Impacts of aviation emissions on community health

August 11, 2025
Airport Round Table Advisory Committee
UW Center for Environmental Health Equity (CEHE)

SCHOOL OF PUBLIC HEALTH
UNIVERSITY of WASHINGTON

1

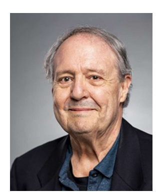
UW Team

Elena Austin
Associate Professor
DEOHS
elaustin@uw.edu

Ningrui Liu
Postdoctoral Researcher
DEOHS
liunr24@uw.edu

Janice North
MS Graduate
Department of Epidemiology
Jlnorth@uw.edu

Edmund Seto
Professor
DEOHS
eseto@uw.edu



Tim Larson
Emeritus Professor
Civil & Env. Engineering
DEOHS
tlarson@uw.edu

UNIVERSITY of WASHINGTON

2

Aviation and Public Health: Why it Matters for King County

Aviation activities generate a range of air pollutants with established health effects. Two major fuel types of concern: **Leaded aviation gasoline** (avgas) for piston-engine aircraft; **Jet A fuel** for turbine and jet aircraft.

Populations living or working near airports may experience higher exposures to lead, ultrafine particles, nitrogen oxides, and other pollutants. **King County has multiple airports with both piston-engine and jet traffic near residential areas, schools, and community spaces.**

Understanding local emission sources and exposures is important for assessing public health impacts. Airborne pollutants from aviation harm neurological, cardiovascular, and respiratory health (US EPA, 2023).

UNIVERSITY *of* WASHINGTON

3

Leaded Avgas: The Largest Remaining Source of Airborne Lead

- Piston-engine aircraft account for ~70% of airborne lead emissions in the U.S. (Klemick et al., 2022).
- Even very low blood lead levels (BLLs) are linked to adverse neurodevelopmental and cardiovascular outcomes (PEHSU, 2024).
- The U.S. EPA (2023) determined that aircraft lead emissions endanger public health and welfare.
- Lead persists in soil, dust, and bone long after emissions stop (WHO, 2023).

Figure 1: Piston engine aircraft (source: proaviationtips.com).

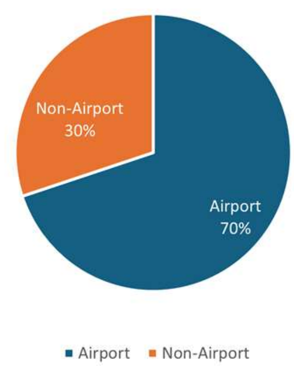
4

Airport lead emissions in King County

Facility Type	KC Facilities (Count)	KC Facilities (%)	Emissions (Tons)	Emissions (%)
Airport	15	58%	1.23	70%
Non-Airport	11	42%	0.53	30%
Total	26	100%	1.76	100%

Airports comprise **58%** of all facilities emitting lead in King County, and they are accountable for **70%** of the airborne lead emissions in the county.

Lead Emissions in King County (Tons), 2020



SCHOOL OF PUBLIC HEALTH
UNIVERSITY of WASHINGTON

Source: Out Nation's Air: Status and Trends Through 2021

5

Evidence from Multiple States: Elevated Child Blood Lead Near Airports

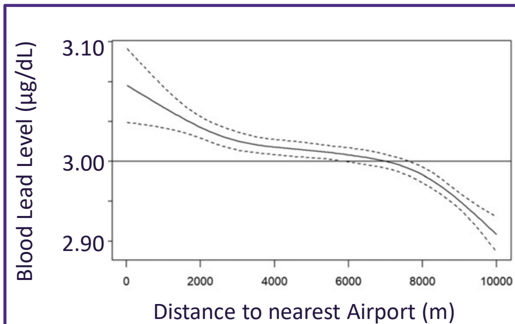


Figure 2: Average modeled blood lead level (BLL) in North Carolina children by residential distance to nearest piston-engine airport (adapted from Saole 2024)

- Multiple studies report higher blood lead levels (BLLs) among children living closer to airports with piston-engine traffic.
  - California: Higher BLLs with proximity, downwind location, and higher traffic volumes (Zahran et al., 2022).
  - North Carolina: Elevated BLLs up to 1.5 km; stronger effects downwind (Soale et al., 2024).
  - Colorado: Increased distance from airports associated with lower BLLs (Berg et al., 2024).

Local context:

- Bellingham WA: Downwind lead deposition sampling doubled background levels (Shull et al., 2025).

6

Health Risks in Adults: More limited evidence

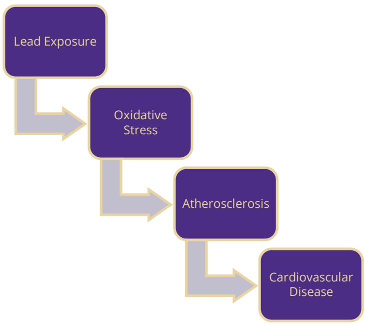


Figure 3: Mechanistic pathway linking lead exposure to cardiovascular disease, adapted from the U.S. EPA Integrated Science Assessment (ISA) for Lead 2020.

- Among older adults, living within 1–3 km downwind of single-runway airports was associated with higher cardiovascular mortality in years with more piston-engine traffic (Klemick et al., 2022).
- Biological pathway is described by the EPA and includes oxidative stress and atherosclerosis (EPA ISA, 2020).

7

Jet A and Non-Lead Aviation Emissions

- Jet A exhaust contains ultrafine particles (UFP), nitrogen oxides (NOx), volatile organic compounds (VOCs), and polycyclic aromatic hydrocarbons (PAHs).
- UFPs can penetrate deep into the lungs, cross into the bloodstream, and have been linked to cardiovascular, neurological, and respiratory outcomes. (EPA ISA PM2.5 2019).
- Elevated UFP levels have been measured several kilometers downwind of airports, including near Sea-Tac (Larson et al., 2017; Austin et al., 2021; Blanco et al., 2022; Liu et al., 2025).

8

Residents near airports face mixed airborne exposures from aviation and non-aviation sources.

The smallest ultrafine particles are disproportionately influenced by aircraft.

Pollutant	1st source	2nd source
CO_2	Gasoline (75%)	Aged (8%)
BC	Oil (22%)	Gasoline (14%)
UVPM	Oil (29%)	Gasoline (14%)
NO_2	Gasoline (44%)	Oil (16%)
PNC		
Total (10-420 nm)	Diesel (37%)	Oil (35%)
10-18 nm	Aircraft (64%)	Diesel (20%)
18-32 nm	Diesel (76%)	Oil (10%)
32-56 nm	Oil (52%)	Diesel (43%)
56-100 nm	Oil (77%)	Wood (17%)
100-178 nm	Wood (67%)	Oil (23%)
178-420 nm	Accum (38%)	Aircraft (15%)
$PM_{2.5}$	Accum (45%)	Wood (23%)

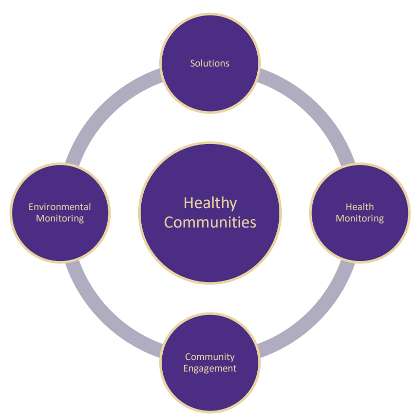
Figure 4: Source contributions to measured pollutants and particle size fractions at monitoring sites near Sea-Tac Airport using Positive Matrix Factorization (PMF). Liu et al 2025

- Source apportionment near Sea-Tac Airport shows distinct source patterns by particle size:
  - Aircraft dominate 10–18 nm particles.
  - Diesel is the main source for 18–32 nm particles; oil combustion, wood smoke, and roadway emissions dominate larger ultrafine sizes.
  - Gasoline and oil combustion contribute to BC and NO_2.
  - $PM_{2.5}$ is primarily from regional roadway and combustion sources.

9

Strategies to Address Airport-Related Air Pollution and Health Risks

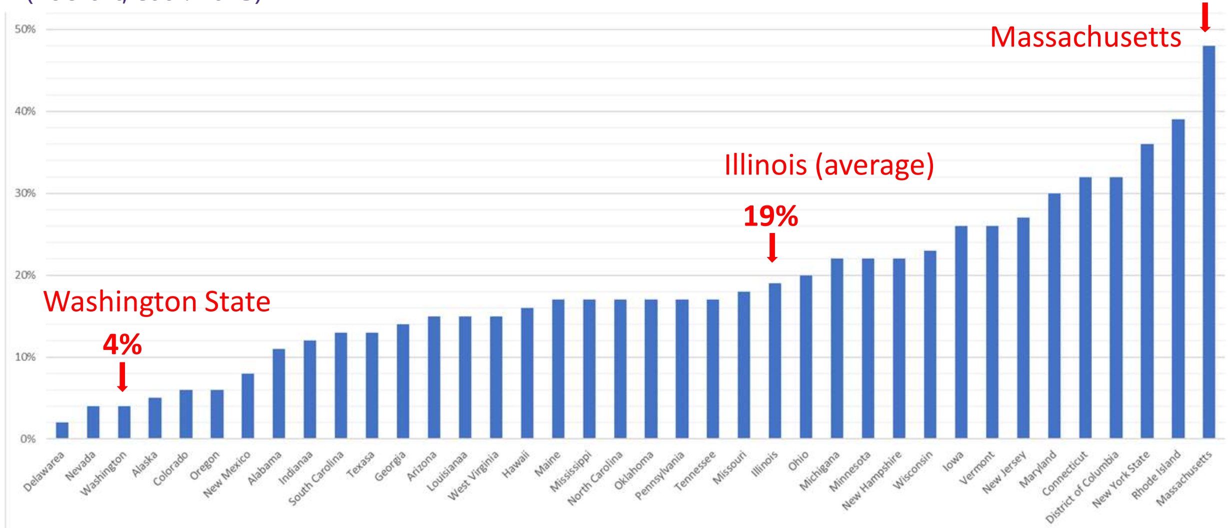
- **Environmental Monitoring**: Evidence supports the value of expanding measurement of airborne lead, ultrafine particles, and other pollutants to better characterize air quality around local airports.
- **Health Monitoring**: Data suggest that exposure reductions solutions, targeted blood lead testing for children living near airports and cardiovascular health assessments for adults in higher-exposure areas may help identify and mitigate risk for at-risk populations.
- **Community Engagement**: Partnering with local communities to share information on air quality, support voluntary testing, and discuss potential solutions can strengthen public understanding and participation.
- **Solutions**: Studies indicate that unleaded aviation gasoline, sustainable aviation fuels, adjustments to ground operations, and implementation of HEPA filtration interventions are shown to reduce impact of aviation emissions.



10

Proportion of Children Tested for Blood Lead Levels in 2017-2018, by State

(Ruckart, et al. 2023)



11

Current Activities

Air Monitoring North & South of SEA (PSCAA & UW)

> Fixed-site and mobile monitoring north and south of SEA; analysis of plume impacts by wind/runway use.

> Modeling impact of sustainable aviation fuels on community air quality.

Community-Led Lead Sampling near KCIA

> Demonstration project with residents: PM2.5/PM10 samplers.

> Training, chain-of-custody, and co-interpretation workshops; results to inform testing and mitigation.

Education & Outreach

> Multilingual materials and community meetings on air quality, indoor interventions and blood lead testing.

Indoor Air Interventions

> UW and King County Public Health Airport, Air quality and Asthma Clinical Trial Investigating HEPA filter intervention and health impacts among children living near airports, with a focus on asthma outcomes.

> King County Public Health & partner community-based organizations distributing HEPA room filters to priority homes/schools.

Figure 5: Enrollment and study information for the UW AAA study. (Airport, Air quality and Asthma research study | Environmental & Occupational Health Sciences)

12

References

- Austin, E., Xiang, J., Gould, T. R., Shirai, J. H., Yun, S., Yost, M. G., ... & Seto, E. (2021). Distinct ultrafine particle profiles associated with aircraft and roadway traffic. Environmental Science & Technology, 55(5), 2847-2858.
- Berg, K., Snow, M., & Richardson, K. (2024). The association between childhood blood lead levels and proximity to airports in Colorado. Discover Environment, 2(1), 32.
- U.S. Environmental Protection Agency. (2022). Lead emissions from the use of leaded aviation gasoline in piston-engine aircraft. EPA-420-F-23-022
- Blanco, M. N., Gassett, A., Gould, T., Doubleday, A., Slager, D. L., Austin, E., ... & Sheppard, L. (2022). Characterization of annual average traffic-related air pollution concentrations in the greater Seattle area from a year-long mobile monitoring campaign. Environmental science & technology, 56(16), 11460-11472.
- Hudda, N., & Fruin, S. A. (2016). International airport impacts to air quality: size and related properties of large increases in ultrafine particle number concentrations. Environmental science & technology, 50(7), 3362-3370.
- Hudda, N., Simon, M. C., Zamore, W., Brugge, D., & Durant, J. L. (2016). Aviation emissions impact ambient ultrafine particle concentrations in the greater Boston area. Environmental science & technology, 50(16), 8514-8521.
- Klemick, H., Guignet, D., Bui, L. T., Shadbegian, R., & Milani, C. (2022). Cardiovascular mortality and leaded aviation fuel: evidence from piston-engine air traffic in North Carolina. International journal of environmental research and public health, 19(10), 5941.
- Larson, T., Gould, T., Riley, E. A., Austin, E., Fintzi, J., Sheppard, L., ... & Simpson, C. (2017). Ambient air quality measurements from a continuously moving mobile platform: Estimation of area-wide, fuel-based, mobile source emission factors using absolute principal component scores. Atmospheric Environment, 152, 201-211.
- Liu, N., Oshan, R., Blanco, M., Sheppard, L., Seto, E., Larson, T., & Austin, E. (2025). Mapping Source-Specific Air Pollution Exposures Using Positive Matrix Factorization Applied to Multipollutant Mobile Monitoring in Seattle, WA. Environmental Science & Technology, 59(7), 3443-3458.
- PEHSU. (2023). Management of Childhood Lead Exposure. Pediatric Environmental Health Specialty Units https://www.pehsu.net/Lead_Exposure.html
- Ruckart, P. Z., Bove, F. J., & Dallas, C. (2023). Evaluating the effectiveness of state-level policies on childhood blood lead testing rates. Journal of Public Health Management and Practice, 29(2), 241-249.
- United States Environmental Protection Agency. (2024). Integrated Science Assessment (ISA) for Lead. U.S. EPA, Office of Research and Development.
- United States Environmental Protection Agency. (2019). Integrated Science Assessment (ISA) for Particulate Matter. U.S. EPA, Office of Research and Development.
- World Health Organization. (2021). WHO global air quality guidelines: particulate matter (PM2. 5 and PM10), ozone, nitrogen dioxide, sulfur dioxide and carbon monoxide. World Health Organization.

13

Thank You

Contact: Elena Austin elaustin@uw.edu

BE BOUNDLESS

14