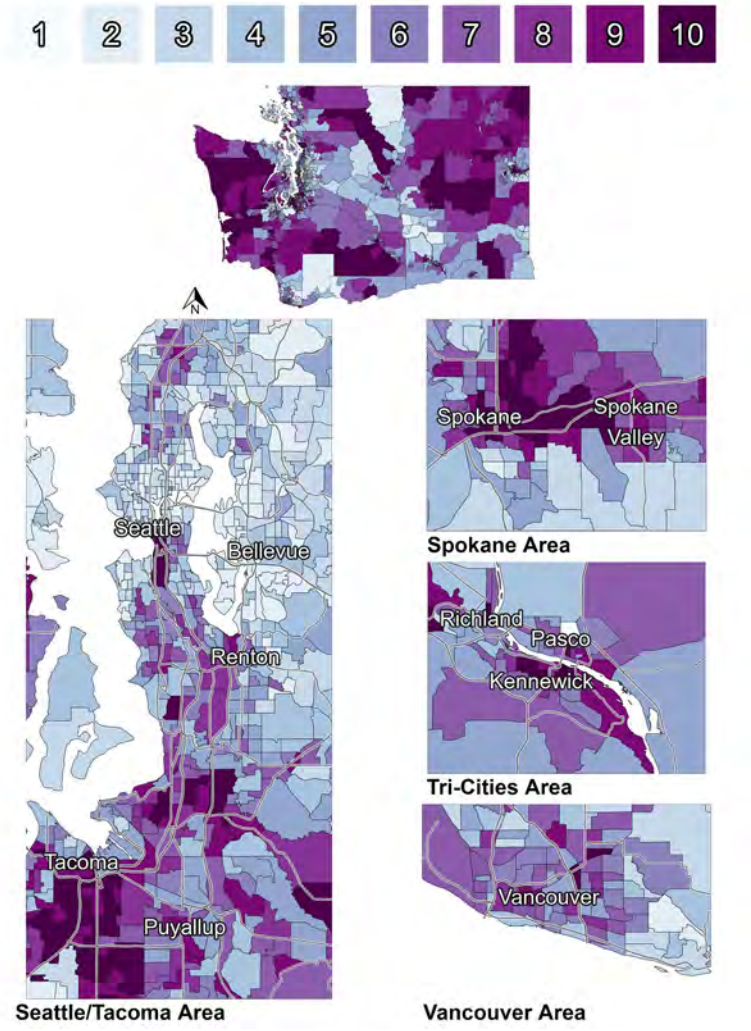
2. Davis, M., Laden, F., Hart, J., Garshick, E., Smith, T. (2010). Economic activity and trends in ambient air pollution. Environmental Health Perspectives, 118(5), 614-9.
3. Athar, H., Chang, M., Hahn, R., Walker, E., & Yoon, P. (2013). Unemployment - United States, 2006 and 2010. MMWR-Morbidity and Mortality Weekly Report, 62(3), 27-32.
4. Dragano, N., Hoffmann, B., Stang, A., Moebus, S., Verde, P., Weyers, E., et al. (2009). Subclinical coronary atherosclerosis and neighbourhood deprivation in an urban region. European Journal of Epidemiology, 24(1), 25-35.
5. Tapia Granados, J., House, J., Ionides, E., Burgard, S., Schoeni, R. (2014). Individual joblessness, contextual unemployment, and mortality risk. American Journal of Epidemiology, 180(3), 280-7.
6. Ala-Mursula, L., Buxton, J., Ek, E., Koiranen, M., Taanila, A., Blakemore, A., et al. (2013). Long-term unemployment is associated with short telomeres in 31-year-old men: An observational study in the northern Finland birth cohort 1966. PLoS One, 8(11), E80094.
7. Pickering, K. (2022). Nonresponse in census surveys [PDF]. Federal Economic Statistics Advisory Committee. U.S. Bureau of Economic Analysis. https://apps.bea.gov/fesac/meetings/2022-12-09/Pickering-FESACNonresponse-in-Census-Surveys-12092022.pdf

Population Characteristics - Sensitive Populations Theme

People with health conditions are more likely to experience worse health issues due to pollution exposure. Current and historical social injustices cause disparities that increase these health conditions. Sensitive populations include those with heart disease, low birth weight, respiratory disease, and disabilities.

Sensitive Populations Theme

This map shows decile rankings for the combination of all measures
in the Sensitive Populations theme
Ranks range from 1 (least impacted) to 10 (most impacted)



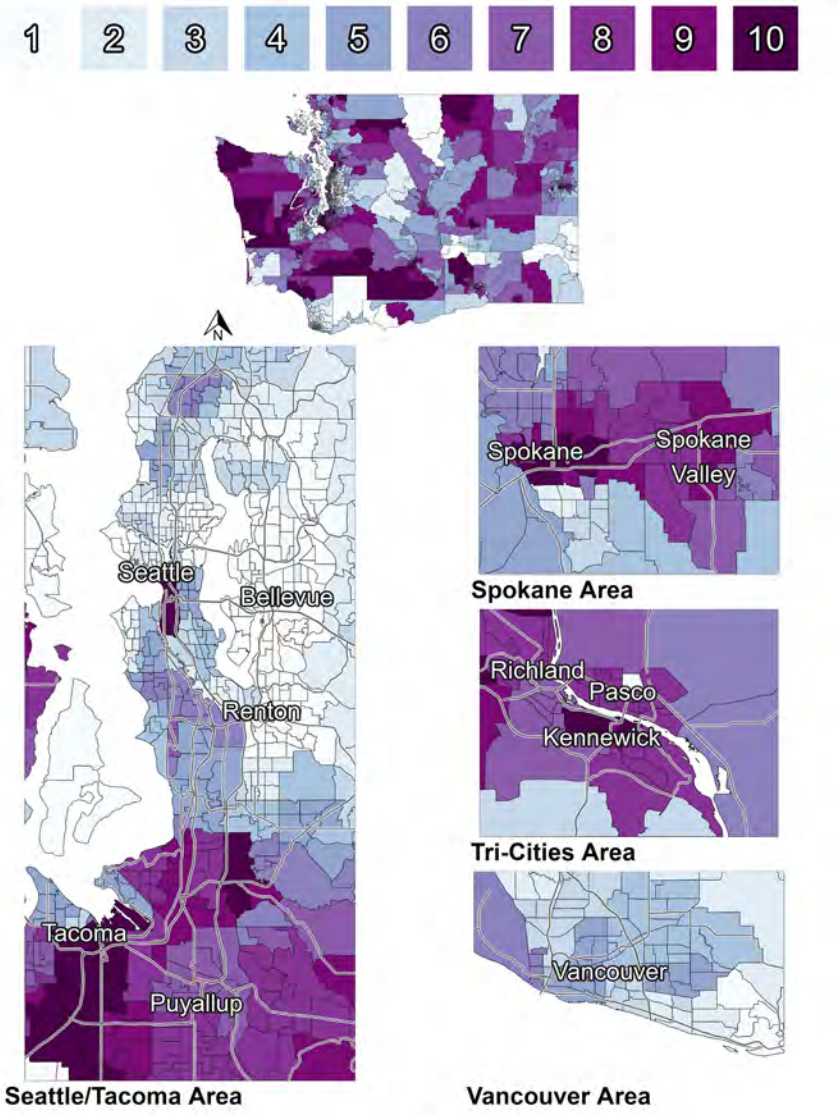
Air Quality-Related Respiratory Disease

Overview

People with lung conditions such as asthma and chronic obstructive airway disease are more sensitive to air pollution. This measure shows emergency department visits for respiratory diseases that are associated with air pollution.

Air Quality-Related Respiratory Disease

This map shows decile rankings for the age-adjusted rate of emergency department visits for respiratory disease related to air quality, 2023
Ranks range from 1 (least impacted) to 10 (most impacted)



Background

People with asthma and other lung diseases are at a higher risk of experiencing health problems from air pollution. Air pollutants irritate the lungs and cause inflammation. This leads to decreased lung functioning. The result can be difficulty breathing, asthma attacks, and loss of life. Outdoor air pollution sources include vehicle exhaust, fire smoke, factory emissions, and livestock farming. Indoor air pollution can be caused by lack of filtration systems, cooking, pets, or mold.
Not everyone has the same risk of air quality-related respiratory disease. Disparities in childhood asthma rates between racial and ethnic groups have increased over the last 10 years. Communities of color have childhood asthma rates 7.5 times higher than mostly white communities. We discuss disparities in pollution exposure that cause these disparities more in depth in our environmental exposure data notes.
Climate-related risks, like wildfires and rising temperatures, increase air pollution and its effects on people's lungs. Communities of color are more impacted by climate change and its health effects.

Evidence
Multiple sources of air pollution worsen asthma by damaging the lungs and airways [1]. One study found traffic-related pollution was responsible for 14% of childhood asthma cases [2]. Outdoor air pollutants correlate with increased symptoms and death among people with chronic obstructive pulmonary disease [3]. Short-term exposure to ozone and particle pollution is associated with lower lung function in children [4].
Nitrogen dioxide pollution contributes to significantly higher rates of childhood asthma in communities of color. This disparity has increased by 19% over the past 10 years [5]. Overall air pollution exposure has decreased, but not everyone has benefited equally. Black, Hispanic, Asian, and other people of color are systemically exposed to more air pollution than whites. This is a lasting impact of racist housing policy [6].
Particle matter and ozone concentration increase with droughts, air stagnation, and wildfire severity. Extreme heat increases the toxic effect of allergens and pollutants [7].

Data Source
Rapid Health Information Network (RHINO) syndromic surveillance data on emergency department visits, 2023

Methods
This measure shows the age-adjusted rate of emergency department visits for “air quality-related respiratory illness” per 1,000 people. It includes visits with chief complaint terms and diagnosis codes for:

- Asthma
- Chronic obstructive airway disease
- Chronic obstructive lung disease
- Chronic obstructive pulmonary disease
- Acute bronchitis
- Emphysema
- Bronc asthma

- Reactive airway disease
- Acute respiratory distress syndrome
- Difficulty breathing
- Chest tightness
- Dyspnea
- Shortness of breath
- Wheezing

It does not include visits with complaints related to fever and congestion. This is to avoid including visits related to infectious disease.

These visits are reported at the zip code level. To create this measure, we summed zip code counts by age group. We calculated the age-adjusted rate of emergency department visits per 1,000 people for each zip code. We use the age-adjusted rate to account for differences in population age. Older people are more likely to experience cardiovascular events, and communities have different age distributions. Age-adjusted rates ensure that the differences we see between communities are not due to differences in the ages of their populations.
To get census tract rates, we multiplied zip code rates by the proportion of people in each census tract within a zip code.

Caveats
This measure does not capture the full burden of lung conditions in the population. It only counts emergency department visits. People who are able to control their asthma with medications prescribed by their primary care doctor and people who do not seek health care are not accounted for in this measure.

Sources

1. Guarnieri, M., Balmes, J.R. (2014). Outdoor air pollution and asthma. Lancet. 383(9928), 1581-92.
2. Perez, L., Declercq, C., Iniguez, C., Aguilera, I., Badaloni, C., Ballester, F. et al. (2013). Chronic burden of near-roadway traffic pollution in 10 European cities (APHEKOM network), Eur Respir J, 42, 594–605.
3. Hansel, N.N., McCormack, M.C., & Kim, V. (2015). The Effects of Air Pollution and Temperature on COPD. COPD: Journal of Chronic Obstructive Pulmonary Disease, 13(3), 372–379.
4. Garcia, E., Rice, M.B., Gold, D.R. (2021). Air pollution and lung function in children. Journal of Allergy and Clinical Immunology. 148(1), 1-14.
5. Kerr, G.H., van Donkelaar, A., Martin, R.V., Brauer, M., Bukart, K., Wozniak, S., et al. (2024). Increasing racial and ethnic disparities in ambient air pollution—attributable morbidity and mortality in the United States. Environ Health Perspect, 132(3), 37002.
6. Tessum, C.W., Paolella, D.A., Chambliss, S.E., Apte, J.S., Hill, J.D., & Marshall, J.D. (2021). PM2. 5 polluters disproportionately and systemically affect people of color in the United States. Science Advances, 7(18), eabf4491.
7. Deng, S.Z., Jalaludin, B.B., Antó, J.M., Hess, J.J., Huang, C.R. (2020). Climate change, air pollution, and allergic respiratory diseases: a call to action for health professionals. Chinese medical journal, 133(13), 1552-1560.

Death from Cardiovascular Disease

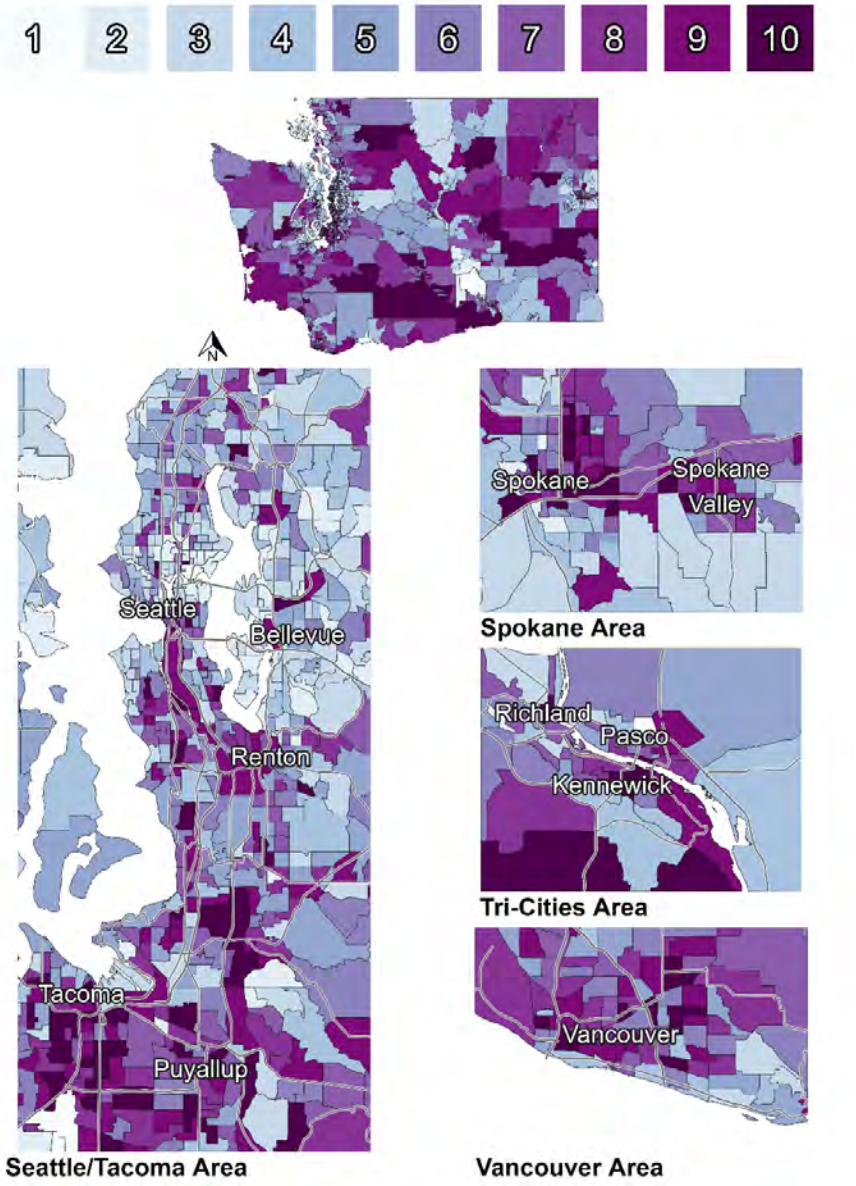
Overview

Cardiovascular disease is closely linked to health equity. Social, economic, and environmental factors create disparities in cardiovascular health and access to care. This measure shows the number of deaths from cardiovascular disease per 100,000 people.

Death from Cardiovascular Disease

This map shows decile rankings for the age-adjusted rate of death from cardiovascular disease, 2020-2024

Ranks range from 1 (least impacted) to 10 (most impacted)



Background

Cardiovascular disease is the leading cause of death in Washington state. Cardiovascular diseases are caused by heart muscles and vessels narrowing or being blocked. Risk factors for cardiovascular disease include:

- Air pollution
- Diet
- Exercise
- Smoking
- High blood pressure
- Diabetes

Many of these risk factors are connected to existing structural inequalities, from food systems that don't provide accessible nutritious food to disparities in pollution exposure.

People with cardiovascular disease experience greater loss of life when exposed to pollution. Historically minoritized populations are the most impacted by this because they experience more heart disease. Non-Hispanic Black people experience the highest rates of cardiovascular disease.

Evidence

Long-term exposure to pollution reduces life expectancy in people with cardiovascular disease [1]. People with heart disease have a higher risk of death when exposed to pollution [2, 3].

Short-term exposure to air pollution is linked to acute coronary events [4, 5]. Survivors of acute coronary events have a higher death rate when exposed to higher levels of air pollution [6].

Non-Hispanic Black people face the highest cardiovascular disease death rates [7].

Data Source

Washington State Department of Health, Center for Health Statistics, death certificate data, 2020-2024.

Methods

This measure uses cardiovascular disease death data from DOH's Center for Health Statistics. The Center for Health Statistics collects information on the deaths of Washington state residents from their death certificates. It includes the deaths of Washington state residents that died in other states or in Canada. A medical provider or examiner determines the underlying cause of death and records it on the death certificate. The underlying cause of death is the disease or injury that started the course of events that led directly to death. Deaths from cardiovascular diseases include major cardiovascular diseases, which is a group of the 113 selected causes of death list from the National Center for Health Statistics. This group of causes of death includes codes 100-178 from the International Classification of Diseases, 10th revision.

This measure shows the age-adjusted rate of deaths per 100,000 people due to cardiovascular disease. We use the age-adjusted rate to account for differences in population age. Older people are more likely to experience cardiovascular events, and communities have different age distributions. Age-adjusted rates ensure that the differences we see between communities are not due to differences in the ages of their populations.

Caveats

Not everyone with cardiovascular disease dies from it. Therefore, death data underestimates the true population with heart disease. This measure serves as a proxy for the prevalence of cardiovascular disease.

The Center for Health Statistics estimates that death certificate data is 99% complete.

Sources

1. Brook, R., Rajagopalan, S., Pope, A., Brook, J., Bhatnagar, A., Diez-Roux, A., et al. (2010). Particulate matter air pollution and cardiovascular disease: An update to the scientific statement from the American Heart Association. Circulation, 121(21), 2331-78.
2. Bateson, T., & Schwartz, J. (2004). Who is sensitive to the effects of particulate air pollution on mortality? A case-crossover analysis of effect modifiers. Epidemiology, 15(2), 143-9.
3. Chen, H., Burnett, R., Copes, R., Kwong, J., Villeneuve, P., Goldberg, M., et al. (2016). Ambient fine particulate matter and mortality among survivors of myocardial infarction: population-based cohort study. Environmental Health Perspectives, 124(9), 1421-8.
4. Pope, C., Muhlestein, J., May, H., Renlund, D., Anderson, J., & Horne, B. (2006). Ischemic heart disease events triggered by short-term exposure to fine particulate air pollution. Circulation, 114(23), 2443-8.
5. Von Klot, S., Gryparis, A., Tonne, C., Yanosky, J., Coull, B., Goldberg, R., et al. (2009). Elemental carbon exposure at residence and survival after acute myocardial infarction. Epidemiology, 20(4), 547-54.
6. Berglind, N., Bellander, T., Forastiere, F., Von Klot, S., Aalto, P., Elosua, R., et al. (2009). Ambient air pollution and daily mortality among survivors of myocardial infarction. Epidemiology, 20(1), 110-8.
7. Centers for Disease Control (CDC). (2019). Spotlight, Racial and Ethnic Disparities in Heart Disease. Racial and Ethnic Disparities in Heart Disease.

Low Birth Weight

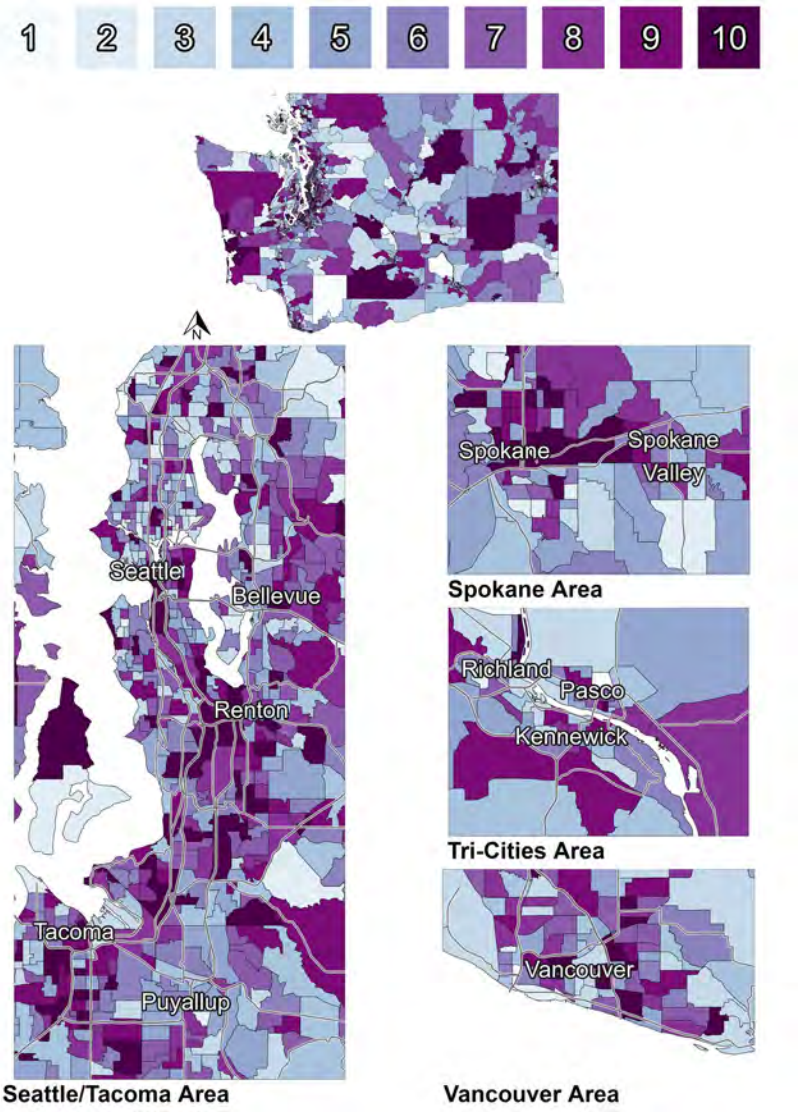
Overview

Low birth weight is an important marker for overall population health. It reflects disparities in maternal health and prenatal care. This measure shows the percentage of infants who are born with low birth weight. Babies born weighing under 2500 grams (approx. 5.5 pounds) are considered to be low birth weight.

Low Birth Weight

This map shows decile rankings for the number of infants with a birth weight under 5.5 pounds, 2020-2024

Ranks range from 1 (least impacted) to 10 (most impacted)



Background

Low birth weight (LBW) is a globally recognized marker for population health. Disparities in LBW show where there are disparities in maternal health. Because of these disparities, infants born to Black mothers are more likely to be LBW than infants born to white mothers. Programs like Women, Infants, and Children (WIC) support growth and nutrition to help address some of the disparities that lead to LBW.

Risk factors associated with LBW include:

- Nutritional status.
- Prenatal care.
- Stress.
- Maternal smoking.
- Maternal age (over 40 or under 20 years old).

Prenatal exposure to pollution and pesticides can also increase the risk of LBW. People born with LBW are more vulnerable to pollution throughout their lives.

Evidence

Babies born with LBW are at risk for infant death and developing health problems later in life. These include coronary heart disease, type 2 diabetes, and asthma [1, 2, 3].

Exposure to air pollution [4], traffic pollution [5], and pesticides [6] are linked to LBW.

Infants born to Black mothers are 2.4 times more likely to be LBW than infants born to white mothers [7]. Participation in WIC programs can reduce these health disparities by providing nutrition and assistance with getting prenatal care [8].

Data Source

Washington State Department of Health, Center for Health Statistics, data from birth certificates, 2020-2024.

Methods

This measure shows the percent of live-born singleton (one baby) infants born with a birth weight of less than 2500 grams (about 5.5 pounds) out of all live-born singleton infants born to people living in Washington. It includes babies born in Washington and babies born elsewhere to Washington residents.

We are only using data on singleton infants. Pregnancies with more than one baby are more likely to result in LBW infants because of physical limitations, rather than other health issues.

Caveats

This measure does not include people currently living in Washington who were born with LBW but were not Washington residents when they were born.

Sources

1. Barker, D., Eriksson, J., Forsn, T., & Osmond, C. (2002). Fetal origins of adult disease: Strength of effects and biological basis. International Journal of Epidemiology, 31(6), 1235-9.
2. Lu, M., & Halfon, C. (2003). Racial and ethnic disparities in birth outcomes: A life-course perspective. Maternal and Child Health Journal, 7(1), 13-30.
3. Nepomnyaschy, L., & Reichman, N. (2006). Low birthweight and asthma among young urban children. American Journal of Public Health, 96(9), 1604-10.
4. Westergaard, N., Gehring, U., Slama, R., & Pedersen, M. (2017). Ambient air pollution and low birth weight—are some women more vulnerable than others? Environment International, 104, 146-54.
5. Ghosh, J., Wilhelm, M., Su, J., Goldberg, D., Cockburn, M., Jerrett, M., et al. (2012). Assessing the influence of traffic-related air pollution on risk of term low birth weight on the basis of land-use-based regression models and measures of air toxics. American Journal of Epidemiology, 175(12), 1262-74.
6. Harley, K., Huen, K., Schall, R., Holland, N., Bradman, A., Barr, D., et al. (2011). Association of organophosphate pesticide exposure and paraoxonase with birth outcome in Mexican-American women. Plos One, 6(8), e23923.
7. Ratnasiri, A., Parry, S., Arief, V.N. et al. (2018). Recent trends, risk factors, and disparities in low birth weight in California, 2005–2014: a retrospective study. Maternal Health, Neonatology, and Perinatology, 4(15).
8. Khanani, I., Elam, J., Hearn, R., Jones, C., & Maseru, N. (2011). The Impact of Prenatal WIC Participation on Infant Mortality and Racial Disparities. American Journal of Public Health 100; S204-S209.

People with a Disability

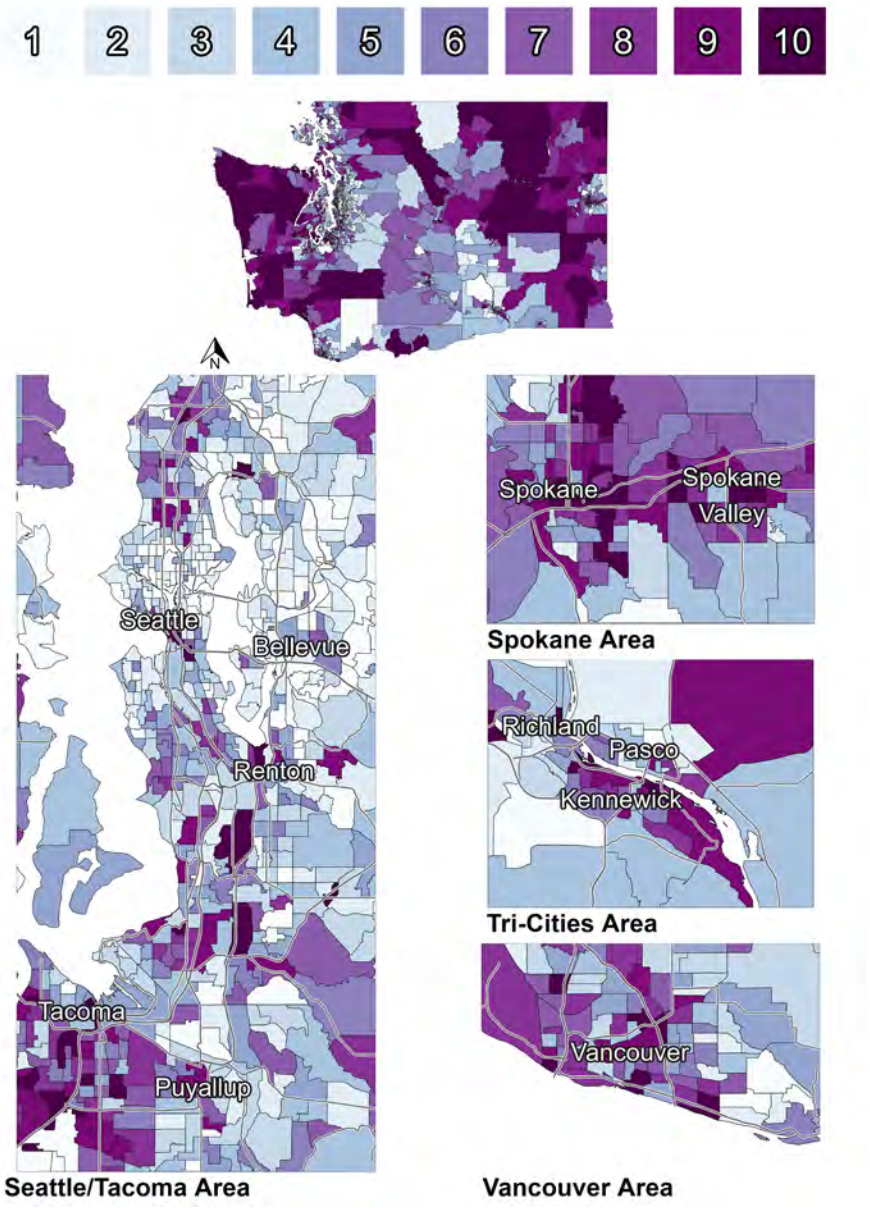
Overview

People with disabilities often experience greater health impacts due to pollution. This measure shows the percentage of the population that reports having at least one disability.

People with a Disability

This map shows decile rankings for the percent of the population that reports having one or more disabilities, 2019-2023

Ranks range from 1 (least impacted) to 10 (most impacted)



Background

Pollution does not impact people equally. People with disabilities are often more impacted by pollution than people without disabilities. Two major reasons for this are:

- Pollution is more harmful to their health.
- They are exposed to more pollution.

People with disabilities often experience greater overall physical and mental health challenges. This can be due to lack of access to health care, limited mobility, or increased rates of other chronic health conditions. As a result, they may be more vulnerable to the impacts of pollution. Furthermore, people with disabilities may struggle to obtain quality health care services. They may face financial, cultural, and structural barriers. This can make their health problems, including the impact of pollution, more severe.

Additionally, people with disabilities tend to have fewer financial resources. People living on a fixed income, such as Social Security Disability Insurance, are more likely to be limited to living in areas that have more pollution. There is more information about how income influences pollution exposure in the data note on Population Living in Poverty.

Disability intersects with other characteristics and identities such as age, race, education, housing, and health insurance coverage. The set of identities each person has influences their experience. Historically minoritized communities face a double burden. They have both higher rates of disability and face more inequities in health, social, and economic status.

Evidence

People with disabilities are disproportionately exposed to air pollution [1].

People living with disabilities are more likely to report greater health challenges. They also have higher rates of smoking, physical inactivity, and other chronic health conditions [2]. After adjusting for socioeconomic differences, adults with a disability are 2.9 times more likely to have heart disease, 1.6 times more likely to have cancer, and 2.6 times more likely to have diabetes [3].

This combination of higher levels of exposure and chronic disease puts them at greater risk of health issues from pollution [4].

Disability is not race and ethnicity neutral. Black and Hispanic adults with diabetes have a higher incidence of amputation than non-Hispanic white adults with diabetes. Non-Hispanic Black adults with a mobility disability are more likely to report difficulties with daily living activities, diabetes, and depression [5].

Data Source

American Community Survey 5-year estimates, S1810 - Selected Disability Characteristics

Methods

The U.S. Census Bureau's American Community Survey (ACS) asks respondents detailed questions on social and economic topics. This measure was developed using census tract-level disability characteristics data from the ACS's 5-year estimates.

This measure shows the percent of the non-institutionalized population that reports having at least one disability. The survey asks about six types of disabilities:

- Hearing
- Vision
- Cognitive
- Ambulatory
- Self-care
- Independent living

See the ACS disability page for more information on disability definitions.

For more information on how ACS data is collected and processed, refer to ACS General Data Users Handbooks.

Data Source	Variables Used	Calculations Performed*
ACS 5-year average, S1810, Disability Characteristics	S1810_C01_001, S1810_C01_019, S1810_C01_029, S1810_C01_039, S1810_C01_047	Non-institutionalized population: S1810_C01_001 # with 1 or more disabilities: sum(S1810_C01_019, S1810_C01_029, S1810_C01_039, S1810_C01_047) % with 1 or more disabilities: sum (S1810_C01_019, S1810_C01_029, S1810_C01_039, S1810_C01_047)/ S1810_C01_001

* For margin of error (MOE) calculations, refer to U.S. Census Bureau, A Compass for Understanding and Using American Community Survey Data Appendix 1. For MOEs in which we derived either the numerator or denominator of a proportion from multiple ACS variables, see "Calculating MOEs for Aggregated Count Data." For MOEs derived from proportions, see "Calculating MOEs for Derived Proportions." The data table shows the estimate for this variable minus the MOE (lower ME) and the estimate plus the MOE (upper ME).

Caveats

The set of questions used by the ACS is known to underestimate neurological disability, psychiatric disabilities, and chronic illnesses [6]. These questions only allow yes or no answers. This may leave out people with intermittent symptoms or who have technologies, medications, or services that mitigate their disability.

The margin of error shows how much uncertainty there is about whether the survey data accurately represents the full population. The confidence interval is the estimate plus or minus the margin of error. There is a 90 percent probability that the true population value is within the confidence interval, after accounting for sampling variability.

All survey data have some margin of error due to sampling variability. Results from smaller populations are less reliable because of their smaller sample sizes, leading to a larger margin of error. Counts for American Indian, Alaska Native, Native Hawaiian, and Pasifika populations are known to be less reliable. The survey design attempts to address these issues through increased sampling rates in smaller populations and on Tribal lands.

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ACS bundles data in one-year, three-year, or five-year groups to get more reliable results. To have census tract data on all 39 counties in Washington, we use the ACS five-year grouping.

Sources

1. Chakraborty, J. (2022). Disparities in exposure to fine particulate air pollution for people with disabilities in the US. Science of The Total Environment 842:156791.
2. Centers for Disease Control (CDC). (2024). Disability and Health. Related Conditions.
3. Dixon-Ibarra A, Horner-Johnson W. (2014). Disability Status as an Antecedent to Chronic Conditions: National Health Interview Survey, 2006–2012. Preventing Chronic Disease 11:130251.
4. Kodavanti UP. (2019). Susceptibility Variations in Air Pollution Health Effects: Incorporating Neuroendocrine Activation. Toxicologic Pathology. 47(8):962-975.
5. Blick R.N., Franklin M.D., Ellsworth D.W., Havercamp S.M., Kornblau, B.L. (2015). The Double Burden: Health Disparities Among People of Color Living with Disabilities. Ohio Disability and Health Program.
6. Hermans, A., Morriss, S., Popkin, S. 2024. An Opportunity for the Census Bureau to More Accurately Estimate the Disabled Population in the US. Urban Institute. https://www.urban.org/sites/default/files/2024-02/An_Opportunity_for_the_Census_Bureau_to_More_Accurately_Estimate_the_Disabled_Population_in_the_US.pdf.
7. Pickering, K. (2022, December 9). Nonresponse in census surveys [PDF]. Federal Economic Statistics Advisory Committee. U.S. Bureau of Economic Analysis. https://apps.bea.gov/fesac/meetings/2022-12-09/Pickering-FESACNonresponse-in-Census-Surveys-12092022.pdf.

Future Map Versions, Measures Under Exploration and Additional Tools

Future Map Versions

We are excited to continue to develop the EHD map. A short description of the currently planned development process is in the Timeline section of the Introduction.

In this section, we will share more details. We look forward to our continued work with the community and Tribal Nations as we develop the map. With the appropriate permission and respect from community partners, leaders, and DOH, we will:

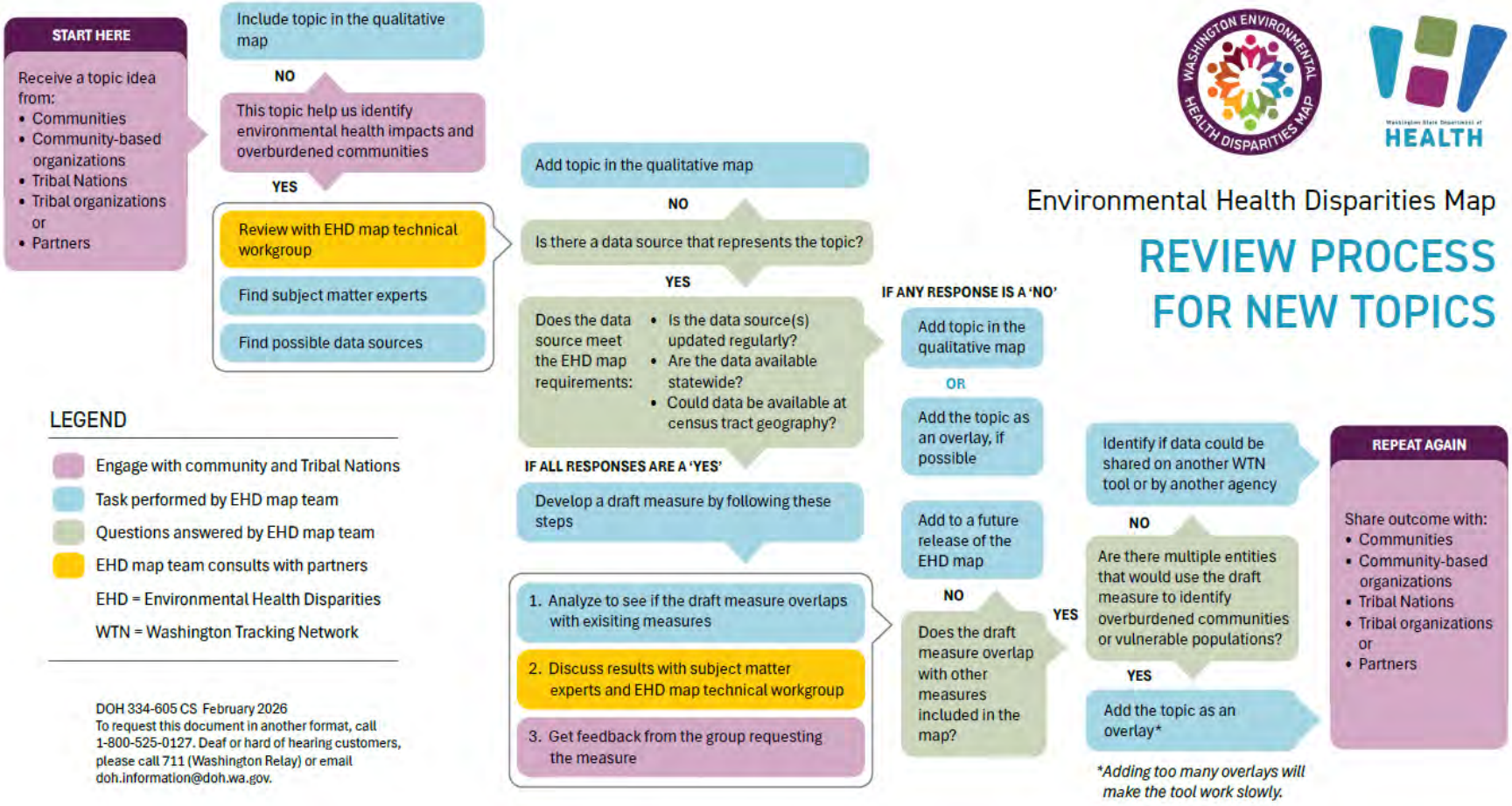
- Summarize and publish the concerns that were raised in the 2025 listening sessions on a qualitative map.
- Continue to engage with communities and Tribal Nations.
- Incorporate additional measures, overlays, resources, and tools as we are able.

As a state agency, we are fortunate to have received feedback thus far. The feedback covers many parts of the map. In reviewing this feedback, our team continues to ask ourselves, “Are there ways that we could make changes to the EHD map or guidance to make it more useful to communities and Tribes?”

Some of the feedback has included different categories of topics that are not currently represented on the map. These topics include environmental, social, and health concerns.

To help our team review these topics, we have developed a process for deciding how to best represent the concern, idea, or topic. This could look like adding a new EHD map measure overlay to the qualitative map or a future tool or resource.

Figure 9. Process for Reviewing New Topics to Consider for Future EHD Map Versions



The process starts with topics or concerns raised by communities and Tribes. Centering their lived experiences is the foundation of this work.

Since the EHD map represents environmental health disparities, the first step is to determine if the concern is connected to environmental health. If there is no connection, we can still document the concern in the qualitative map. If there is a connection, the EHD map team will consult with the EHD map technical workgroup. This will help us identify possible data sources and find subject matter experts.

This path leads to 2 main possible actions:

- **If there is no acceptable data source**, the team will document the concern in the qualitative map. An acceptable data source must 1.) represent the community or Tribal need, 2.) be updated regularly, and 3.) be available statewide at the census tract level.
- **If there is an acceptable data source**, the EHD map team develops a draft measure.

Every new draft measure requires an analysis. This determines whether the new measure provides information that is too similar to information already on the map. We will share results with the group(s) who raised the concern, the EHD map technical workgroup, and subject matter experts.

If agreement is reached about the composition and the value of the new measure, we will add it to a future EHD map version. This new measure will follow HEAL Act requirements. If agreement is not reached, the EHD map team will work closely with community, Tribes, and subject matter experts to investigate other ways to capture the concern and/or topic.

The above process relies on building trust and ensuring safety for community and Tribes. We are grateful to walk alongside them in this work and learn together. We recognize that healing begins by first identifying where harms have and are occurring. We hope to do this in a way that supports meaningful and transformative change.

Measures Under Exploration

We have started working on or plan to work on the following additional measures for future EHD map versions:

Health Care Access

During the community and Tribal listening sessions, health care access was brought up as a concern. Health care access continues to be one of the biggest factors defining health status, especially for historically minoritized populations. Access is also determined by geography, economic status, and cultural and social aspects (like language spoken), prejudice, and unfair treatment due to race.

Historically minoritized populations have lower satisfaction with health care and receive worse health care due to systemic racism. These complexities make it challenging to capture the different aspects of health care access.

Since the last version of the map, the team has explored different options to add a health care access measure. We were unable to create or identify a measure that captured the complexity of concerns. We will prioritize this in the next version.

Noise Pollution

During the first round of listening sessions and sessions since then, various communities brought up noise pollution as a concern. Environmental noise pollution is linked to traffic noise from roads, rails, maritime (sea), and air. These noises have shown to impact health in many ways, including sleep disturbance, learning difficulties, adverse birth outcomes, mental health disorders, hypertension, and heart disease. In this version of the map, these data have been added as an overlay. We will use the developed process to determine next steps.

Self-Sufficiency Standard

The self-sufficiency standard measures the income required for families to meet their basic needs without relying on public or private assistance. We have begun investigating whether we could replace the current poverty measure with the self-sufficiency standard data. This is because poverty fails to reflect the harsh economic realities faced by millions of families today.

The current definition of poverty is criticized for its flawed and outdated methodology. It is based on the outdated assumption that food costs make up one-third of a family's budget.[3] By 2022, the average family of 4 allocated only 13 percent of their budget to food.[4]

The self-sufficiency standard calculates the cost of housing, childcare, food, transportation, healthcare, and other costs families have. It is tailored to specific family types and geographic locations. The self-sufficiency standard is currently calculated at the county level. We will need to create a small area estimation to integrate this into the EHD map.

Mortgage Discrimination

Mortgage discrimination refers to lenders denying loans or giving higher interest rates to potential homebuyers based on characteristics such as race or neighborhood. This practice increases the risk of housing instability and is associated with the lasting impacts of racist housing policies such as redlining.

We have explored using data published by the Home Mortgage Disclosure Act (HMDA) to identify census tracts with higher interest loans. When we decided on the measures for this version of the map, the HMDA data had not yet been released for 2020 census tracts. So we were unable to include this measure. We will explore adding mortgage discrimination as an overlay or a measure in future versions.

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[3] Fisher, GM. (1992). The development and history of the poverty thresholds. Social Security Bulletin. 55(4), 43-6.
[4] Meyers, S, Paulin, GD, Thiel, K. (2023). Consumer expenditures in 2002. Report 1107. US Bureau of Labor Statistics.

Other Concerns and Topics

We have maintained a list of environmental risk factors from concerns raised before the 2024-2025 community engagement events. This is the list of concerns that are currently not included in the map:

- Access to traditional foods
- Climate change, health risk, and vulnerability
- Drinking water contaminants
- Fish and natural resource consumption rates
- Groundwater
- Harmful algal blooms
- Indoor air quality (mold)
- Intergenerational knowledge transfer
- Marine water quality
- Natural resource-dependent livelihoods
- Occupational risk
- Ocean acidification
- Septic system failures
- Stream temperature pollution
- Various built environment measures and tree canopy
- Wealth inequality

This is a list of concerns from the 2024-2025 non-Tribal community engagement activities:

- Lack of government accountability (local, state, and federal)
- Lack of accountability (housing and housing criteria)
- Lack of accountability (air quality)
- Lack of accountability for pollution dumping
- Lack of access to interpreters (linguistic isolation to resources)
- Lack of access to jobs
- Lack of accessibility to basic needs
- Lack of affordable childcare
- Lack of affordable healthcare and resources
- Lack of affordable housing to own (single-family)
- Lack of affordable and nutritious foods
- Lack of affordable indoor recreational locations for kids and adults
- Lack of affordable taxes
- Lack of caregiving training
- Lack of career development and skill opportunities
- Lack of community gardens
- Lack of culturally appropriate care
- Lack of digital access and education resources

- Lack of drinkable water
- Lack of education on how to advocate for one's child at school
- Lack of effective housing weatherization
- Lack of efficient heating and cooling in homes
- Lack of enrichment classes in K-12 education
- Lack of credit score impacts (disabled, elderly, and/or unhoused)
- Lack of a future
- Lack of forward-facing community inclusion in government decision-making
- Lack of hope
- Lack of housing (growing unhoused population)
- Lack of justice
- Lack of landlord accountability
- Lack of landlord regulation enforcement
- Lack of livable wages
- Lack of mental trauma awareness, resources, and support
- Lack of mentorship
- Lack of modernized schools
- Lack of opioid relapse support
- Lack of personal transportation and transportation expense to access healthcare
- Lack of pollution awareness (railroads)
- Lack of postpartum care and resources to combat depression
- Lack of racism accountability (legal)
- Lack of realistic food stamp allotment per household
- Lack of resource communication
- Lack of resources for the unhoused population
- Lack of safety (aviation)
- Lack of safety (Black and Latiné communities scared of police)
- Lack of Section 8 housing
- Lack of subsidized housing weatherization
- Lack of successful systems processes
- Lack of support for Black people
- Lack of support for people with disabilities (autism)
- Lack of support for people with disabilities in K-12 education
- Lack of support groups for runaway youth
- Lack of proper waste disposal
- Lack of proactive suicide prevention support
- Lack of support for re-entry population
- Lack of timely transportation
- Lack of transition for foster care youth
- Lack of transportation around city limits
- Lack of trust (fake news)

- Lack of visibility (those overcoming opioid use)
- Lack of wildfire education and resettlement resources
- Lack of decreased work hours (farmworkers)
- Ageism
- Air pollution from concentrated animal feeding operation dairy farms
- Cancer incidence
- Displacement by HB-1 and H2A Visa workers (farmworkers)
- Displacement by technology (farmworkers)
- Electrical efficiency
- Fair housing termination process
- Fear of displacement by new immigrants
- Fear of Immigration and Customs Enforcement (I.C.E.)
- Fecal contamination from dairy farms
- Food insecurity
- Gentrification
- Heat islands
- Housing affordability
- Housing discrimination
- Housing segregation
- Housing quality
- Increased income disparity
- Increased noise pollution
- Limited telehealth support
- Liquid fuel contamination
- Mental health care access
- Negligent care
- Opioid use and impacts on this population
- Per capita number of aging adult care facilities
- Police bias
- Preeclampsia
- Racism (embolden)
- Resentment
- Septic tank quality
- Septic and solid waste violation concerns
- Stress
- Trauma
- Unsafe working conditions for farmworkers
- White supremacy

We will create a summary report from the 2025 community engagement events by regional area. The summary report will include:

- The number of listening sessions, roundtables, and attendees
- Top themes
- How organizations plan to use the gathered information
- How gathered information has changed organizations' community engagement model

Additional Tools

Qualitative Map

We will use the process described earlier in this section to decide if we can develop the community's concerns into new measures for future versions of the EHD map. We recognize that this process will take time, and it may be years before they are released on the map. One of the lessons that we have learned by working with the community is the importance of showing that their feedback is valued in more immediate ways.

"In terms of education, are there other indicators that could be measured. Literacy levels, or how information should be shared."

In response, we explored the idea of developing a qualitative EHD map based on feedback from community partners. The current vision for this tool is to share community stories at the county level and reflect the lived experiences of communities. The quote in the blue box is an example of the type of information that we would include.

There are several potential uses of this tool. It could serve as a resource for the 7 HEAL agencies as they work on Environmental Justice Assessments and provide communities with additional information to support self-advocacy.

Tracking Changes Over Time

The HEAL Act requires DOH to develop a tool to track changes in health disparities over time. Version 3.0 uses 2020 census tracts. DOH worked with Washington State University to create a crosswalk (a guide that matches old and new data) to new census tract boundaries. We did this to convert EHD map ranks and measures from Versions 1.0 and 2.0 into 2020 census tracts. With that data in the same geography, the next step is to develop ideas for effectively displaying these data and test it using mapping software. Our team will begin working on creating this visualization in 2026.

Appendices

Appendix A: Frequently Asked Questions

This section addresses several questions and concerns that we've received.

1. **Why does it take so long to update the map?**

Each update to this map involves many steps that take time. These steps include community and Tribal engagement, evaluating and developing new measures, reviewing and updating existing measures, and updating and creating communication materials. Read the Future Map Versions section to learn more about the steps for updating the map. We are a small team, and we appreciate your patience with us.

2. **Why is the data out of date?**

There are many steps to add data to the EHD map, and each of these steps takes time. Much of the data we use in the EHD map comes from state or federal agencies that conduct surveys, collect health data, or test water and air for pollution. It takes time for these agencies to summarize, check the accuracy of, and publish the data.

By the time we publish our map, it is common for the data to be at least a few years old. The EHD map team also has a process to add data, and we aim to update the data every 3 to 4 years. Updating the map is a balance between keeping the data relevant and maintaining some consistency for agencies that rely on it for decision-making.

3. **Why is the map deficit based?**

The HEAL and CCA Acts suggest using the EHD map to help direct funding to address risks or deficits. The deficits are the result of structural inequities that need to be named and identified. For some, naming disparities make them uncomfortable. However, many highly impacted and minoritized community members have shared that naming their lived experiences validates their realities.

The move to an asset-based model requires that we start by identifying who and what is causing the most harm. Failure to properly identify the ways disparities affect different populations and geographies would create a weak foundation for an asset map. We would create more harm than good and have little effect on closing social, structural, population, and geographical inequities. We must make the invisible visible, the silence voiced, and the harm named.

In the future, we plan to provide resources that communities can use to protect themselves and add community strengths and assets.

4. **Can community-based organizations and community members use other supportive tools for grant applications?**

We highly recommend using other sources of knowledge when making decisions. This includes community and Tribal engagement and any additional relevant data. The EHD map is not a full representation of the risks a community experiences. Other organizations may have specific requirements for grants, so we recommend you reach out to whoever is administering the grant or funding for more information.

5. Why is measure "x" not on this map?

Generally, there are 3 main reasons a measure is not on the map, even though we've heard the concern expressed by communities or Tribes:

1. There are no data available for this concern at the census tract level. As a small team, we rely on data published by state or federal agencies, researchers, and groups as a starting point for creating our measures. When there are no data available, we do not have the financial resources to generate our own data to create a new measure.
2. The measure is already very similar to one of the existing measures. Because of the way the overall EHD rank is calculated, having topics that measure similar factors will bias the overall EHD rank in favor of those concerns represented multiple times. We do our best to balance specific community and Tribal concerns, and repeating data that is already on the map.
3. We want to include the measure, but we are still working on it. Sometimes it can take a while for us to figure out what data is available and create a measure that best reflects community and Tribal concerns.

6. Why can't we have more measures of health or racism?

We are always looking to add important measures to the EHD map. Some measures may take longer to develop, depending on what data are available. Please refer to the Measures Under Exploration section of this report for more information on this process. If there are additional concerns that you think should be reflected on the EHD map, please reach out to our team.

7. Can you add more overlays to the map?

We try to limit overlays to topics that people actively use. Having too many can cause the map to load more slowly and make it harder to use. The new map platform allows users to add overlays for their own use from any spatial data file already published on the internet. This includes any data in the Washington State Geospatial Data portal and many federal databases. Users can do this by using the "Add Data" button at the top right of the map.

8. Is it possible to recalculate any of the rankings at a different geographic level instead of census tracts (e,g., school districts, zip code, block group, and/or county)?

No. The EHD map ranks (including individual measures and theme ranks) should only be used at the census tract level. We present these measures at the census tract level because it provides the best balance of protecting individual privacy for health and economic data and precision in representing environmental concerns.

Additionally, many measures are calculated using distance or population weights. These do not translate accurately to other geographic levels. Recalculating at a different geography would reduce the reliability of the results.

We recommend using the EHD map as a starting point and supplementing it with local datasets. If you need assistance with this, reach out to our team.

9. How has the change from 2010 to 2020 census tracts impacted the map?

The U.S. Census Bureau redraws census tract boundaries every 10 years. Each census tract has around 4,000 people. Major factors driving the change in census tract boundaries include people moving in or out of an area, changes in housing development, and gentrification.

The 2020 census tract redistricting created 313 new census tracts in Washington state. Most of these are areas where an urban census tract gained population and was divided into 2 or more new census tracts.

The main result of this change is that more census tracts are ranked at 9 or 10 since there are more census tracts. However, most of the changes in the rankings are not because of the change from 2010 to 2020 census tracts. Instead, they come from changes in how measures are calculated, new measures added, and updates to the data.

10. How were the rankings calculated?

The ranks were created in R using the COINr package. We followed the description of the model in the Methodology section of this report. The full code is available by contacting us at ehdmap@doh.wa.gov.

11. How is the EHD map used in policy and program decisions?

The map is used as a starting point for identifying communities that should be prioritized for funding. The funding addresses environmental health disparities.

The EHD map is used as a resource to address environmental health disparities by many different agencies and programs. Each group uses the EHD map in different ways. We recommend reaching out to specific programs for more details on how they use the map.

The Climate Commitment Act (CCA) lists the EHD map as one of multiple data sources that can be used to identify “overburdened communities.” Vulnerable populations must receive at least 35 percent of the direct benefits from CCA investments. Communities (i.e. census tracts) that contain Tribal lands or have an overall EHD rank of 9 or 10 are considered overburdened communities.

The Healthy Environment for All Act establishes a goal of directing 40 percent of grants and other resources that create environmental benefits to vulnerable populations and overburdened communities. This law specifically applies to actions from 7 covered state agencies. These

agencies are the departments of Agriculture, Commerce, Ecology, Health, Natural Resources, and Transportation, and the Puget Sound Partnership.

Finally, other agencies, organizations, and programs sometimes use the EHD map to help inform decisions. We recommend using this tool in combination with additional tools, datasets, and resources. Many of these groups use the cumulative EHD rank as a useful piece of information to help decide where to direct funding, programmatic activities, or other efforts.

For all these uses, the EHD map should serve as a starting point for creating a plan for equitable community engagement. It should not be the only factor in allocating funding or making decisions.

Appendix B: Abbreviations

AADT: Average Annual Daily Traffic

ACS: American Community Survey

AIRPACT: Air Measure Report for Public Awareness and Community Tracking

CalEPA: California Environmental Protection Agency

CDC: United States Centers for Disease Control and Prevention

CERCLIS: Comprehensive Environmental Response, Compensation, and Liability Information System

CNT: Center for Neighborhood Technology

COPD: Chronic Obstructive Pulmonary Disease

COVID-19: Coronavirus Disease 2019

DEOHS: University of Washington Department of Environmental & Occupational Health Sciences

DOH: Department of Health (Washington State)

ECY: Department of Ecology (Washington State)

EHD: Environmental Health Disparities

EJ: Environmental Justice

HMS: Hazard Mapping System

HEAL: Healthy Environment for All Act (SB 5141, 2021)

IBL: Information By Location tool on the Washington Tracking Network

INFA: Infrastructure/Adoption

IQ: Intelligence Quotient

Km: Kilometers

LBW: Low Birth Weight

MOE: Margin of Error

MRFEI: Modified Retail Food Environment Index

NPL: National Priorities List

NOAA: National Oceanic and Atmospheric Administration

NOx: Nitrogen Oxides

OFM: Washington State Office of Financial Management

PM: Particulate Matter

PSCAA: Puget Sound Clean Air Agency

RHINO: Rapid Health Information Network

RSEI: Risk-Screening Environmental Measures

TRI: Toxic Release Inventory

TSDF: Hazardous Waste Treatment Storage and Disposal Sites

US EPA: United States Environmental Protection Agency

VOCs: Volatile Organic Compounds

WIC: Women, Infants, and Children

WTN: Washington Tracking Network (Washington State Department of Health)

Appendix C: Analysis of Race/Ethnicity and Sensitivity Analysis

In Washington, there are significant racial and ethnic disparities in environmental health risk. Examining this association can provide more information about racial inequities in environmental justice in Washington. This analysis uses 2024 population estimates from the Office of Financial Management.

Figure 10. Cumulative EHD Rank by Race and Ethnicity

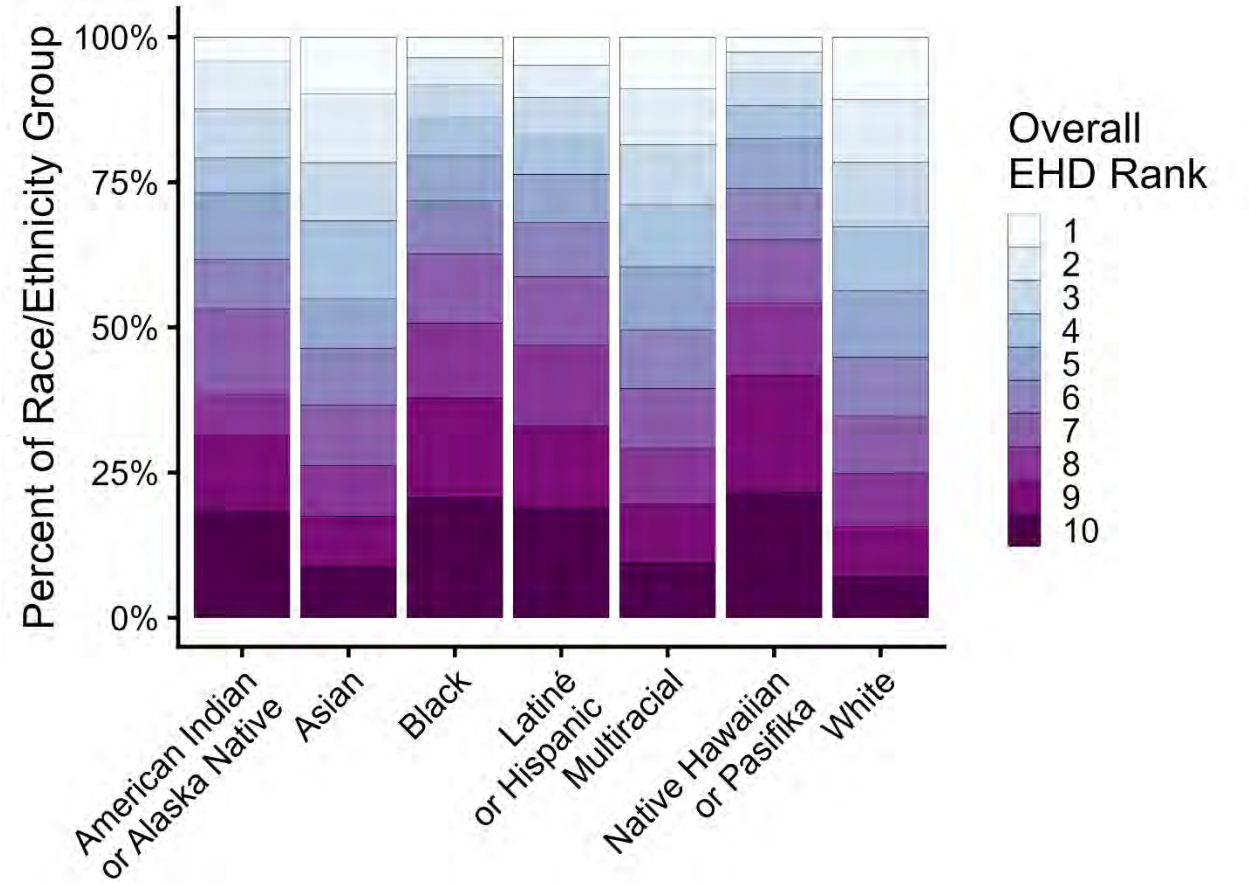


Figure 10 shows the percentage of people within each racial or ethnic group who live in communities corresponding to each overall EHD rank. The ranks range from 1 (least impacted) to 10 (most impacted).

Historically minoritized communities are particularly impacted by environmental health disparities. Fifty-five percent of White residents in Washington live in communities with an overall EHD rank of

1 – 5. This represents 50% of communities least impacted by environmental health disparities.

In contrast, only 26% of Native Hawaiian or Pasifika residents, 28% of Black residents, and 31% of Latiné or Hispanic residents live in communities with an overall EHD rank of 1 – 5.

Figure 11. Percent of Race/Ethnicity Groups Living in a Census Tract that Contains Tribal Land or With an Overall EHD Rank of 9 or 10

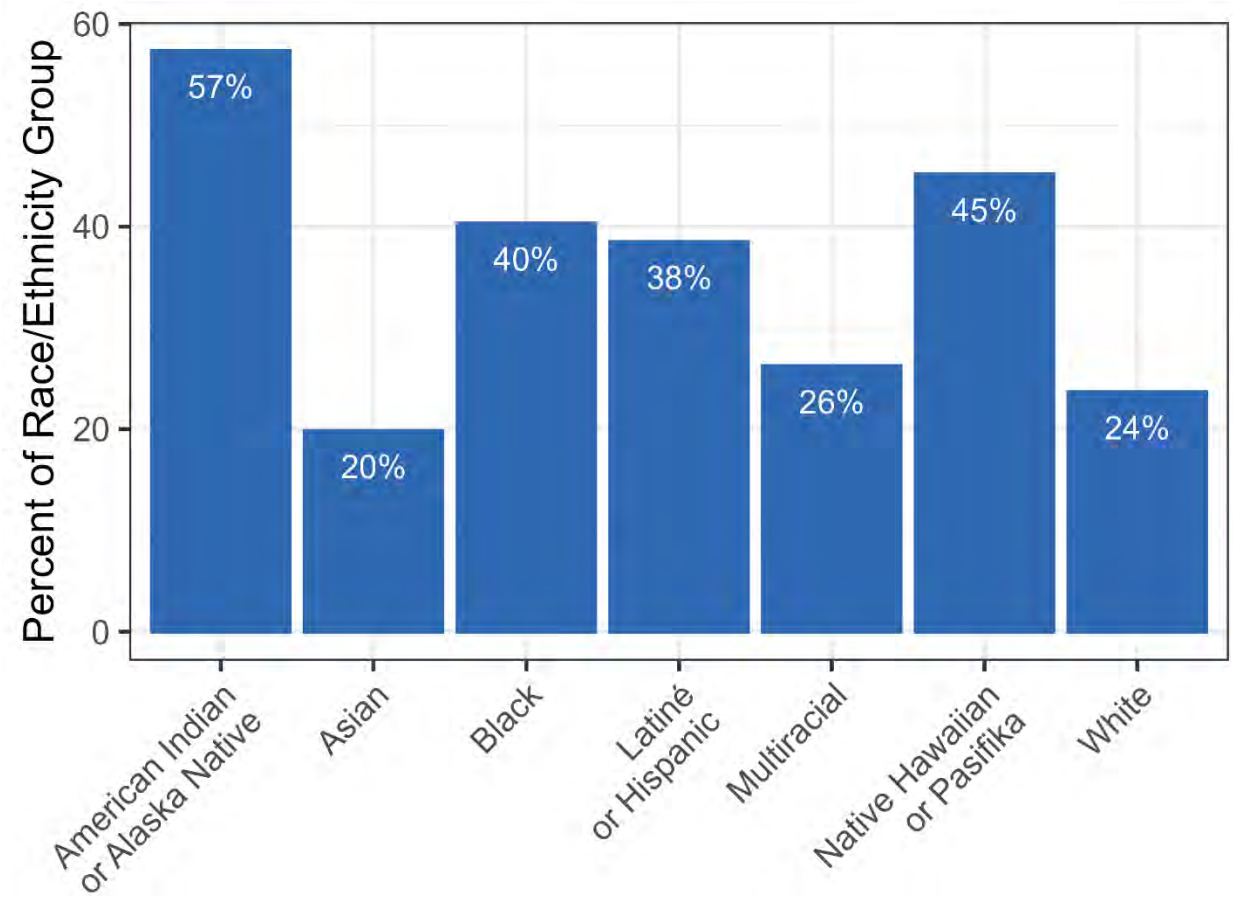
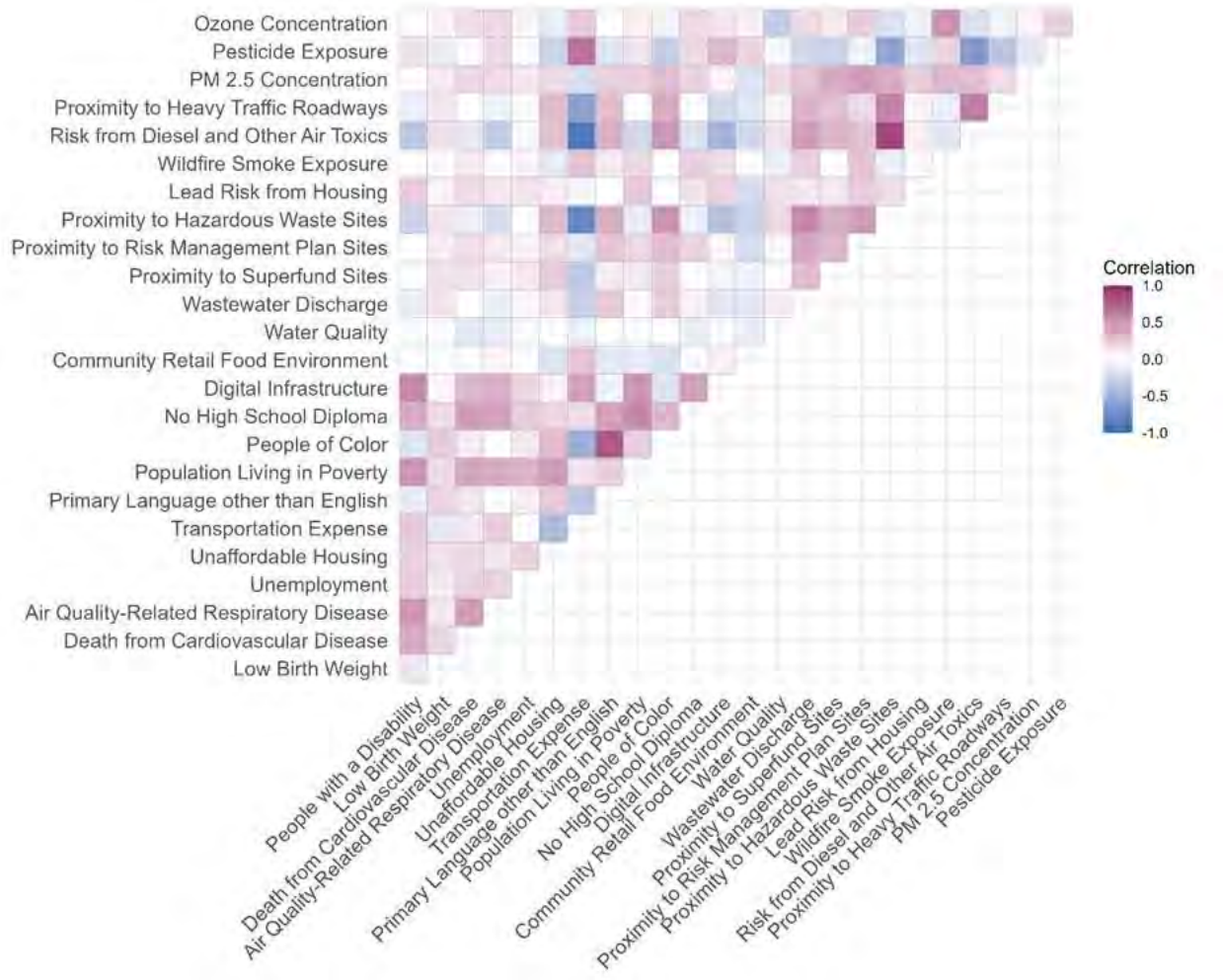


Figure 11 shows the percentage of people within each race or ethnic group who live in a census tract with an overall EHD rank of 9 or 10 or a census tract that contains any Tribal land.

The racial and ethnic disparities are clear. American Indian/Alaska Native, Native Hawaiian/Pasifika, Black, and Latiné/Hispanic individuals are much more likely to experience higher pollution burdens and social and health vulnerabilities than other racial or ethnic groups.

Figure 12. Correlation Matrix Between Each Measure Rank



The EHD map team conducted an analysis to judge how each measure rank relates to the other measure ranks.

Relationships between the measure ranks are visualized in Figure 12. A darker red color indicates a stronger positive relationship. This means that if one measure has a high value, then the other measure is also likely to have a high value. A darker blue color indicates a stronger negative relationship. This means that if one measure has a high value, then the other measure is likely to have a low value.

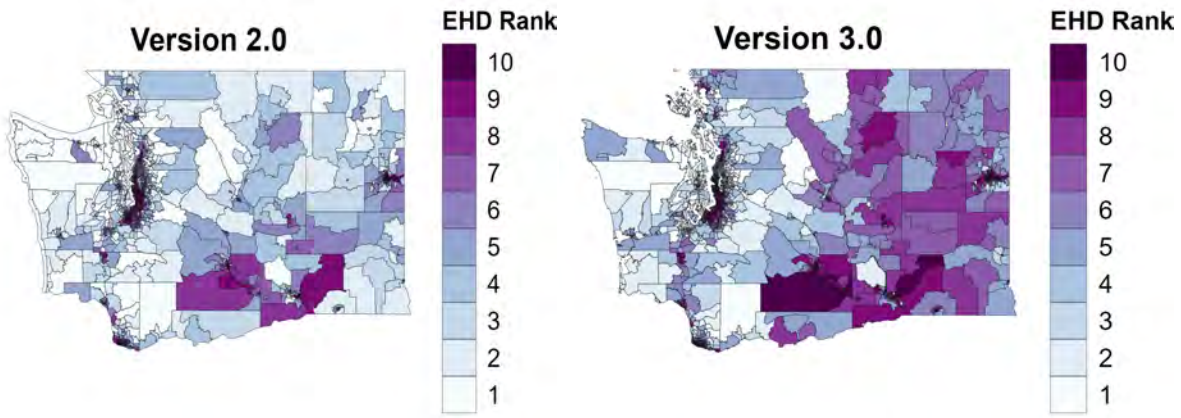
These relationships are important because they help us identify overlapping risks and vulnerabilities that are common in Washington. If 2 measures have a strong positive relationship, it means many communities in Washington are likely to experience both or neither of those risks. On the other hand, a strong negative relationship between 2 measures means that these are less likely to impact the same communities.

Figure 12 shows that most socioeconomic measures have a positive relationship with each other. The strongest positive relationship between environmental factors is between the Proximity to

Hazardous Waste Sites and Risk from Diesel and Other Air Toxics measures. This is primarily because these 2 sources of pollution are the highest along major roadways in densely populated, urban areas.

Measures that are higher in rural areas, such as Pesticide Exposure and Transportation Expense, have a negative relationship with measures that are higher in urban areas. For example, Risk from Diesel and Other Air Toxics and Proximity to Heavy Traffic Roadways.

Figure 13. Change in EHD ranks between Version 2.0 and Version 3.0

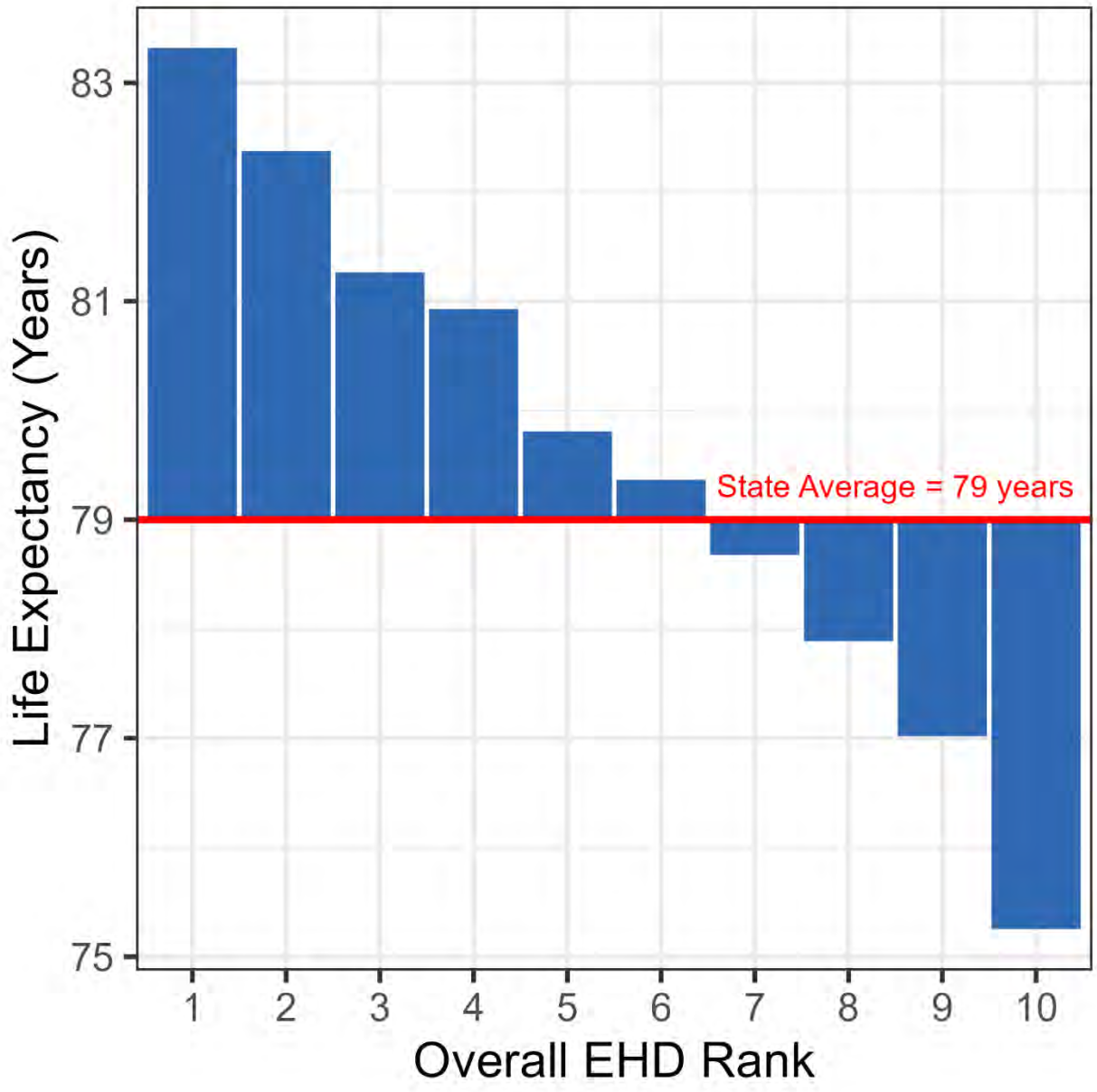


It is difficult to quantify the changes between Version 2.0 and 3.0 because the census tract boundaries changed from 2010 to 2020. The maps above show the overall EHD ranks for each census tract in Washington for Version 2.0 and Version 3.0.

The addition of the Wildfire Smoke Exposure, Pesticide Exposure, Community Retail Food Environment, and Digital Infrastructure measures increased the overall rank of many rural and eastern Washington communities.

Comparing the relationship between the cumulative EHD rank and other quality of life metrics helps us judge how well the map model reflects the impacts of environmental health disparities.

Figure 14: Average Life Expectancy at Birth by Overall EHD Rank

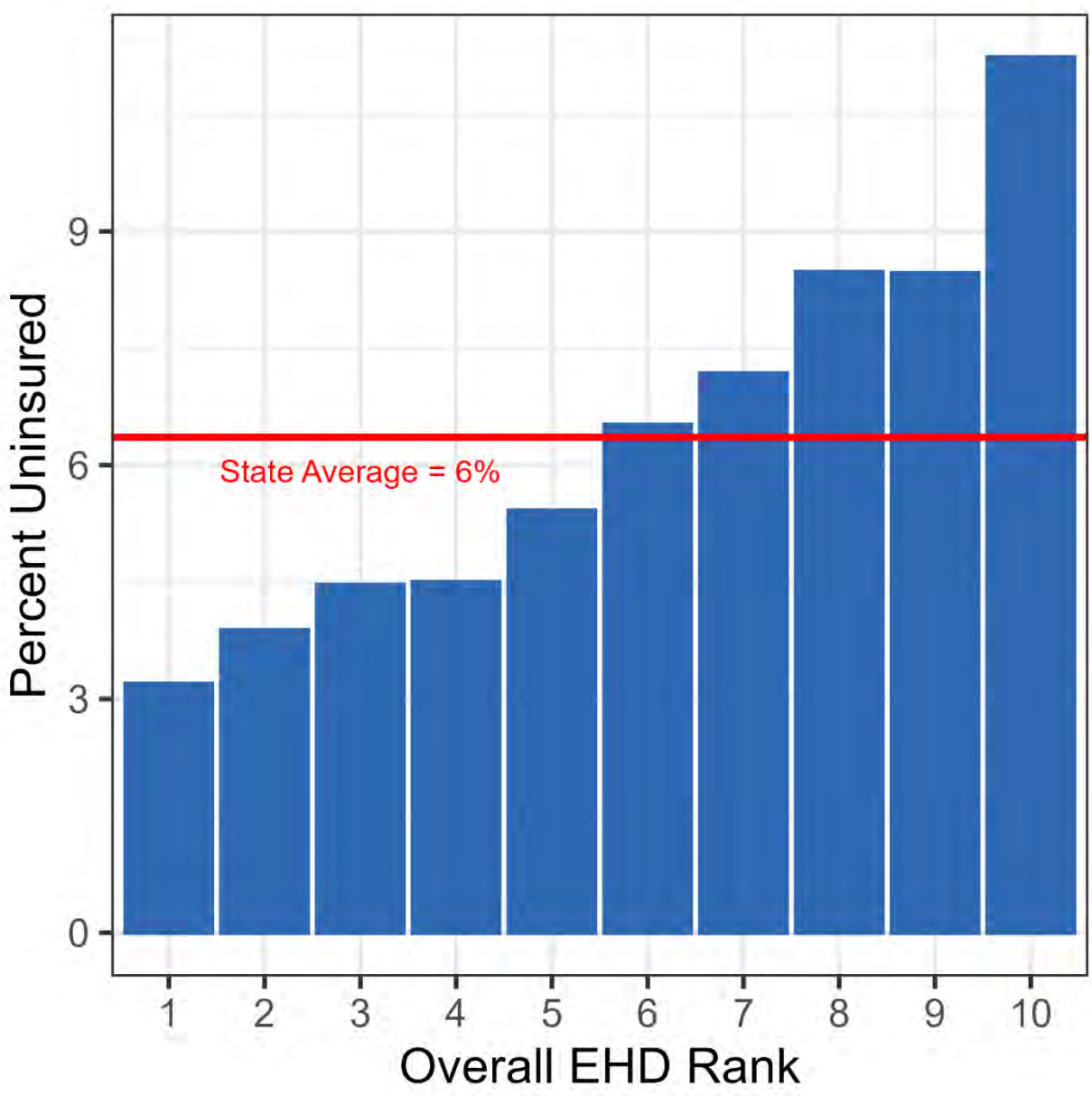


The average life expectancy between 2021 and 2023 was 79 years for Washington residents.

Figure 14 shows that people living in census tracts with a higher EHD rank have a lower life expectancy compared to people living in census tracts with a lower rank.

This indicates that as environmental health disparities increase, life expectancy decreases. On average, the population living in census tracts with a rank of 1 has a life expectancy of about 83 years. Compare this to a life expectancy of about 75 years among those living in census tracts with a rank of 10. This is an eight-year difference in life expectancy.

Figure 15. Percent of People Without Health Insurance by Overall EHD Rank



Across Washington state, 6% of people were uninsured in 2023, according to the American Community Survey.

Figure 15 shows that there is a positive relationship between EHD rank and being uninsured. People living in a census tract with a higher rank are more likely to be uninsured. Eleven percent of people living in a census tract with a rank of 10 are uninsured. This is compared to 3% of people living in a census tract with a rank of 1 who are uninsured.

Contact Information

Access the mapping tool
https://www.doh.wa.gov/EHDmap

DOH EHD map webpage
https://doh.wa.gov/data-statistical-reports/washington-tracking-network-wtn/washington- environmental-health-disparities-map

Email
mailto:ehdmap@doh.wa.gov