



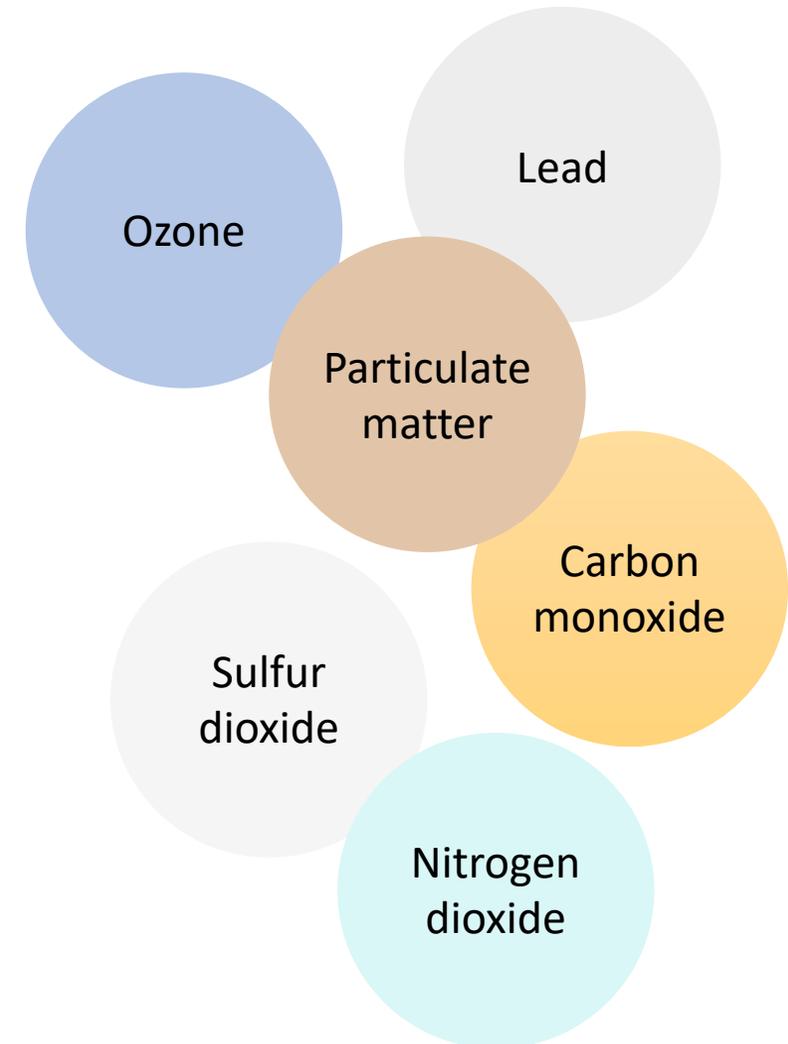
Mortality Associated with Long-term PM_{2.5} Exposure among Overburdened Communities in Washington State

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Section 3 of the Climate Commitment Act requires Ecology to:

- Identify “overburdened” communities “highly impacted by air pollution”
- Expand criteria air pollution monitoring
- Develop strategies to reduce criteria air pollution
- **Conduct periodic reviews to track progress**
- Outreach and engage with communities



Environmental justice – (from RCW 70A.02.010(8)) the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income 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 by prioritizing vulnerable populations and overburdened communities, the equitable distribution of resources and benefits, and eliminating harm.

RCW 70A.65.020: Environmental justice review.

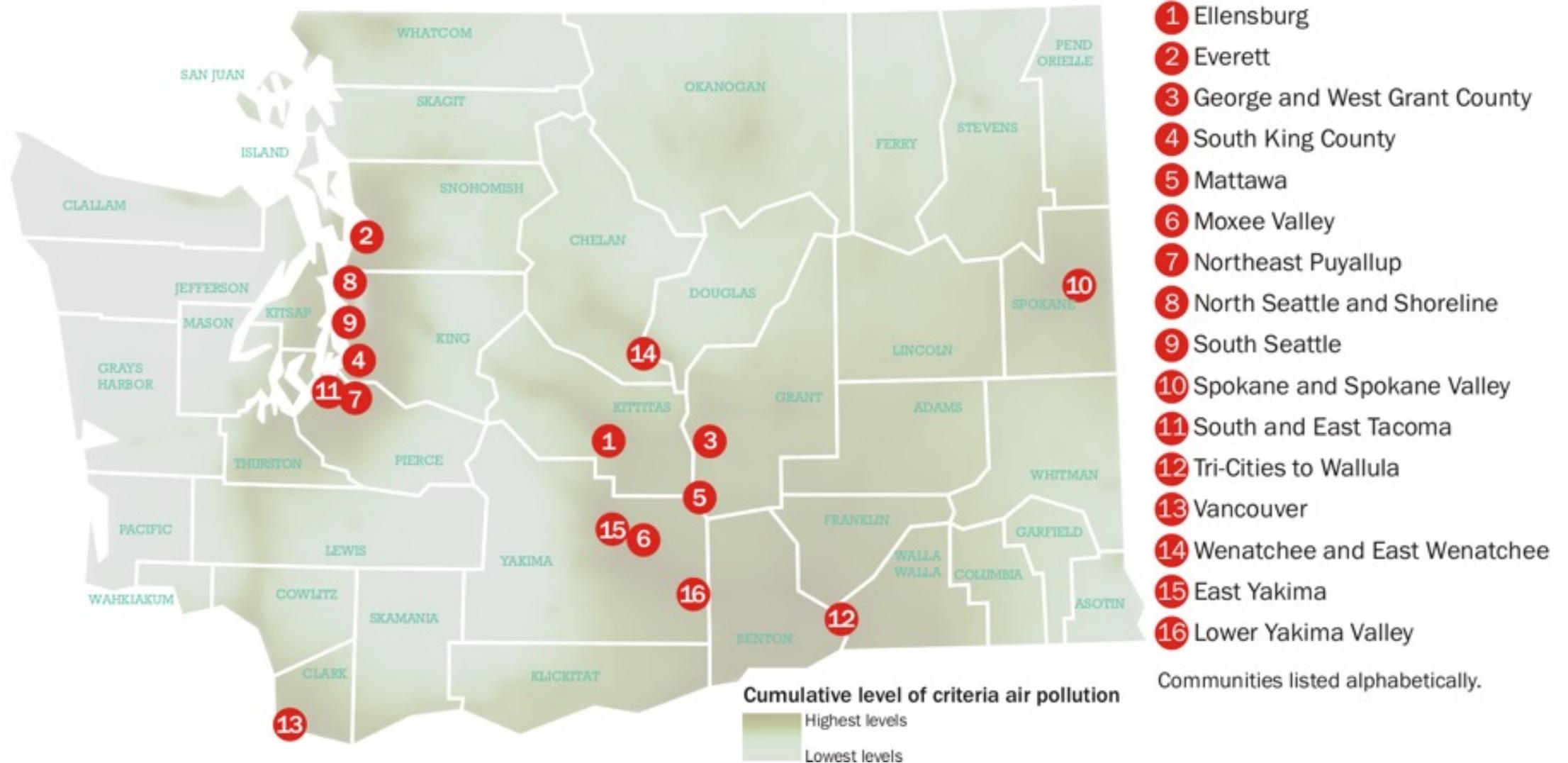
Overburdened community – (From RCW 70A.65.010(54))

Overburdened community highly impacted by air pollution

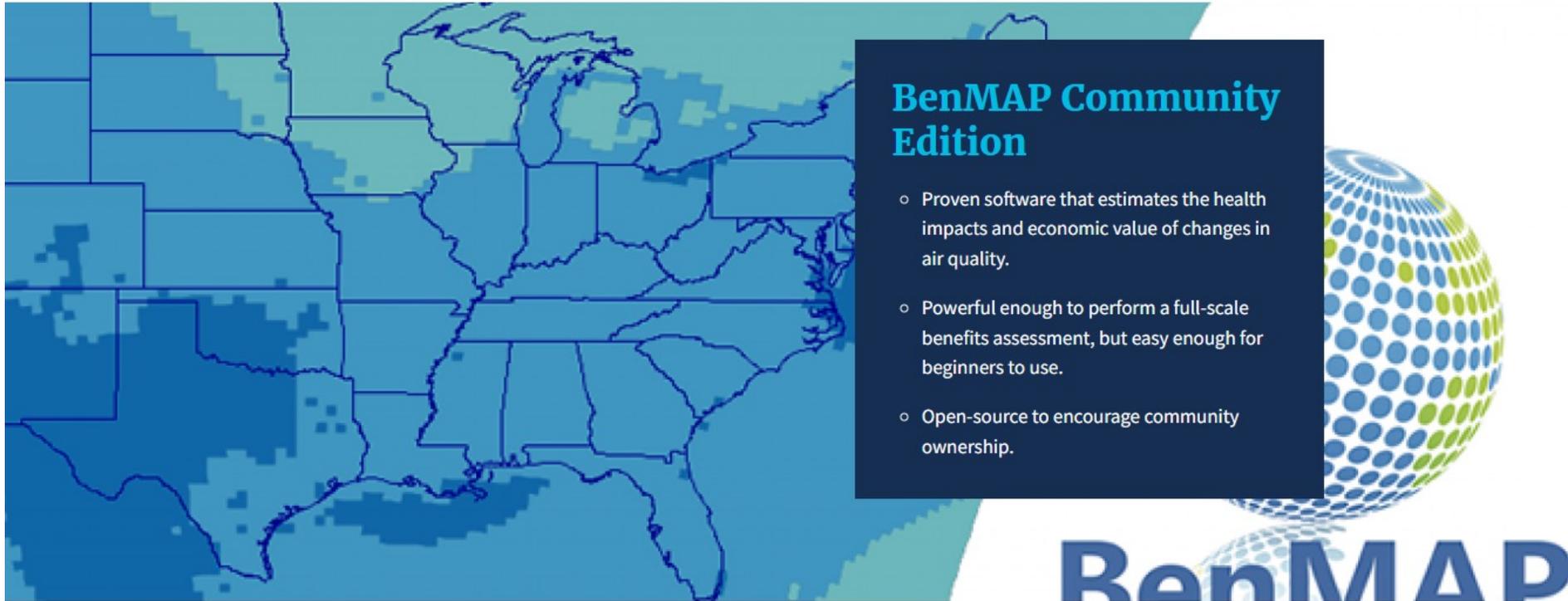


Aerial Photograph of Puyallup WA

16 identified overburdened communities in WA



Environmental Benefits Mapping and Analysis Program - Community Edition (BenMAP-CE)



BenMAP-CE is an open-source computer program that calculates the number and economic value of air pollution-related deaths and illnesses. The software incorporates a database that includes many of the concentration-response relationships, population files, and health and economic data needed to quantify these impacts.

BenMAP-CE enables users to load their own data or use pre-loaded datasets for the U.S. and China, including

- Air quality data
- Demographic data
- Economic values
- Concentration-response relationships

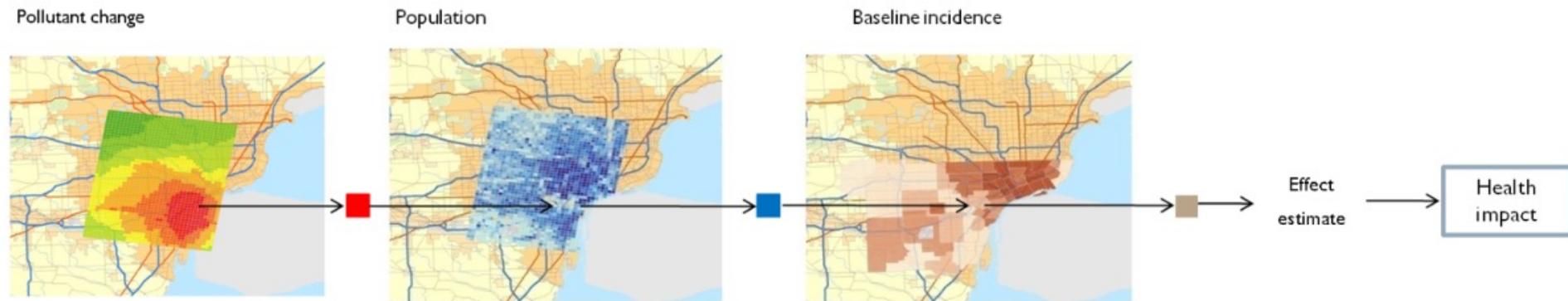
Health and economic impacts

Health impact functions used in BenMAP-CE:

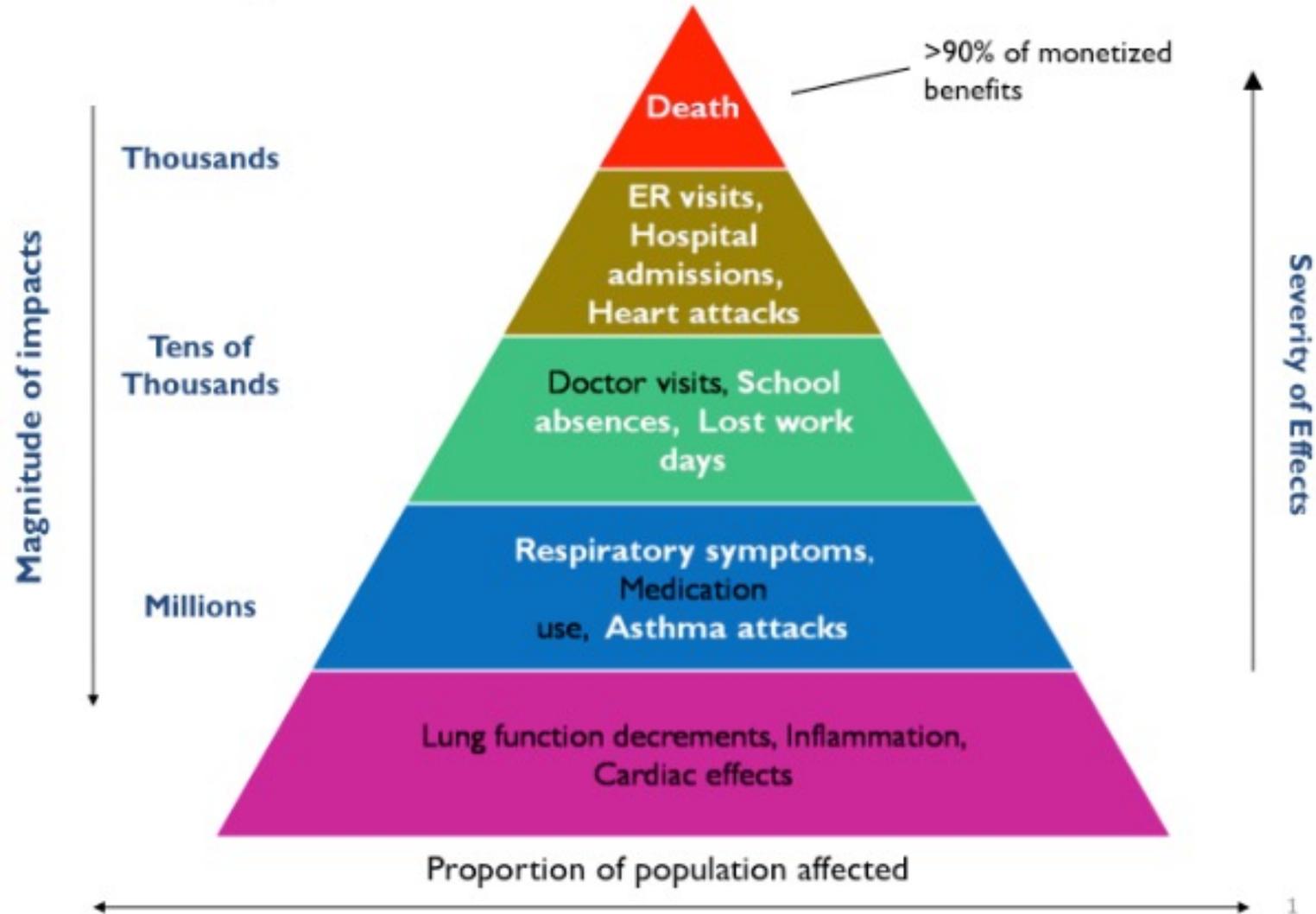
1. Modeled or monitored air quality changes
2. Population data
3. Baseline incidence rates
4. An effect estimate

Economic values calculation:

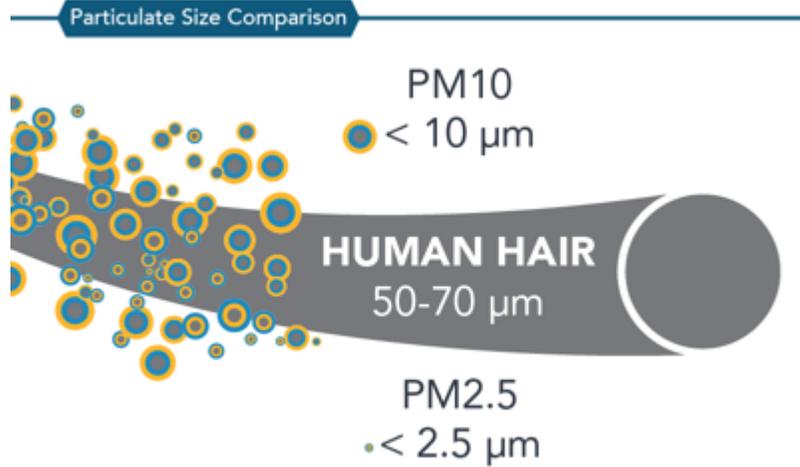
1. Cost of illness
2. Willingness to pay



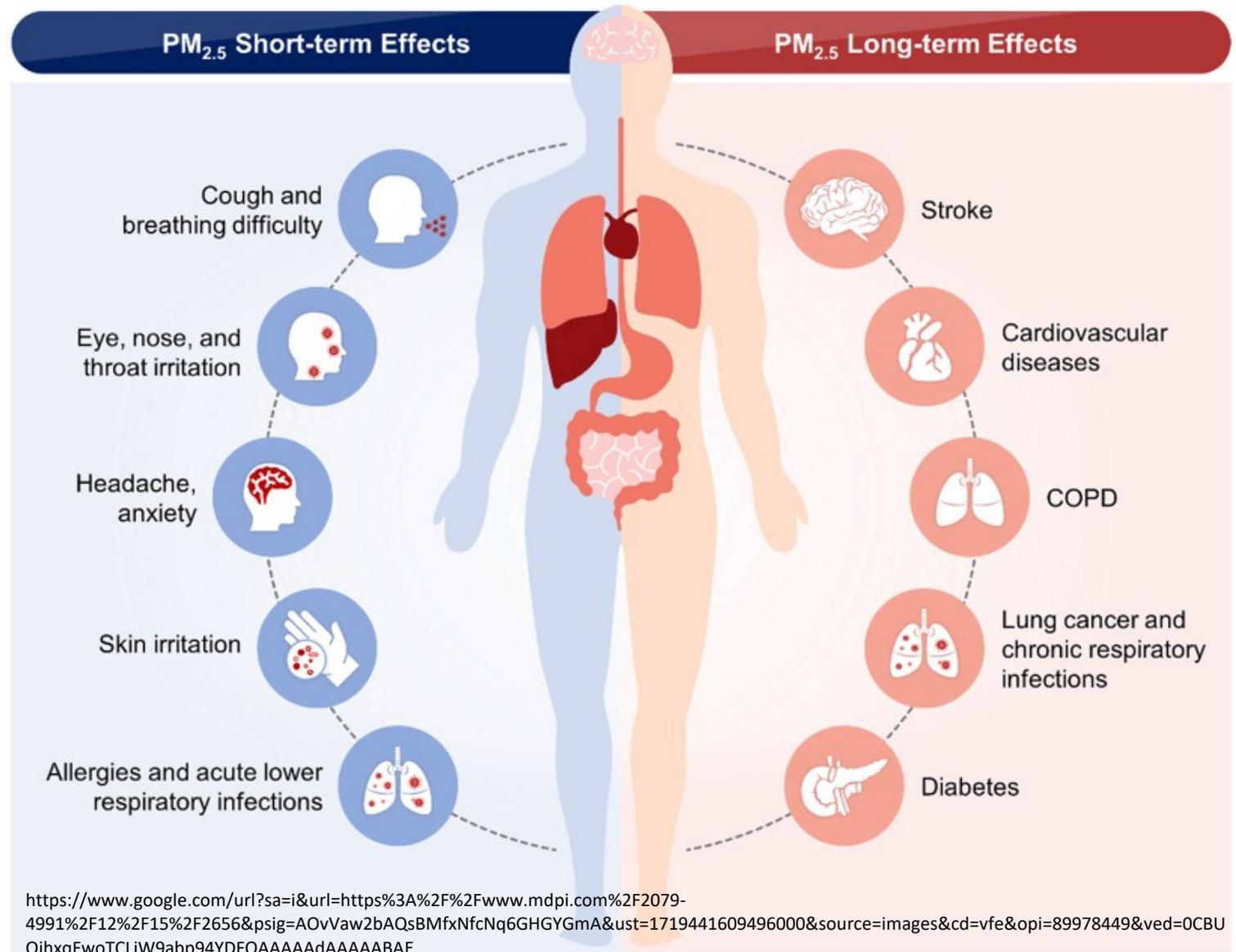
A “Pyramid of Effects” from Air Pollution



PM_{2.5} and its health effects



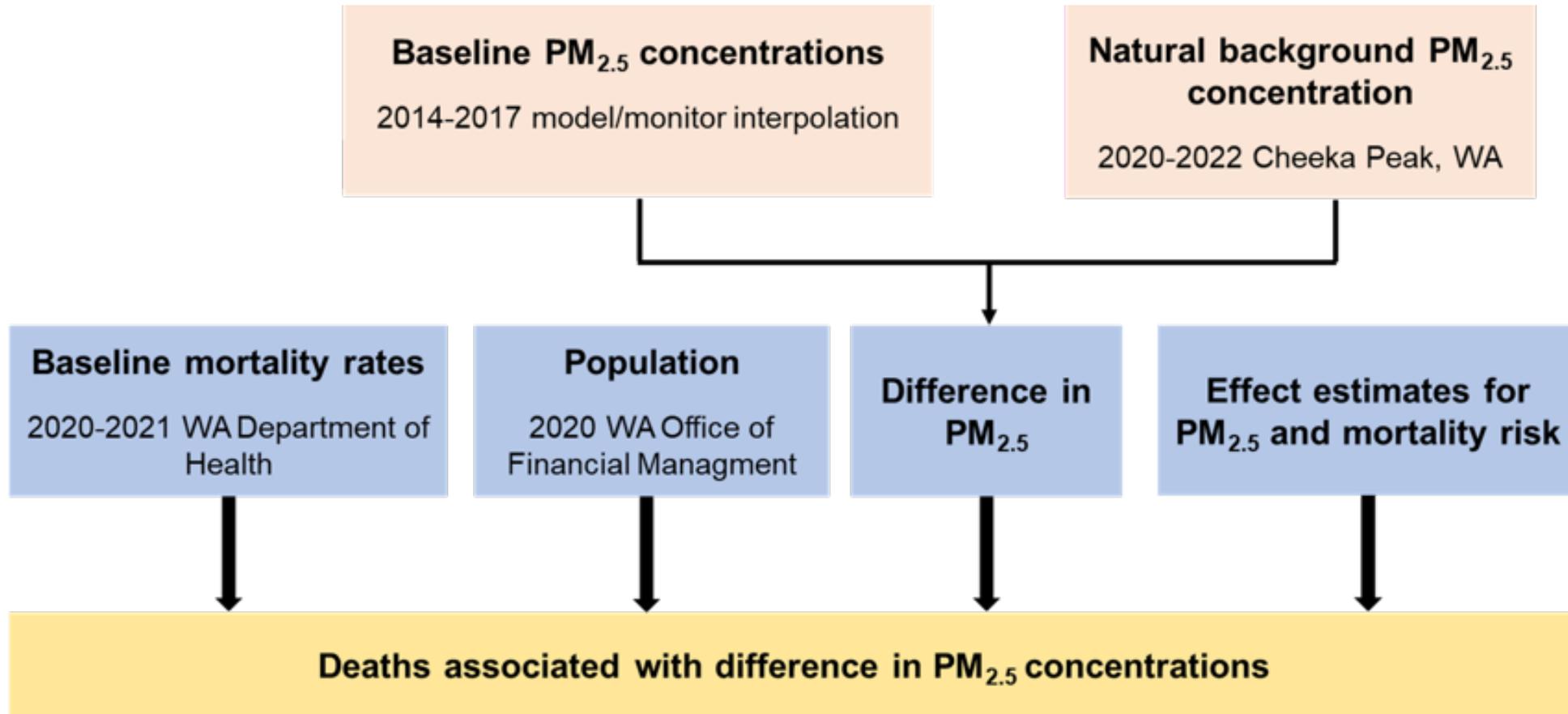
<https://ww2.arb.ca.gov/resources/inhalable-particulate-matter-and-health>



Summary of BenMAP inputs

Inputs	Data source	Year	Scale
Baseline PM_{2.5} concentration	AIRPACT model/monitor interpolation	July 2014-June 2017	Census Tract
Natural background PM_{2.5} concentration	Monitor at Cheeka Peak, WA	2020-2022	Point
Population	WA Office of Financial Management	2020	Census Tract
Baseline mortality rate	WA Department of Health	2020-2021	Census Tract
Baseline health incidence	BenMAP-CE pre-loaded datasets	2020	County

BenMAP data flow



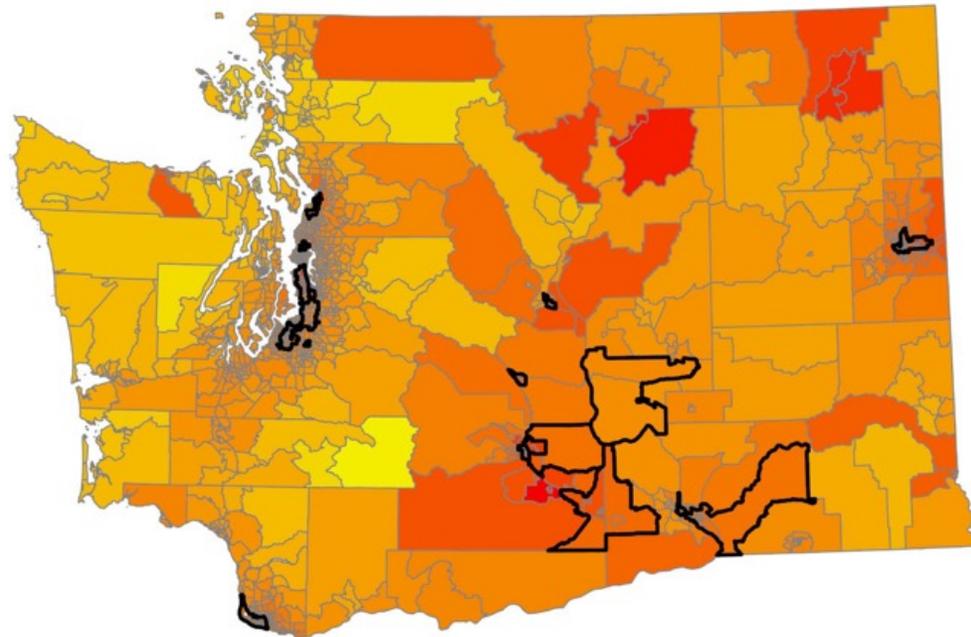
BenMAP's health impact function

$$\Delta Y = (1 - e^{-\beta * \Delta AQ}) * Y_0 * Pop$$

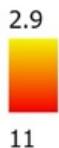
- **ΔY** = the estimated health impact attributed to air pollution,
- **β** = the beta coefficient from an epidemiologic study (most often a log-linear statistical model),
- **ΔAQ** = defined change in air quality,
- **Y_0** = baseline rate (i.e., incidence) for the health effect of interest,
- **Pop** = population exposed to air pollution.

Average PM_{2.5} concentrations are higher in overburdened communities

2014-2017 monitor-model interpolated



PM_{2.5}
concentration
(ug/m³)



Overburdened community
boundaries

State average:
6.4 $\mu\text{g}/\text{m}^3$

Overburdened communities
average:
7.2 $\mu\text{g}/\text{m}^3$

Overburdened communities comprised 17% of the state population



7.7 million total
Washingtonians in 2020



1.3 million residents in
overburdened communities

Based on 2010 census tract boundaries and 2020 population data from WA Office of Financial Management

Demographics in overburdened communities differed from WA state

- People under 20 years of age (27% in overburdened communities vs 25% statewide)
- People of color:
 - Hispanic (26% vs 13%)
 - Asian (11% vs 9%)
 - Black and African American (7% vs 4%)
 - Native Hawaiian and Other Pacific Islander (1.3% vs 0.7%)
- People with low income (38% vs 24%)
- People without health insurance (10% vs 6%)

Calculation of annual mortality rates



Annual deaths
associated with PM_{2.5}



X 100,000



Population

Office of Financial Management
Better information. Better decisions. Better government. Better Washington

Mortality rates were adjusted for age

Why adjust?

- Risk of death increases with age
- Age distributions can vary from community to community

Solution:

- Apply age-specific rates in the community to a 'standard population' (Washington State age distribution)
- The resulting rate is not 'real' but allows for comparison across populations

PM_{2.5}-related all-cause mortality is higher in overburdened communities compared to state

	<u>Washington State</u>	<u>Overburdened Communities</u>
18–84-year-olds	25 (12–37) Annual deaths per 100,000 people	46 (33–59) Annual deaths per 100,000 people*
65–99-year-olds	36 (33–39) Annual deaths per 100,000 people	69 (62–75) Annual deaths per 100,000 people*

*After adjustment for age based on the WA statewide age distribution

Estimates for 18-84-year-olds and 65-99-year-olds are based on concentration-response functions reported by Pope et al (2019) and Di et al. (2017), respectively

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Annual PM_{2.5}-related deaths in overburdened communities

People ages 18–84:

398

Annual PM_{2.5}-related deaths
(Uncertainty range: 173 to 607)

People ages 65–99:

122

Annual PM_{2.5}-related deaths
(Uncertainty range: 110 to 133)

Estimates for 18–84-year-olds and 65–99-year-olds are based on concentration-response functions reported by Pope et al (2019) and Di et al. (2017), respectively

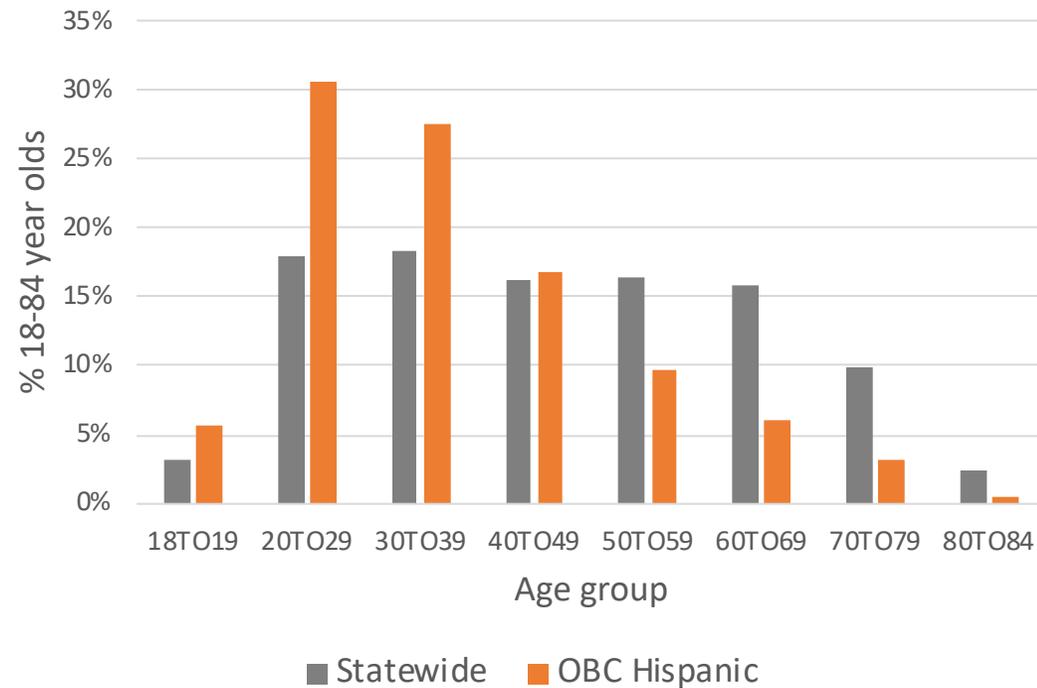
Hispanic and Black people have highest age-adjusted annual mortality rates in overburdened communities

18–84-year-olds in overburdened communities

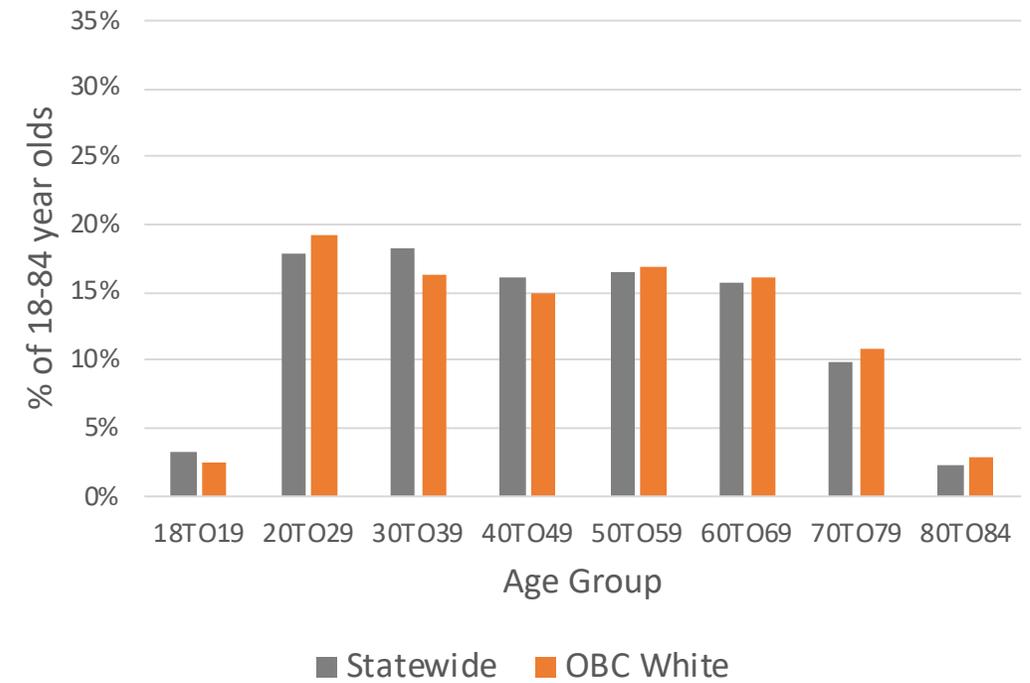
Ethnicity and Race Groups	Crude Mortality rate per 100,000 people [uncertainty]	Adjusted mortality rate per 100,000 people [uncertainty]
Hispanic	38 [22 to 54]	78 [44 to 110]
Non-Hispanic American Indian and Alaska Native	36 [-24 to 90]	43 [-30 to 109]
Non-Hispanic Asian	33 [-23 to 84]	36 [-25 to 91]
Non-Hispanic Black	42 [13 to 69]	56 [17 to 92]
Non-Hispanic Native Hawaiian and Other Pacific Islander	22 [-15 to 56]	41 [-28 to 104]
Non-Hispanic Two or more races	22 [-15 to 56]	39 [-27 to 98]
Non-Hispanic White	43 [28 to 58]	41 [27 to 55]

Age distributions differ between racial and ethnic groups

Hispanic Group



Non-Hispanic White Group

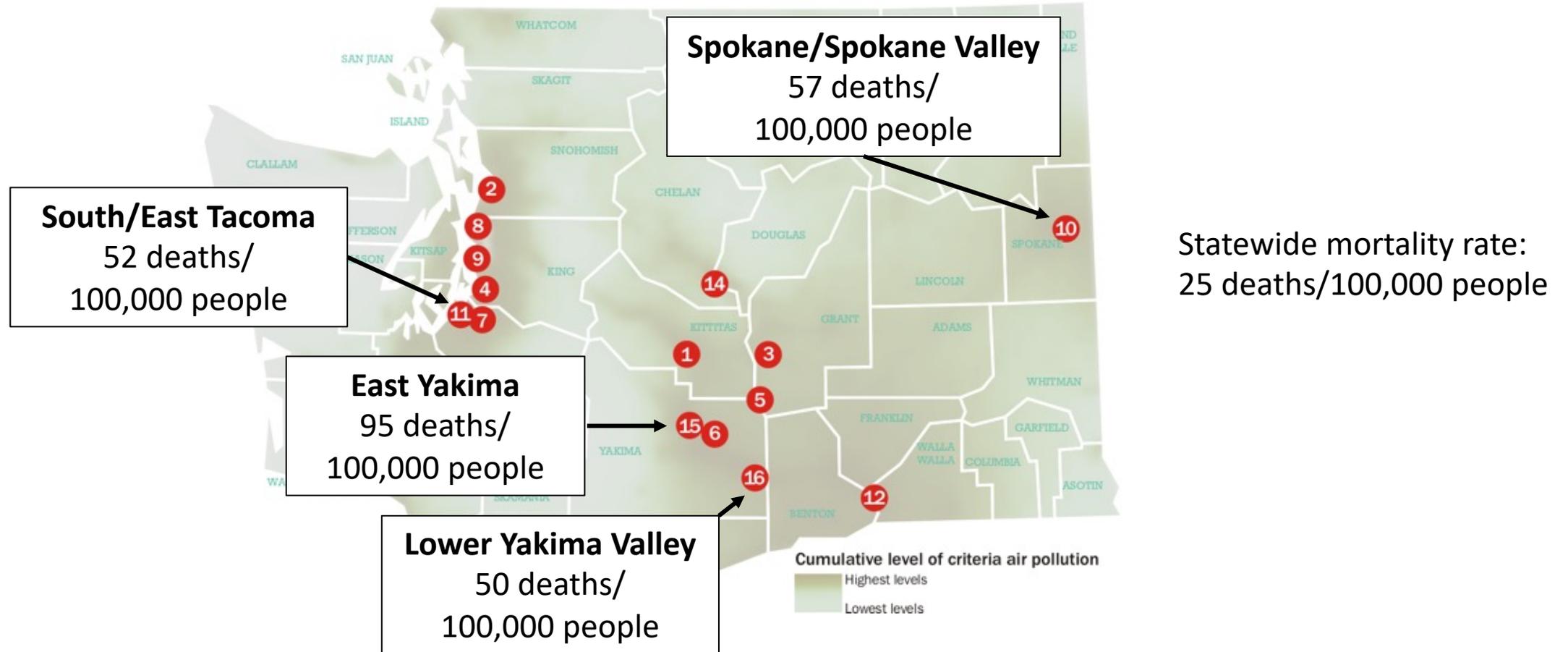


Hispanic and Black individuals have highest adjusted mortality rates in overburdened communities

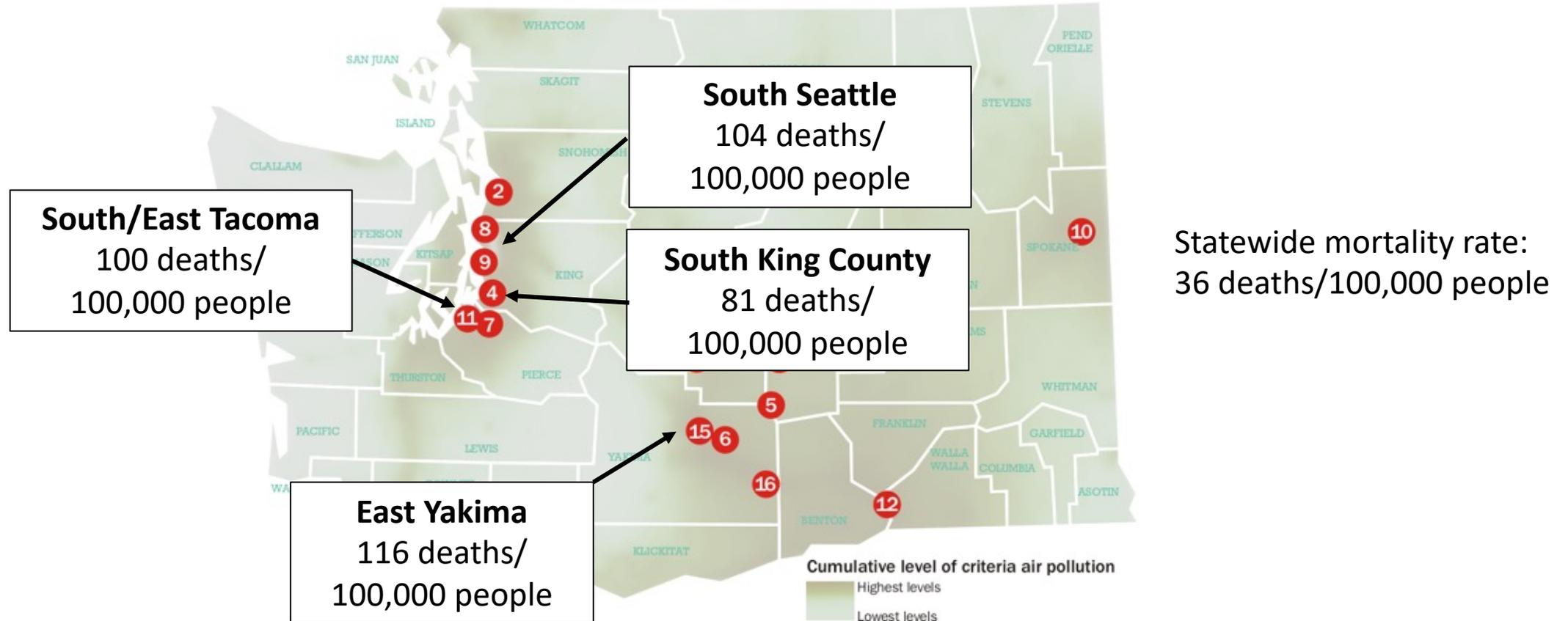
65–99-year-olds in overburdened communities

Race, Ethnicity Group	Crude Mortality rate per 100,000 people [uncertainty]	Adjusted mortality rate per 100,000 people [uncertainty]
Hispanic	141 [122 to 160]	147 [127 to 166]
Non-Hispanic American Indian and Alaska Native	93 [57 to 126]	93 [57 to 127]
Non-Hispanic Asian	88 [69 to 105]	88 [69 to 105]
Non-Hispanic Black	174 [168 to 181]	176 [169 to 182]
Non-Hispanic Native Hawaiian and Other Pacific Islander	106 [65 to 145]	109 [67 to 149]
Non-Hispanic Two or more races	86 [53 to 118]	89 [55 to 122]
Non-Hispanic White	51 [49 to 53]	51 [49 to 53]

Communities with highest PM_{2.5}-associated mortality rates among 18–84-year-olds



Communities with highest PM_{2.5}-associated mortality rates among 65–99-year-olds



Summary

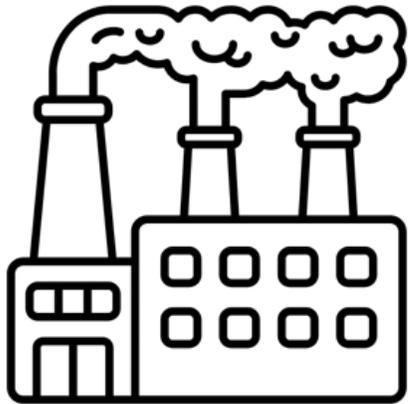
- PM_{2.5}-associated deaths in overburdened communities:
 - About 400 deaths among adults 18–84-year-olds
 - About 120 deaths among older adults 65–99-year-olds
- Hispanic and Black, African American people have highest age-adjusted mortality rates
- Health impacts from PM_{2.5} are variable across overburdened communities

Limitations and uncertainty

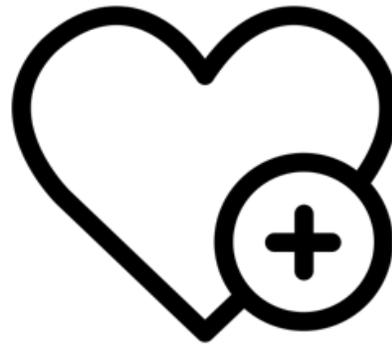
- Different time periods and geographical resolution of model inputs
- PM_{2.5} data comes from interpolation methods
- Inaccuracies in addresses and small numbers with death data
- Effect estimates based on national studies, not specific to the PNW

Next steps for the Environmental Justice Review

- Next review to completed by December 2025



Additional air pollutants



Additional health events



Community/Tribal engagement
Qualitative data collection

Thank you!

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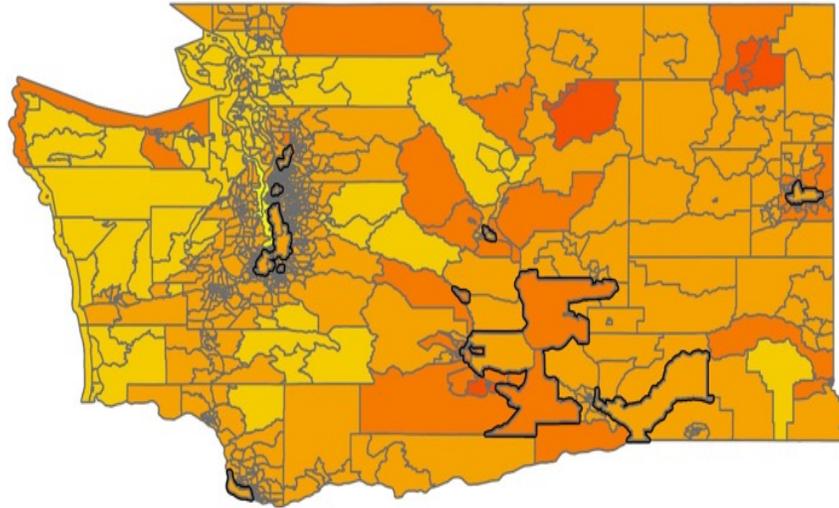
WA Department of Health

Randy.Stalter@doh.wa.gov

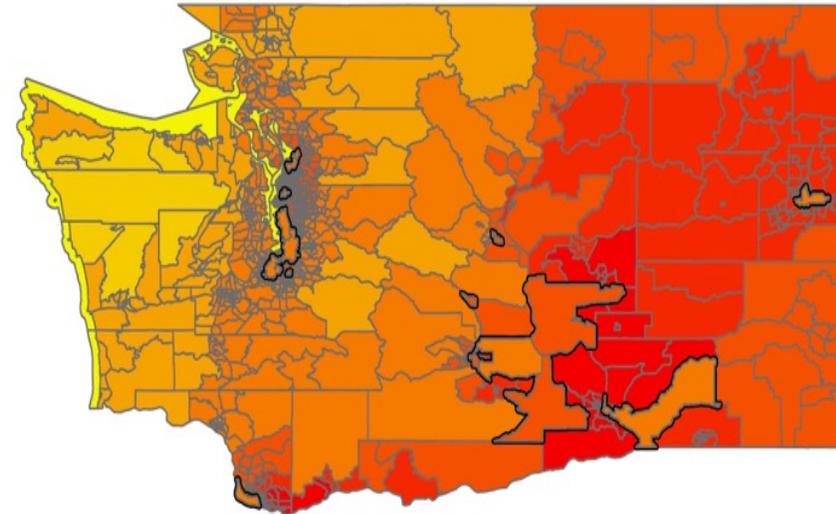


Additional Slides

2014-2017 monitor/model interpolated



2020 NAMS/SLAMS & CMAQ fusion



PM_{2.5} concentration (ug/m³)



0-3

3-5

5-7

7-9

9-11

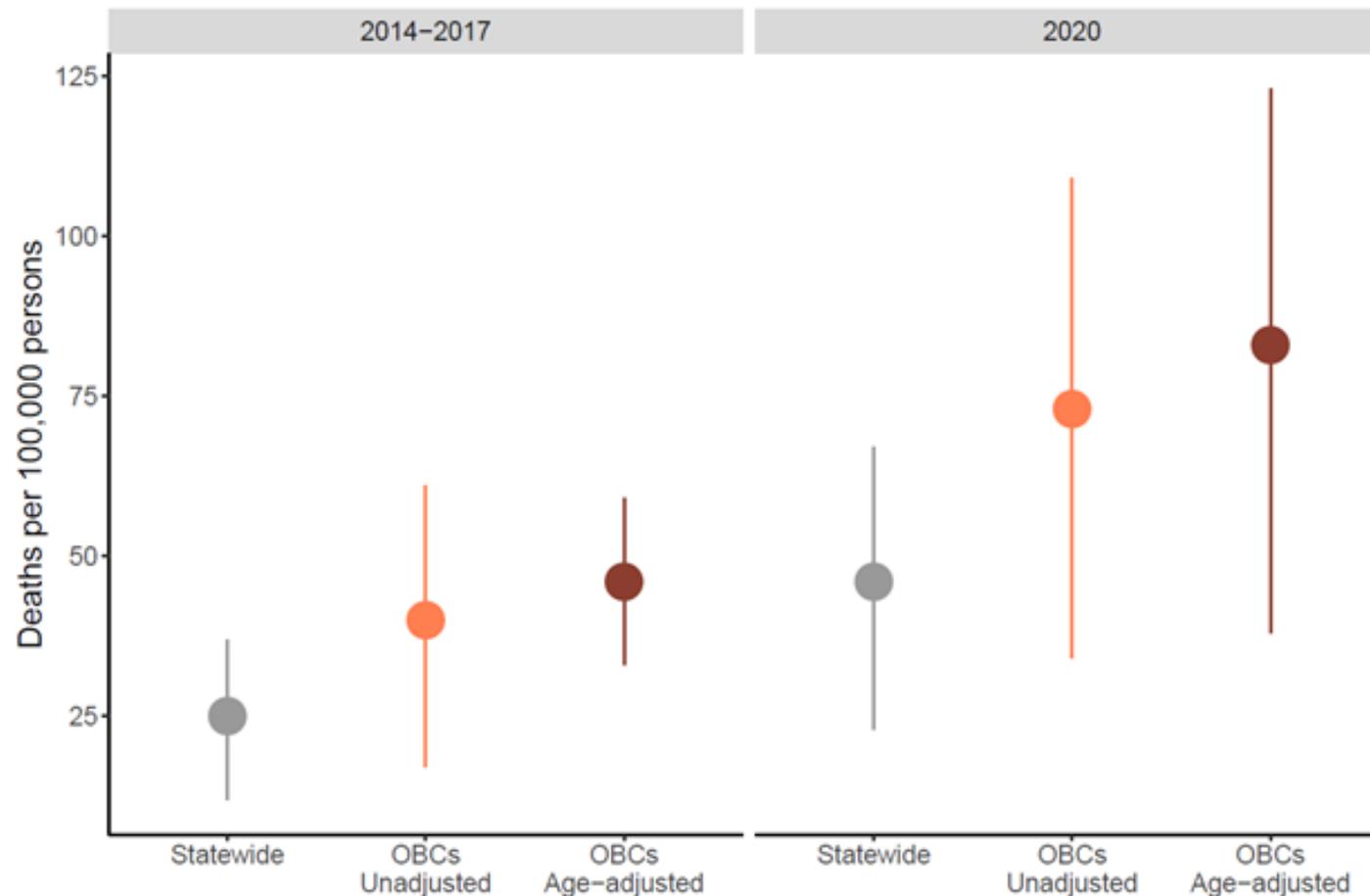
11-13

13-20



OBC boundaries

All-cause mortality rates for overburdened communities (OBCs) compared to the statewide average



Mortality rates for overburdened communities (OBCs) by race and ethnicity group, 2020 CMAQ fusion data

Race and Ethnicity Group	Annual number of deaths [95% uncertainty range]	Age-adjusted annual death rate per 100,000 people [95% uncertainty range]
Hispanic	152 [88 to 210]	149 [86 to 205]
Non-Hispanic American Indian or Alaska Native	7 [-5 to 17]	75 [-53 to 185]
Non-Hispanic Asian	59 [-41 to 146]	56 [-39 to 139]
Non-Hispanic Black	47 [15 to 76]	87 [27 to 142]
Non-Hispanic Native Hawaiian and Other Pacific Islanders	4 [-3 to 11]	69 [-48 to 171]
Non-Hispanic multiple races	13 [-9 to 32]	69 [-48 to 170]
Non-Hispanic white	447 [293 to 591]	78 [51 to 103]