

Health Effects of Wildfire Smoke and impact on pediatric asthma

December 2, 2025

Wenatchee School District

Board Meeting

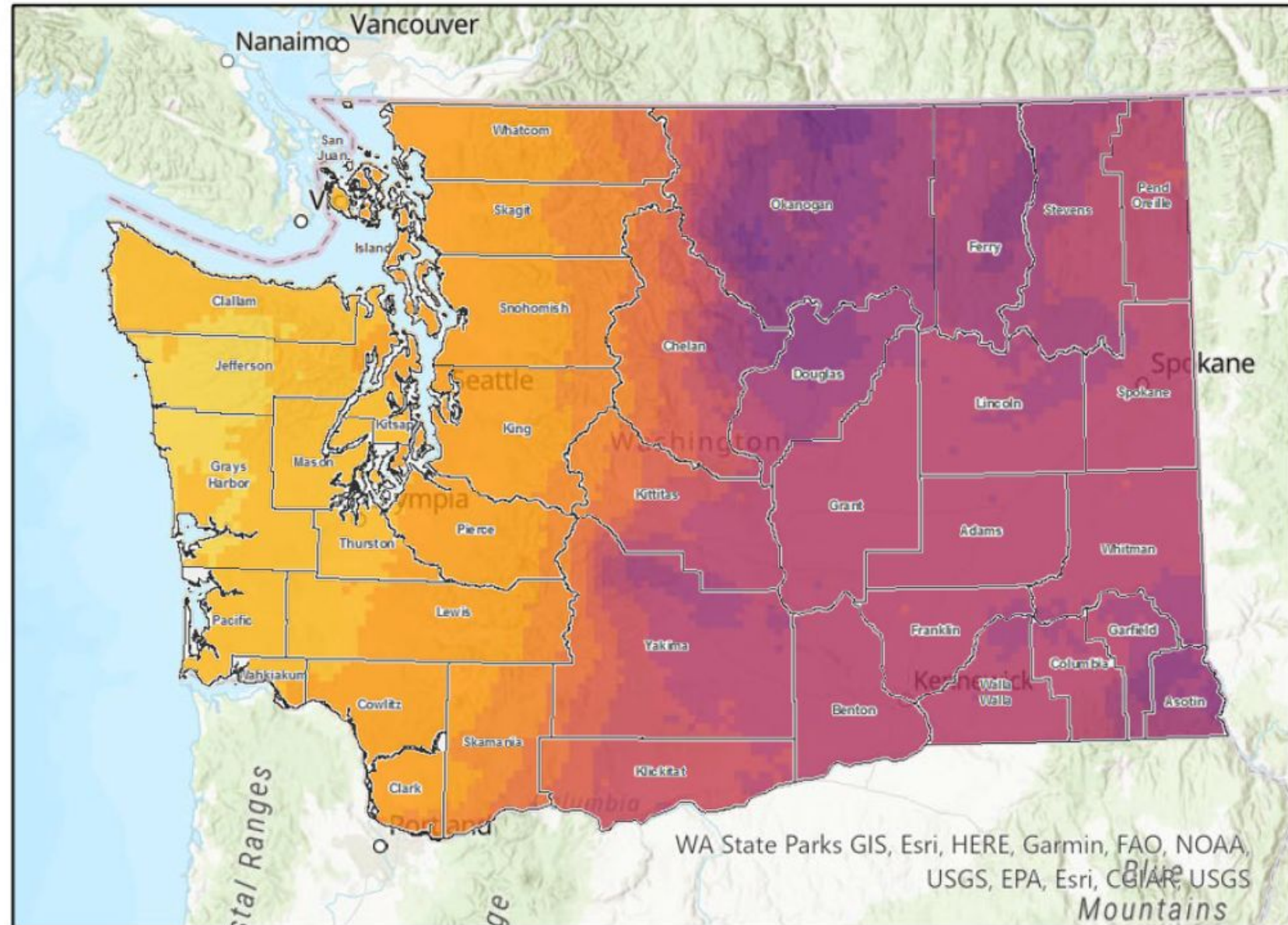
Geography of WFS in WA

Average heavy smoke
days/year (2015-2021)
from satellite data

Highest risk east of Cascades

Highest risk counties:

Okanogan
Chelan
Douglas
Yakima
Ferry
Asotin



Annual mean

days

0-2

3-4

5-6

7-8

9-10

11-12

13-14

15-16

17-18

19-20

21-22

23-24

25-26

27-28

29-30

31-32

33-34

35-36

■ >36

Wildfire and Smoke hazards for Wenatchee

Wildfire & Smoke

Wildfire and smoke are hazards of high concern in Wenatchee, with much of the city within the wildland urban interface, where structures border wildfire fuels (Exhibit 23). Exhibit 24 shows where wildfire risk affects greater concentrations of housing units, including much of the west side of the city.

As changes to weather patterns occur, Wenatchee is expected to see nine more days of high fire danger each year (Exhibit 22). Chelan County is expected to see an increase of ten days. There is an 87% chance that conditions will be optimal for wildfire in Wenatchee at some point between 2030 and 2059. Countywide, the likelihood is 44%. Compared to other climate hazards, wildfire is one of the greatest threats in Wenatchee.

Exhibit 22. Wildfire and Smoke Indicators

Indicator	Projected Change*
High Fire Danger Days Annually (Wenatchee)	+9 days
High Fire Danger Days Annually (Chelan County)	+10 days
Likelihood of Climate and Fuel Conditions for Wildfire (in the 30-year period) (Wenatchee)	87%
Likelihood of Climate and Fuel Conditions for Wildfire (in the 30-year period) (Chelan County)	44%

*Change in high fire danger days compares modeling for the 2050s with the 1980s. Likelihood of climate and fuel conditions is for the period between 2030 and 2059.
Source: UW Climate Impacts Group, 2025; BERK, 2025.

- Wenatchee is expected to see nine more days of high fire danger each year.
- Compared to other climate hazards, wildfire is one of the greatest threats in Wenatchee.

PM_{2.5}

- Primary pollutant in wood smoke
- Particulate matter in WFS is very small (0.4-0.7 μm)
- Common to see 24-hour PM_{2.5} concentrations >200 mcg/m³ in vicinity of a fire
 - EPA sets regulations for 24-hour PM_{2.5} concentration at 35 mcg/m³
- Not all PM_{2.5} is created equal – PM_{2.5} from WFS may be more toxic than that from other ambient air pollution

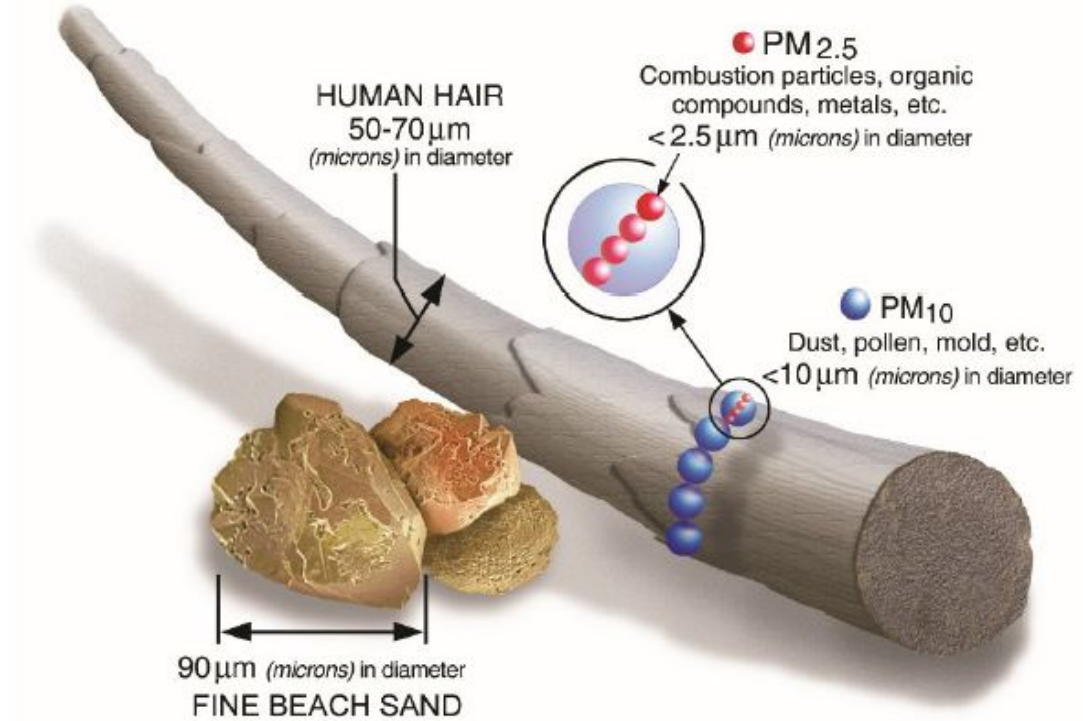
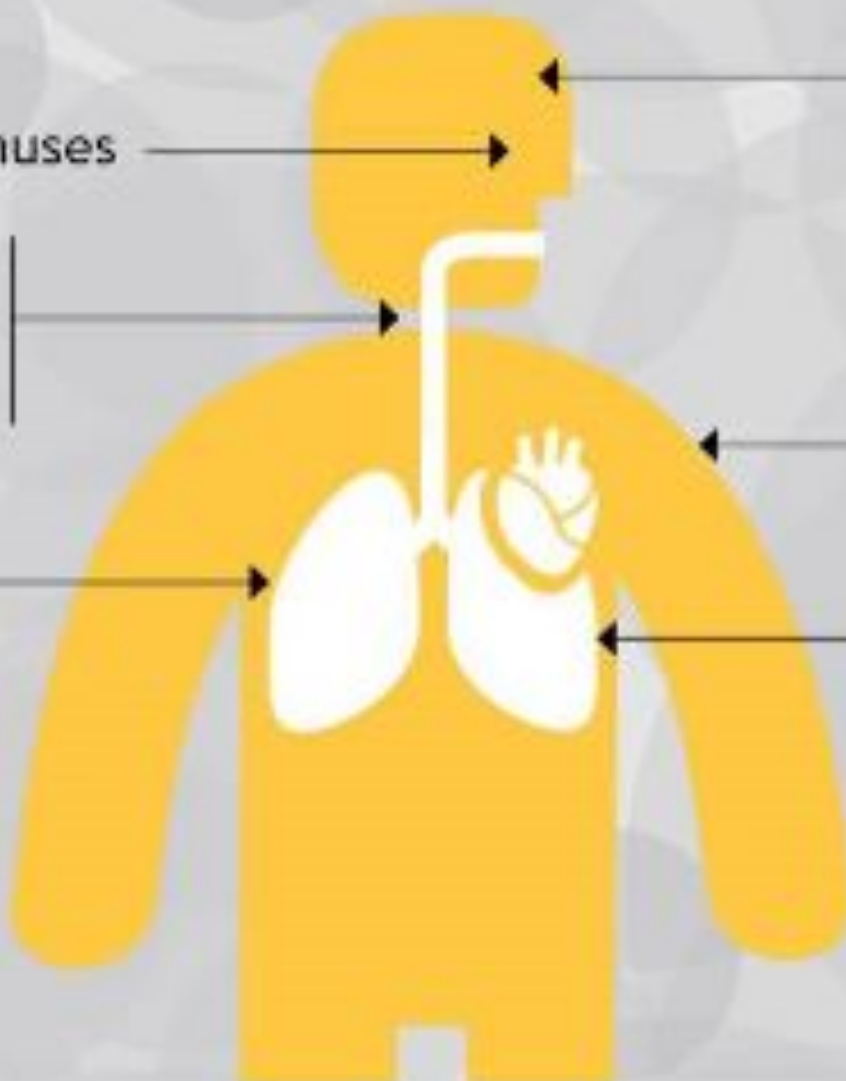


Image: <https://www.epa.gov/pm-pollution/particulate-matter-pm-basics>

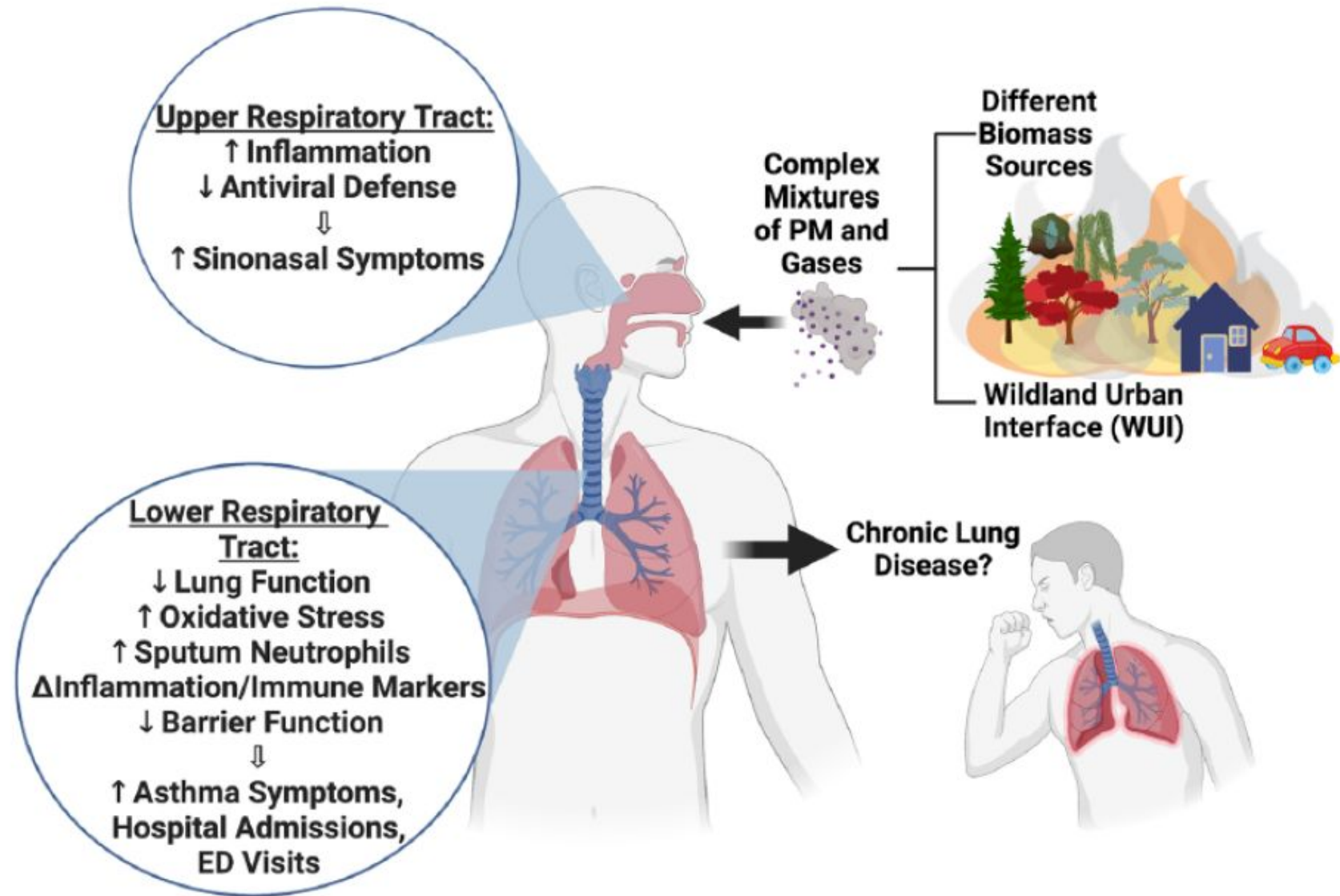
Fine particles (PM 2.5) pollution from wildfire smoke can cause:

- 
- The diagram shows a stylized human figure in orange. The respiratory system is highlighted in white, including the trachea, bronchi, and lungs. Arrows point from various symptoms listed on the left and right to specific parts of the body: 'Headache' points to the head; 'Irritated eyes and sinuses' points to the face; 'Irritated throat' and 'Increased coughing' point to the throat area; 'Difficulty breathing' points to the lungs; 'Increased fatigue' points to the upper chest/shoulder area; 'Asthma attacks' and 'Chest pain' point to the lower chest area.
- Headache
 - Irritated eyes and sinuses
 - Irritated throat
 - Increased coughing
 - Difficulty breathing
 - Increased fatigue
 - Asthma attacks
 - Chest pain

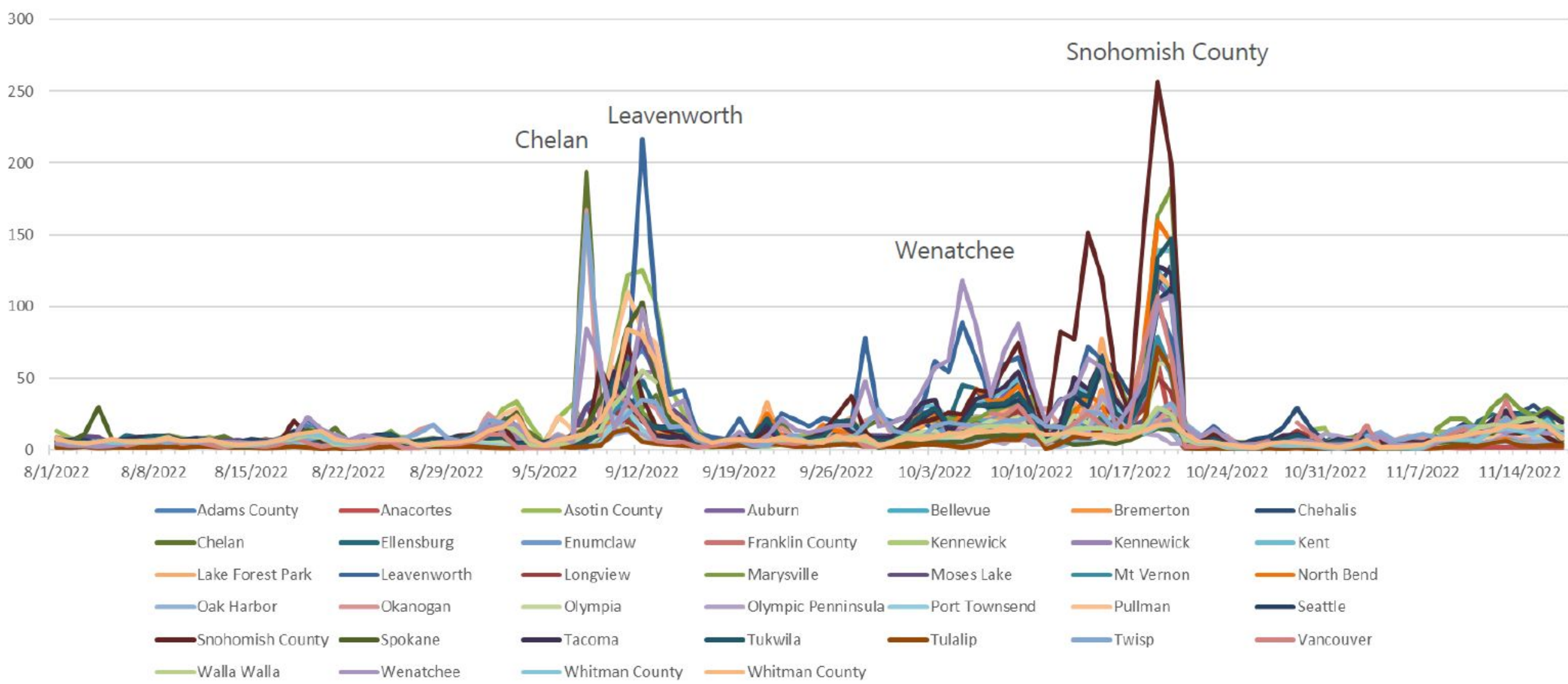
Impact of WFS on Asthma

- Clearest evidence points to acute impacts shortly after exposure
- In general population, relative risk of asthma morbidity (e.g. ED visits or hospitalizations) ~ 1.10 per 10 mcg/m³ increase in WFS PM_{2.5}
- Increased risk of new-onset asthma noted in Canadian firefighters
- Long-term impacts on lung function observed in infant rhesus monkeys
- Increased exposure risks for those of low socioeconomic status and for indigenous groups
- In children, WFS causes:
 - Worsened asthma symptoms
 - Increased pediatric ED visits for asthma
 - Increased hospitalizations for asthma
- Young children and those with higher BMI are at higher risk of exacerbations

Effects of WFS on the Respiratory Tract

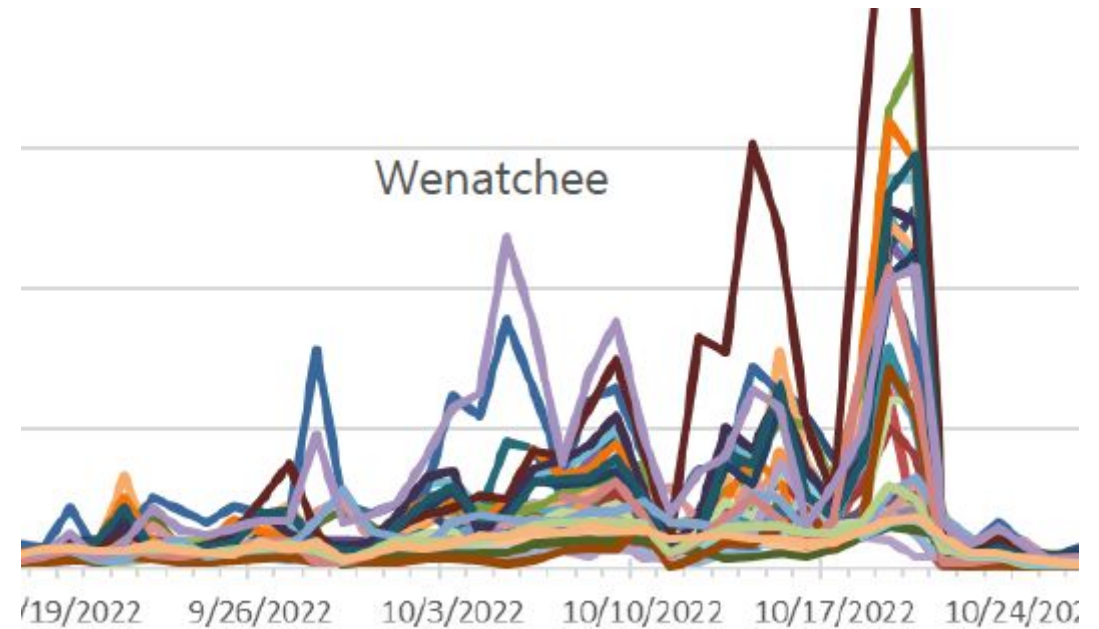
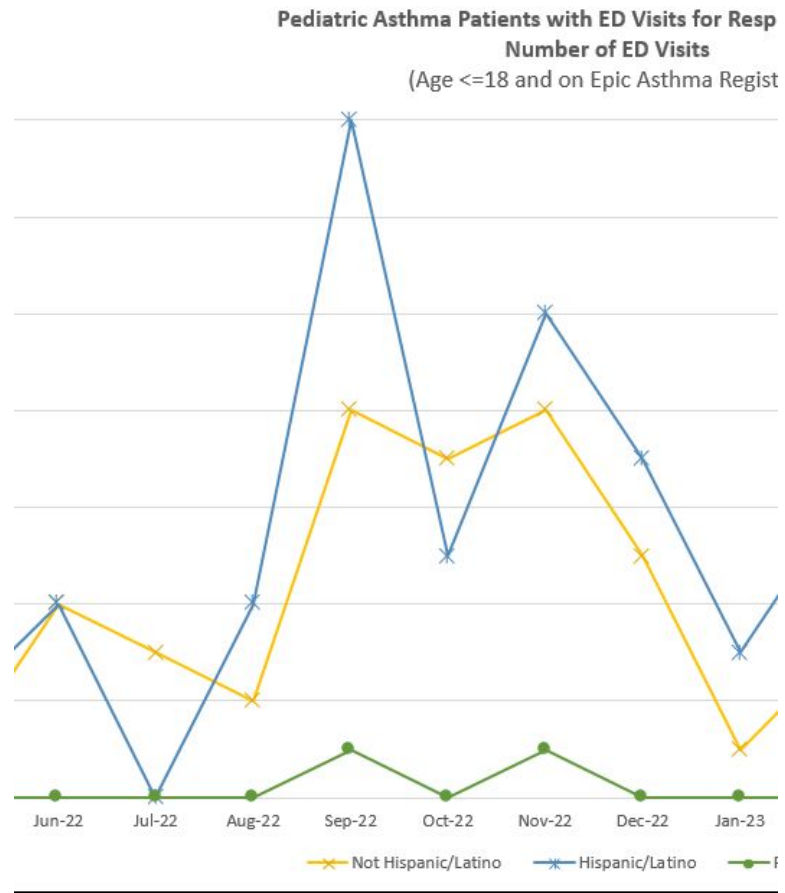


Daily average PM2.5 in Washington, Aug-Nov 2022

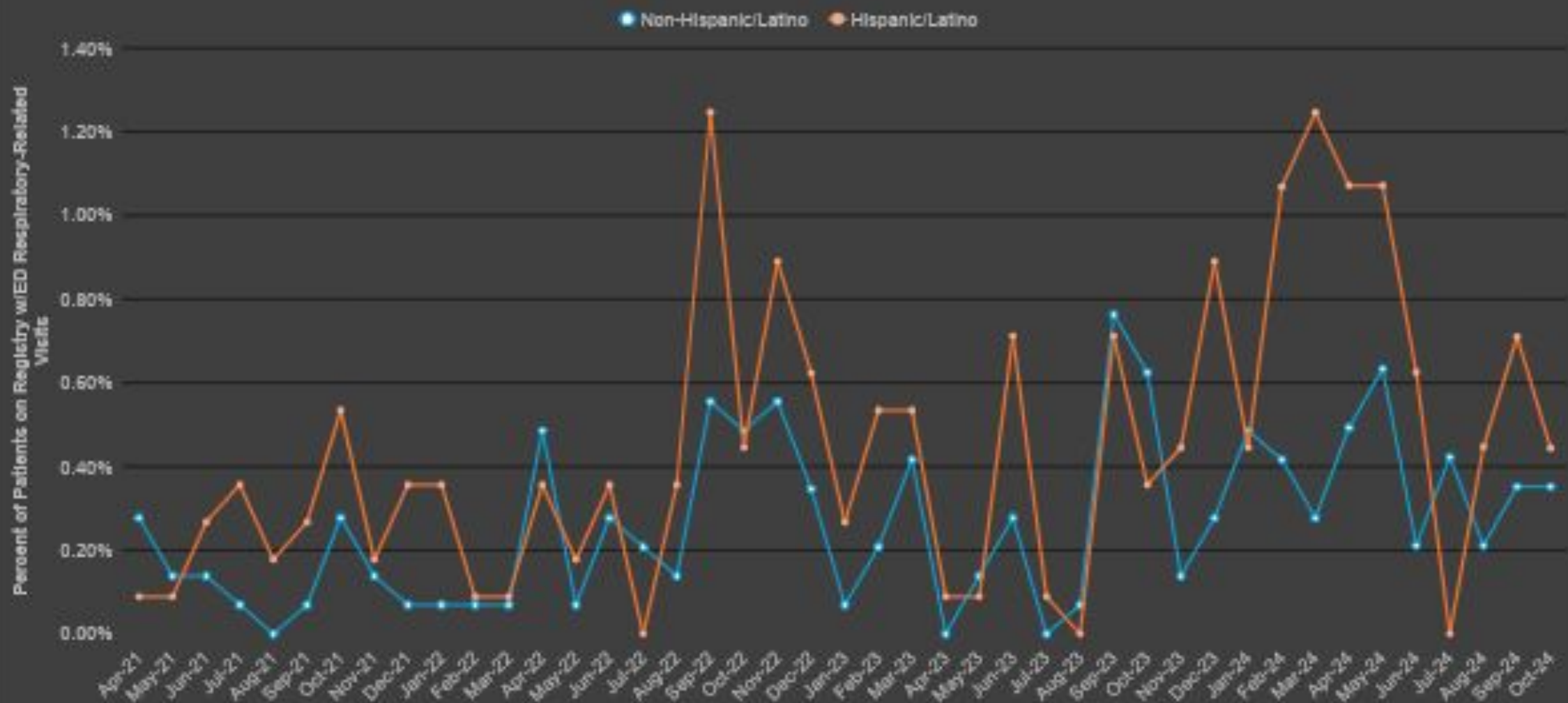


Data source: WA Dept of Ecology, 2022

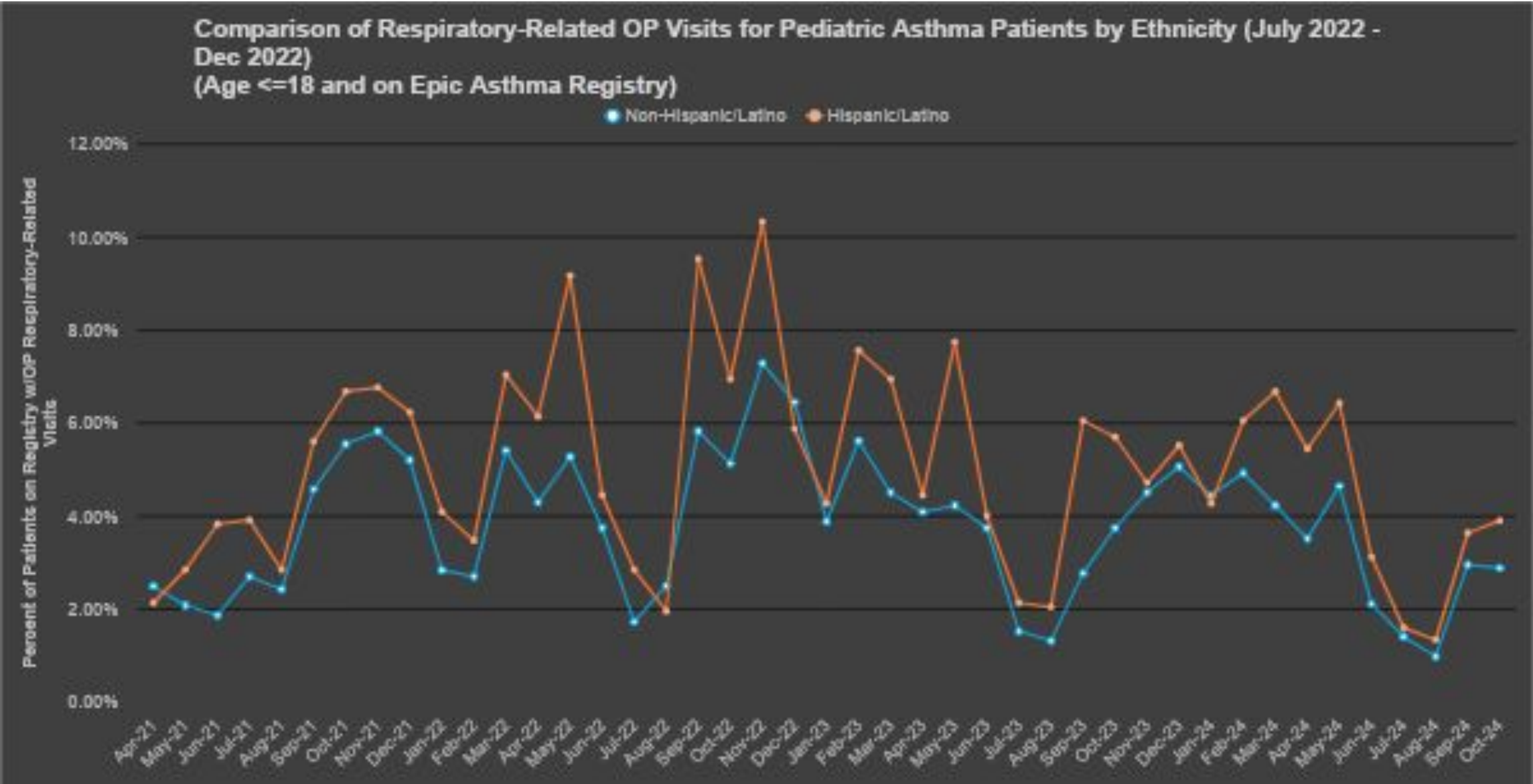
Comparison of Wildfire smoke PM2.5 and ED visits at Central Washington Hospital for kids with asthma



Comparison of Respiratory-Related CC & MC ED Visits for Pediatric Asthma Patients by Ethnicity (July 2022 - Dec 2022)
 (Age <=18 and on Epic Asthma Registry)



Outpatient visits for children with asthma during wildfire episode in fall of 2022



Surveillance Investigation of the Cardiopulmonary Health Effects of the 2012 Wildfires in North Central Washington State

Washington State Department of Health

December 2015

Table 8a (continued). Outpatient visits for subcategories of respiratory disease (listed as first diagnosis) before (15 days: 8/25–9/8) the 2012 wildfires in north central Washington compared to during (34 days: 9/9–10/12) and after (19 days: 10/13–10/31).

Age group	Visits Before		Visits During		Before to During Comparisons			Visits After		Before to After Comparisons		
	Number	Average daily	Number	Average daily	Excess ¹	O/E ²	95% CI ³	Number	Average daily	Excess ¹	O/E ²	95% CI ³
Chronic obstructive pulmonary disease and allied conditions excluding asthma (ICD-9-CM 490-492, 494-496)												
All	252	17	912	27	10	1.60	1.05-2.32	501	26	10	1.57	1.03-2.30
0–18	10	1	63	2	1	2.78	0.33-10.59	44	2	2	3.47	0.53-11.53
19–64	81	5	314	9	4	1.71	0.79-3.21	193	10	5	1.88	0.91-3.45
65+	161	11	535	16	5	1.47	0.83-2.39	264	14	3	1.29	0.71-2.18
Asthma (ICD-9-CM 493)												
All	256	17	1090	32	15	1.88	1.19-2.65	430	23	6	1.33	0.84-1.99
0–18	94	6	450	13	7	2.11	1.13-3.59	161	8	2	1.35	0.60-2.62
19–64	127	8	501	15	6	1.74	0.97-2.88	206	11	2	1.28	0.63-2.29
65+	35	2	139	4	2	1.75	0.49-4.45	63	3	1	1.42	0.33-3.95
Pneumoconiosis and other lung diseases due to external agents (ICD-9-CM 500-508)												
All	16	1	49	1	0	1.35	0.11-5.84	14	1	-0	0.69	0.02-4.50

¹ Excess represents the excess number of average daily visits calculated by subtracting the average number of daily visits before the wildfires from the average number of daily visits during the specified period; subtraction might not look accurate due to rounding.

² O/E: ratio of observed number of average daily visits to the expected number based on average daily visits in the period corresponding to before the wildfires; bolding indicates the O/E is statistically significant at $p < 0.05$ (i.e. the O/E is outside the range we might expect through random variation or chance).

³ 95% CI: 95% confidence interval around O/E. If the CI includes one, the O/E is not outside the range we expect by chance alone. Due to rounding a CI of 1.00 might be either greater or less than one, e.g., 1.004 or 0.9998.

Conclusions of Department of Health Surveillance 2012

These findings, combined with previously published studies, underscore a continued need for effective interventions to minimize harmful effects of smoke from wildfires. Healthcare system planning should reflect the seasonally increased need for adequate staffing, sufficient resources, and personnel training to meet the needs of those at risk during wildfire seasons. Children, especially those with asthma, seem predisposed to harmful effects of wildfire smoke and should be targeted with additional efforts to reduce illness and disease exacerbations.

Health departments in north central Washington can use these results to tailor health messages during wildfires. General advice to minimize exposure to wildfire fire smoke seems important, given the overall increase in respiratory disease visits, our inability to distinguish people with preexisting disease from those with no history of disease, and what we know from other studies. The overall increase in children's visits for respiratory disease suggests a need for special attention to children. Additional studies on long-term effects of wildfire smoke are needed, as are studies designed to eliminate confounding effects of weather and other environmental factors are needed.

Clinic initiative to decrease health effects of wildfire smoke

- Clinic Setting
 - Providing an Asthma action/management plan for all kids with asthma
 - Providing a Wildfire Smoke Action Plan for families with a child with asthma
 - This gives the patient and family instructions on what to do with their asthma medications when they are having a mild, moderate or severe flare up of their asthma.

Asthma Action Plan

Warning: this patient's asthma action plan has not been signed!

Asthma Action Plan

Asthma severity: ☐ intermittent ☐ mild persistent ☐ moderate persistent

Asthma triggers: ☐ severe persistent ☐ exercise induced bronchospasm

Asthma triggers: ☐ animal dander ☐ dust mites ☐ cockroaches ☐ indoor mold
☐ pollen ☐ outdoor mold ☐ tobacco smoke ☐ smoke odors, and sprays
☐ vacuum cleaning ☐ exercise ☐ respiratory infection

Best peak flow: 450 [Recalculate zone peak flow ranges]

Green Zone

Peak flow: more than 360

You have all of these: breathing is good, no cough or wheeze, can work/play, and sleeps all night

Inhaled Medication: Fluticasone [1] 2 Puffs [2] Twice Daily [3]

Other Medication: [4] [5] [6]

Pre-Exercise Medication: [7] [8] [9]

Other instructions: [100%]

Yellow Zone

Peak flow: 225 to 360

You have any of these: cough, wheeze, tight chest, coughing at night

Inhaled Medication: Albuterol [1] 2 Puffs [2] Every 4 Hours PRN [3]

Other Medication: [13] [14] [15]

Other instructions: [100%]

Red Zone

Peak flow: less than 225

You have any of these: medicine is not helping, breathing is hard and fast, nose opens wide, cannot walk or talk well, ribs show

Inhaled Medication: Albuterol/ipratropium [4] 2.5mg via nebulizer [6] Every 15 Minutes Until You Get Help [1]

Other Medication: [19] [20] [21]

Other instructions: [100%]

Not Signed

Mark as Reviewed Last reviewed by Kiahn, Tami J, MA-C on 6/24/2024 at 2:38 PM

Close Cancel Previous Next

Wildfire Smoke Action Plan

Washington Wildfire Smoke Action Plan

Name: _____ Date: _____

PREPARE: What to do before wildfire season starts

- ☐ Fill in your personalized action plan (below)
- ☐ Set up air quality alerts (see resources)
- ☐ Stock up on filters for HVAC system, HEPA air cleaner
- ☐ Replace old/dirty air filters
- ☐ Stock up on well-fitting N95 masks (see resources)
- ☐ Set up a clean room in your home (see resources)
- ☐ Make sure you have all asthma medications at home
- ☐ Update your asthma action plan with your provider

ACTION PLAN: What to do during wildfire season

- ☐ Check your air quality daily: www.airnow.gov or _____
- ☐ Use your air quality forecast to plan your activities: www.airnow.gov or _____
- ☐ When outdoor air quality is poor...
 - ☐ Limit your activity outdoors (see chart below)
 - ☐ Close your windows/doors/chimney flue
 - ☐ Wear your N95 mask outdoors
 - ☐ Use your clean room
 - ☐ Turn on your HVAC system, HEPA air cleaner, or DIY box fan filter
 - ☐ Use your grocery delivery service: _____
 - ☐ Use your pharmacy delivery service: _____
- ☐ Reduce other sources of air pollution in your home
- ☐ For cleaner air, go to: _____
- ☐ Contact your health care provider for symptoms (call 911 for emergencies):
 - o Name: _____ Practice: _____ Phone #: _____
 - o Name: _____ Practice: _____ Phone #: _____

AQI	Description	Activity Recommendations	
		General Recommendations (write names)	Sensitive Individuals (write names)
0-50	Good	No changes needed.	No changes needed.
51-100	Moderate	No changes needed.	Mild health risk. Consider reducing prolonged or heavy outdoor exertion. Reduce your activity if you have symptoms.*
101-150	Unhealthy for sensitive groups	Mild health risk. No changes needed, but reduce your outdoor activity if you have symptoms.*	Moderate health risk. Reduce prolonged or heavy outdoor exertion. Spend less time outdoors, take more breaks, do less intense activities, and go inside if you have symptoms.*
151-200	Unhealthy	Moderate health risk. Reduce prolonged or heavy outdoor exertion. Take more breaks.	Serious health risk. Avoid prolonged or heavy outdoor exertion (light, short activity may be okay). Wear N95 mask outdoors. Move outdoor activities indoors or reschedule to a time when air quality is better.
201-300	Very unhealthy	Serious health risk. Avoid prolonged or heavy outdoor exertion. Wear N95 mask outdoors. Move outdoor activities indoors or reschedule to a time when air quality is better.	Dangerous conditions. Avoid all outdoor activity. Wear N95 mask if you must go outdoors. Move outdoor activities indoors or reschedule to a time when air quality is better.

Wildfire Smoke Action Plan

For Children with Asthma

1 PREPARE Before wildfire season I will...



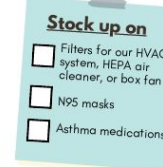
Fill in my action plan (below)



Find out my child's N95 mask size (ages 7+)



Set up air quality alerts



Stock up on

- ☐ Filters for our HVAC system, HEPA air cleaner, or box fan
- ☐ N95 masks
- ☐ Asthma medications



Set up a box fan filter or HEPA air cleaner



Replace any old/dirty air filters



Set up a clean-air room in my home



Update my child's asthma action plan with our provider

2 ACTION PLAN During wildfire season I will...

- ☐ Check my air quality (AQI) and forecast daily, using:

(app, website, radio station)



www.airnow.gov

- ☐ Use my air quality forecast to plan our activities.

- ☐ Use the chart on the back to decide when to:

- Limit our activity outdoors
- Wear N95 masks outdoors (kids 7+ and adults)

- ☐ On smoky days, reduce our smoke exposure indoors by:

- Turning on our HVAC system, HEPA air cleaner, or box fan filter
- Closing our windows/doors/chimney flue
- Avoiding anything that makes the air quality in our home worse
- Using our clean-air room
- Considering going somewhere else for clean air

- Put our air conditioner on the "circulate" setting

- ☐ Choose an indoor "smoky day" activity when we can't go outside

- ☐ Contact our health care provider for symptoms according to our asthma action plan

Indoor "Smoky Day" Activities

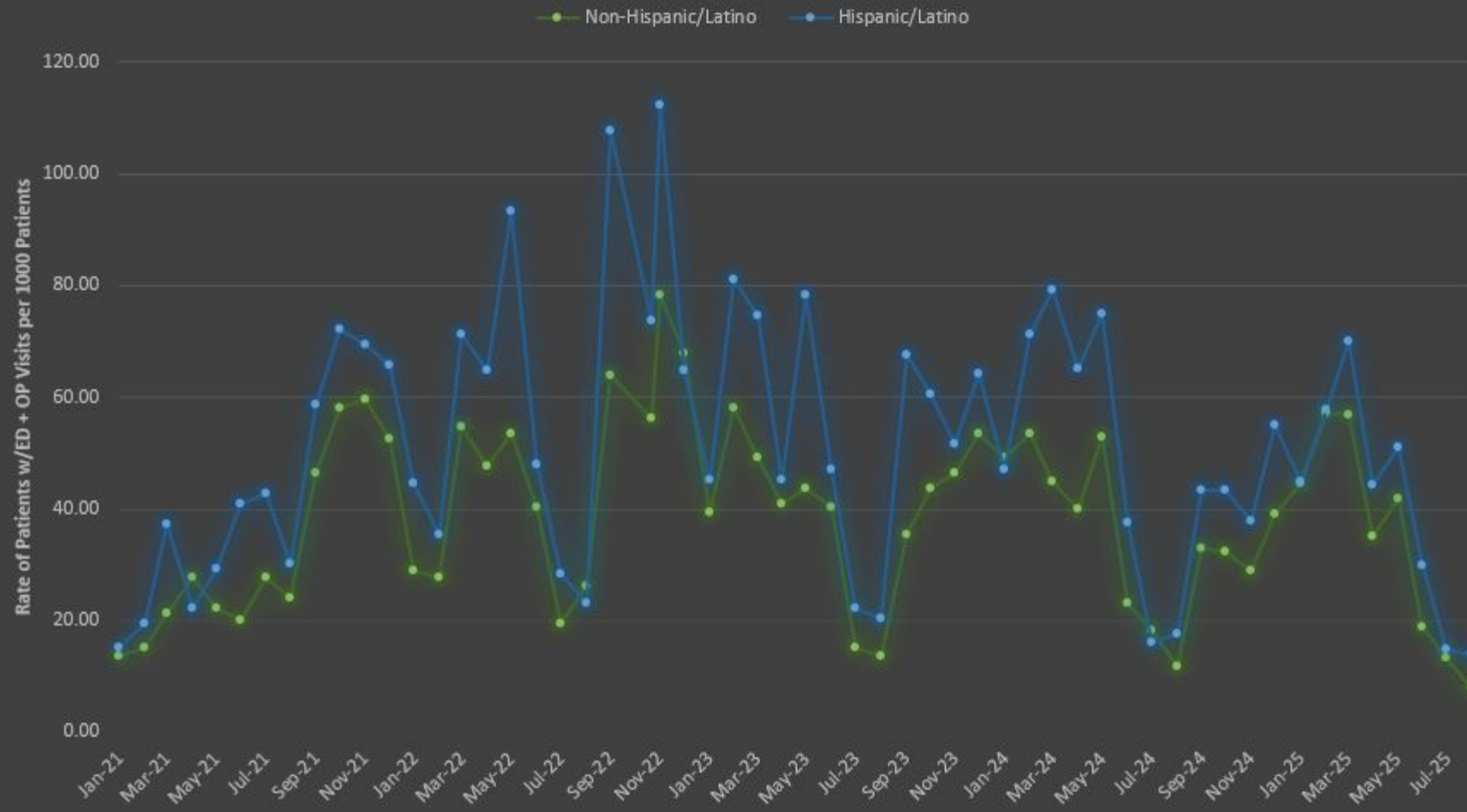
- 1.
- 2.
- 3.

Clean air places outside my home

- 1.
- 2.
- 3.

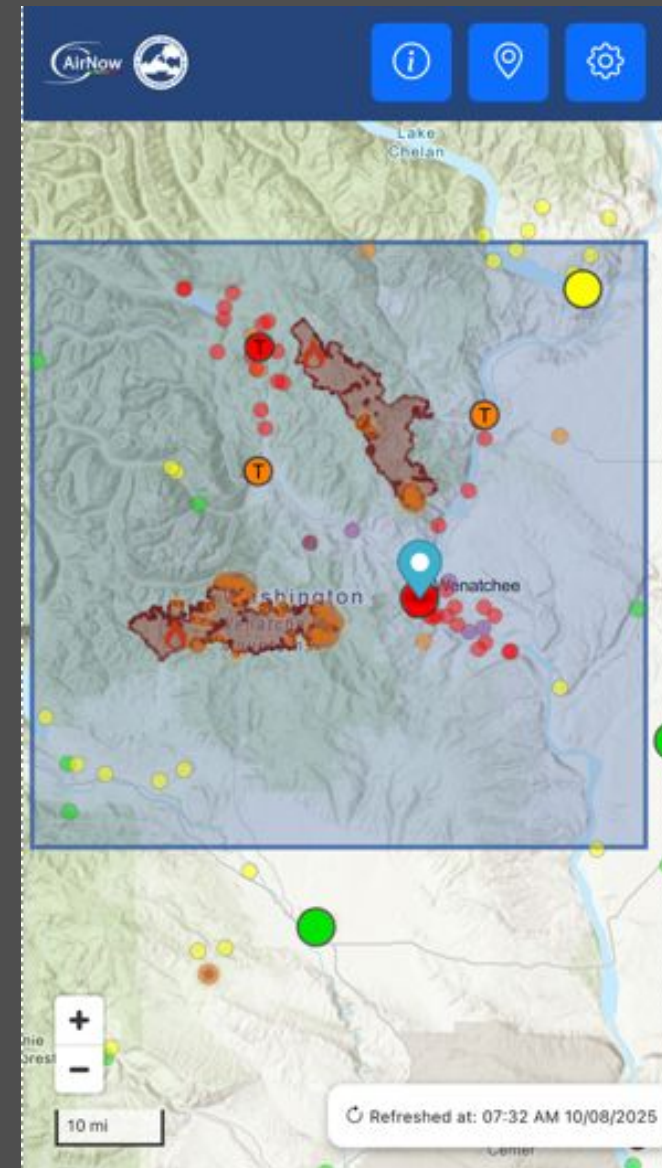
Created by Dr. Crocker with the Pediatric Environmental Health Specialty Units

Comparison of Respiratory-Related ED + OP Visit Rate for Pediatric Asthma Patients by Ethnicity 2021 - 2025 YTD (Age <=18 and on Epic Asthma Registry)

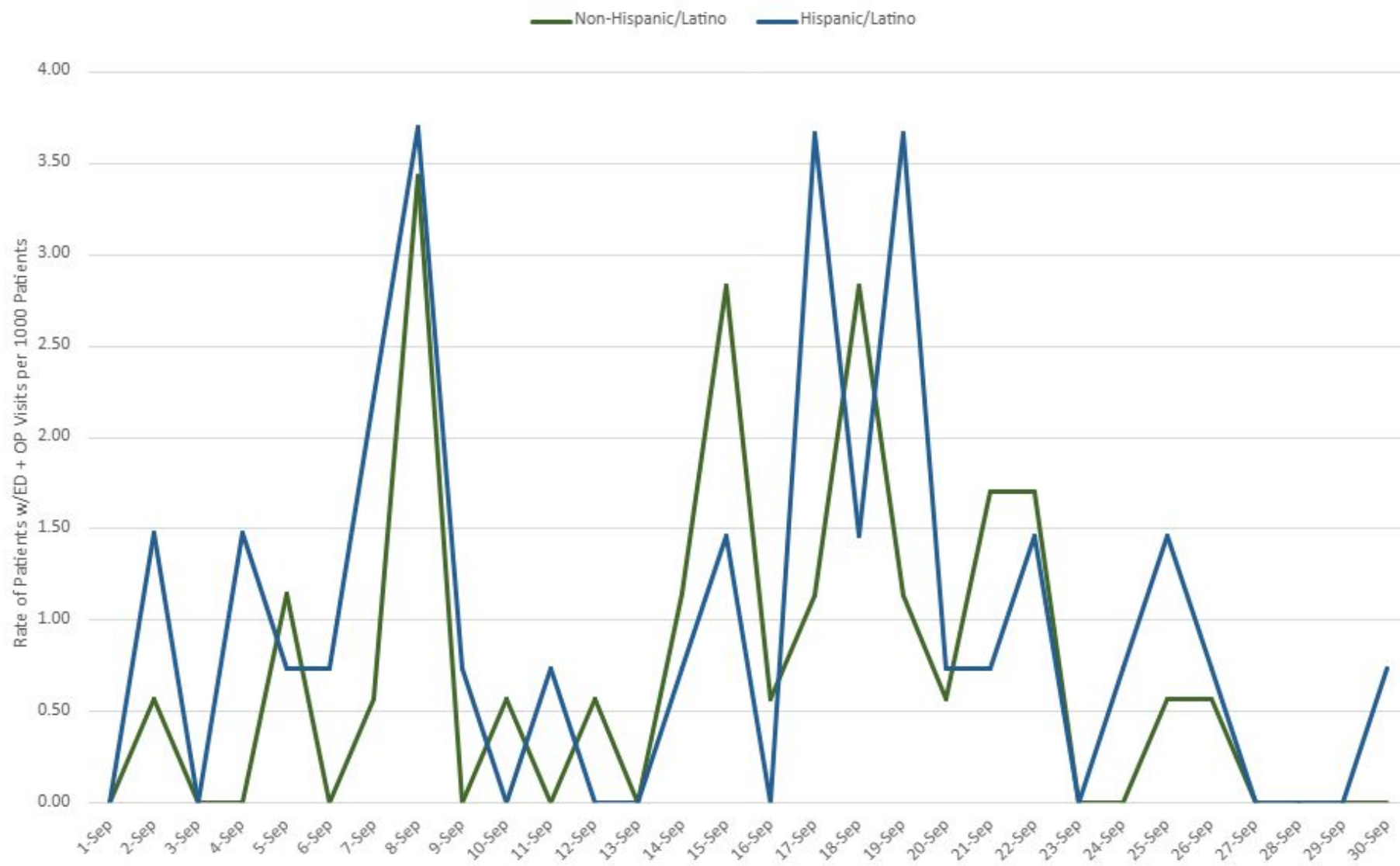


Wildfire smoke episode starts on Sunday, August 30, 2025 and continues

Wildfire Smoke episode starts on
September 1, 2025 in Wentachee
and much of North Central
Washington



Comparison of Respiratory-Related ED + OP Visit Rate for Pediatric Asthma Patients by Ethnicity
Sept 1-30, 2025 Wildfire Smoke Season (Age <=18 and on Epic Asthma Registry)



Results from 2 weeks post wildfire episode

- 50% Less Respiratory related Emergency department visit for children with asthma who had an asthma action plan compared to children with asthma who did not have an asthma action plan on days 1-14 of the Wildfire smoke episode in 9/2025
- 71% less outpatient visits for children with asthma who had an asthma action plan in place vs. children with asthma who did not have an asthma action plan in place during the first 14 days of wildfire smoke episode of 9/2025
- Significant reduction in disparity of **outpatient care visits** for respiratory problems for children with asthma between Hispanic children with asthma and Non-Hispanic children with asthma at Confluence Health in comparison to 2022 wildfire smoke episode.

Indoor Air Quality

Factors affecting indoor Air quality

Housing units older than 30 years have lower insulation levels, and may lack energy-efficient modern heating and cooling systems

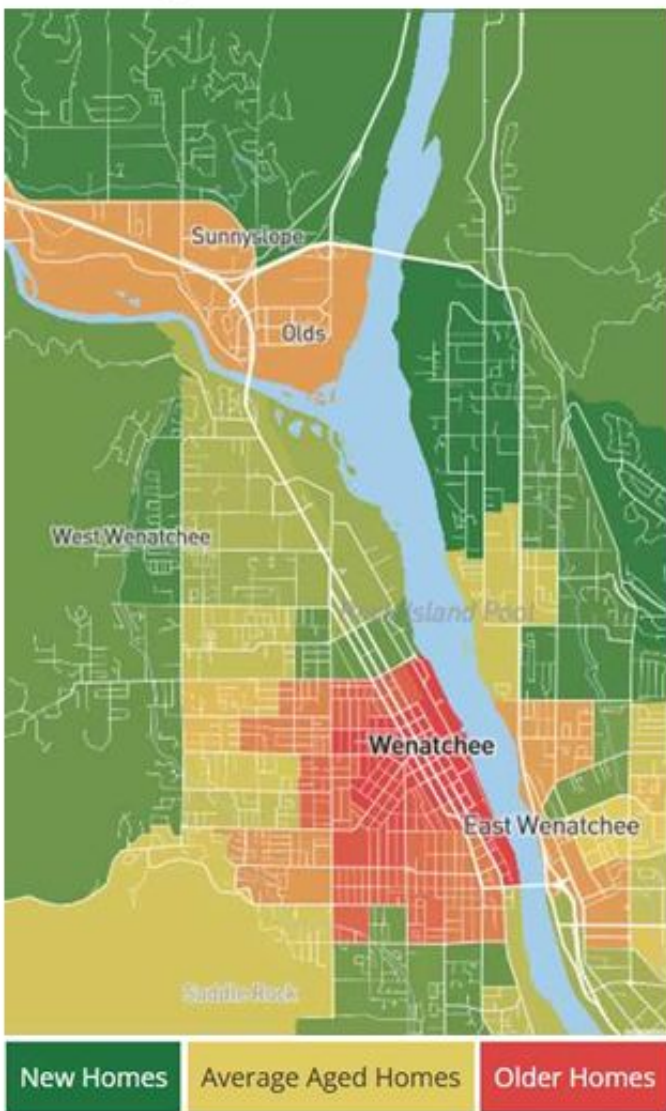
Exhibit 8. Age of Homes in Wenatchee, by Housing Year Built

Housing Year Built	Estimate
Build after 2000	2,906
Built 1980-1999	3,523
Built 1960-1979	3,121
Built 1940-1959	2,850
Build before 1940	2,158
Total	14,558

Source: American Community Survey 5- year Estimates, 2023.

Homes that are in the darkest shade of red have homes that are, on average, 80 years or older.

Exhibit 9. Age of Homes in Wenatchee



Note: Areas in green have homes that are, on average, 15 years old or newer. Areas in the darkest red shades have homes that are, on average, 80 years or older.
Source: Best Neighborhoods, 2024.

Indoor Air Quality at Wenatchee High School during Wildfire Smoke Episode in September – October 2025

- Wenatchee High School was built in 1971 (55 years ago)
- HVAC equipment lacking high-quality filtration to be able to adequately clean the air when AQI is high and ventilation not adequate to keep smoke out of the building
- Chelan Douglas Health District air sensors noted AQI ranging between 133-244 on October 7, 2025 in Wenatchee High School with variability throughout different areas of the high school
- Air scrubbers and extra Air purifiers were brought in which reduced AQI with continuous use over several days

Protecting students and staff from effects of wildfire smoke by improving indoor air quality

- Wildfire smoke which causes poor air quality, has dangerous health effects to all individuals, both through outdoor exposure and indoor exposure.
- Children (under the age of 18) are more vulnerable to the health effects of wildfire smoke.
- The high school building has proven that it cannot adequately sustain healthy indoor air quality when outdoor air quality is unhealthy due to wildfire smoke.
- Wildfire smoke episodes and days of heavy smoke are predicted to increase in frequency and number of days per year in the coming years.
- While air purifiers can improve or mitigate indoor air quality during these episodes, a better solution would be to make the high school building more resilient to wildfire smoke so that indoor air quality remains in a healthy range even during wildfire smoke episodes.

Upstream driver of health effects of wildfire smoke: →
Age of building and indoor air quality-
Solution: improve indoor air quality in schools



Downstream intervention: ←
Providing asthma action plan and wildfire smoke action plan to kids with asthma and their families