

ASSESSING CHILDHOOD LEAD POISONING RISK FROM MIDDLETON MUNICIPAL AIRPORT

December 2022

Executive Summary

1

There are several potential sources of lead exposure that still exist today beyond the [primary drivers of lead poisoning](#)—exposure to lead paint chips and contaminated dust in older homes—including that of emissions from lead-containing aviation fuels used to fly piston-driven small aircraft.

Childhood exposure to lead can result in adverse health impacts. The continued use of leaded aviation fuels (avgas) by small piston-engine aircrafts is an often overlooked source of lead exposure in communities residing near airports that support this type of aircraft. Previous research has demonstrated that leaded avgas emissions may pose a health threat to children that live or attend schools in close proximity to these airports; this is especially the case for children living within 1 km from the airport.

2

At this time, Public Health Madison & Dane County does not have evidence that the Middleton Municipal Airport has contributed to elevated blood lead levels in the surrounding community, yet this finding is limited by available data.

People who live in the Town and City of Middleton, Wisconsin have expressed concern about the potential contribution of leaded avgas emissions from the local Middleton Municipal Airport to environmental lead contamination and childhood lead poisoning. An analysis of the lead level test results among the nearly 1700 children receiving lead tests in the Town and City of Middleton during 2010 – 2020 was conducted by Public Health Madison & Dane County to evaluate the levels of lead poisoning among children living in close proximity to the airport.

A total of nine children who lived in Middleton during this time period reported lead poisoning (lead levels of $\geq 5 \mu\text{g/dL}$); only one of these children lived within the 1 km zone from the airport. Additional investigation revealed the child's lead exposure preceded their Middleton residency. As a comparison, blood test results among children living within one kilometer of the Dane County Airport were also evaluated; four children out of 440 tested were lead poisoned. While the data do not reveal high levels of lead poisoning near either airport, there are limitations to the data. For example, not every child is tested for lead poisoning. Additionally, some children have confounding factors, such as living near the airport *and* living in older homes.

3

Lead remains a health hazard, and communities have taken action to mitigate air lead emissions.

The results do not diminish the fact that leaded avgas emissions does contribute to environmental levels of lead alongside other current and/or historical sources of lead in Dane County. Moreover, the level of lead contamination and the contribution from the Middleton airport to the risk of environmental lead exposure could change if the airport expands, or residential structures and neighborhoods are expanded closer to this airport; in this case, additional analysis would be warranted. Initiatives undertaken by other jurisdictions include increasing availability to unleaded fuel, modifying engine idling rules, and conducting educational initiatives of pilots. Additionally, the Environmental Protection Agency is actively assessing the impact of avgas emissions on public health and will release a determination in 2023, potentially to be followed by a proposal of regulatory standards for lead emissions from aircraft engines.

Background

Exposure to lead during childhood can result in several health effects including impacts on academic and intellectual development and achievement, attention related issues, behavioral problems, and hearing loss.¹ The leading cause of lead poisoning in the United States (and in Dane County) remains exposure to lead paint chips and contaminated dust in homes built prior to 1978. Progress has been made in the reduction of childhood lead exposure--banning the use of leaded gasoline in cars and trucks, lead-based paints, and lead solder in plumbing resulted in a dramatic decline in childhood lead exposure in this country^{2,3}. Despite these successes, childhood lead exposure remains a serious public health problem. Wisconsin statute (Wis. Stats 254.11[9]) defines “lead poisoning” as a blood lead level of 5 µg/dL or more. Recently, the CDC lowered the level at which it recommends action, to 3.5 µg/dL.⁴ All authorities agree there is no blood lead level in children that is free of adverse health effects.^{4,5}

Emissions from aircraft using leaded aviation fuel is the leading source of lead in the air

An ongoing route of lead exposure is the continued use of lead additives such as tetraethyl lead in aviation fuels (avgas) to achieve the high octane levels required for piston-driven small aircraft and prevent engine damage.^{6,7} Despite the official phase out of leaded gasolines for automobiles by 1995, the most commonly used avgas today contains up to 2.12 grams of lead per gallon, called “100 octane low lead gasoline,” or 100LL.⁷ This fuel is usable by all general aviation planes and currently required by planes with high compression engines. An unleaded avgas alternative—94 octane unleaded—is commercially available at many sites and [an estimated 60-70% of general aviation planes](#) can be operated using this fuel.⁸

Emissions from aircraft using leaded avgas is currently the largest source of lead air contamination in the United States, comprising 70% of annual emissions of lead to air.⁹ As a result, concentrations of lead are higher near airports that allow operation of smaller piston-engine aircraft and provide an additional source of childhood lead exposure alongside other current and historical sources already present in the environment.^{6,7,10}

Potential exposure risk from small aircraft airports

In October 2022, the US Environmental Protection Agency (EPA) proposed an [“Endangerment Finding for Lead Emissions from Aircraft Engines that Operate on Leaded Fuel,”](#):

“...to find that lead air pollution may reasonably be anticipated to endanger the public health and welfare within the meaning of section 231(a) of the Clean Air Act. The Administrator is also proposing that engine emissions of lead from certain aircraft cause or contribute to the lead air pollution that may reasonably be anticipated to endanger public health and welfare under section 231(a) of the Clean Air Act.”¹¹

Final findings will be issued in 2023, which could be followed by a proposal of regulatory standards for lead emissions from aircraft engines as well as avgas fuel standards.¹²

This recent proposal by EPA is based on research indicating that the combustion of leaded avgas by piston-engine small aircraft may pose a health threat to children that live or attend schools in close

proximity to airports that support the operation of these types of aircraft by either the inhalation of lead or the ingestion of the contaminant after it settles into the surrounding soils.^{6,10}

The EPA further estimates that children living within 1 km (0.62 miles) of airports are at the greatest risk of being exposed to lead from avgas emissions.^{10,11} A study by Miranda et al. (2011) found that children residing within 500m and 1000m (1km) of the tested airports demonstrated 4.4% and 3.8%, respectively, increases in blood lead levels, with no significant increase at greater distances.⁶ Zahran et al (2017) also studied blood lead levels in children residing in the vicinity of general aviation airports and found that child blood lead levels increase dose-responsively in proximity to airports, the flow of piston engine aircraft traffic, and wind conditions.¹³ A [study](#) at the Reid-Hillview Airport in Santa Clara County, California, indicated a small increase (0.2 µg/dL) in blood lead levels among children living within half a mile of the airport.¹⁴

In summary, factors that impact exposure risk include the patterns and amount of aircraft activity, concentration of lead in the avgas, the duration of average time spent by aircraft in run-up operations prior to take-off, and meteorological data.¹⁰ In other words, the potential health risks posed by proximity to an airport that support piston-engine aircraft operations are not created equally; an airport in question may contribute more or less than expected to childhood lead exposure risk within the identified 1 km hazard area.

Dane County Context

The leading cause of lead poisoning in Dane County remains exposure to lead paint chips and contaminated dust in homes built prior to 1978. This ongoing challenge reinforces the continued need for surveillance, identification, and mitigation of potential lead exposure hazards, combined with prevention and treatment services for children identified with or at risk for elevated blood lead levels.

Assessment of childhood lead poisoning risk from the Middleton Municipal Airport

Middleton Municipal Airport, also known as Morey Field, located in Middleton, Wisconsin supports the operation of piston-engine small aircraft. The elevated risk of lead exposure posed by similar airports across the country has led to concerns in the surrounding community about the potential health risk from avgas lead emissions. Similar to other communities, the focus of concern is the possible exposure of children to elevated levels of lead in the environment and an increase in childhood lead poisoning. As noted earlier, emissions from leaded avgas are the largest source of lead in the air in the United States; this is also true for Dane County where the Middleton Municipal Airport is located. In fact, this airport reportedly contributes an estimated 32% of the county's overall lead emissions.¹⁵

As described below, there is no systematic data available regarding blood lead level in children near the Middleton Airport. What is known is that air lead levels near the airport, while higher in proximity to it, are lower than the 2016 EPA [ambient air quality standard](#) for lead of 0.15 µg/m³.¹⁶ Measurement of ambient lead concentrations around the Middleton Airport estimated ambient lead levels range up to 0.01 µg/m³ monthly and 0.008 µg/m³ annually.¹⁷

Understanding blood lead testing data in Dane County

Throughout Wisconsin, children should be tested for lead poisoning when they meet one of four criteria, established by the Wisconsin Department of Health Services:¹⁸

- Does the child live in or visit a house build before 1950 (including child care centers and homes of friends or relatives)?
- Does the child live in or visit a house or building built before 1978 that has recently undergone or is currently undergoing renovations (including child care centers and home of friends or relatives?)
- Does the child have a sibling or playmate with lead poisoning?
- Is the child enrolled in Medicaid or WIC?

The overall picture of blood lead testing in Middleton and Dane County is subject to some data gaps:

- The number and distribution of children who live in older housing stock is unknown
- The number and distribution of children who live in housing undergoing renovations is unknown
- The number of children who qualify for a blood lead test who are not tested is unknown
- Close proximity to airports is not a criteria for blood lead testing in absence of other criteria
 - The number of children who live in close proximity to the Middleton airport is unknown

To ascertain completeness of blood lead testing data, one proxy is Medicaid data, given that all Medicaid-enrolled children should receive a blood lead test, per the criteria above. In 2021 in Dane County, there were 5,880 Medicaid-enrolled children that were required to be tested; of those, 1,866 (32%) received their required test. Thus, there is a gap in who should be tested for lead poisoning and who receives a test.

The roles of Public Health Madison & Dane County and local health departments regarding lead exposure center in the areas of prevention and management. Rather than conduct novel research, we focus on translating to practice locally. Specifically, our activities are:

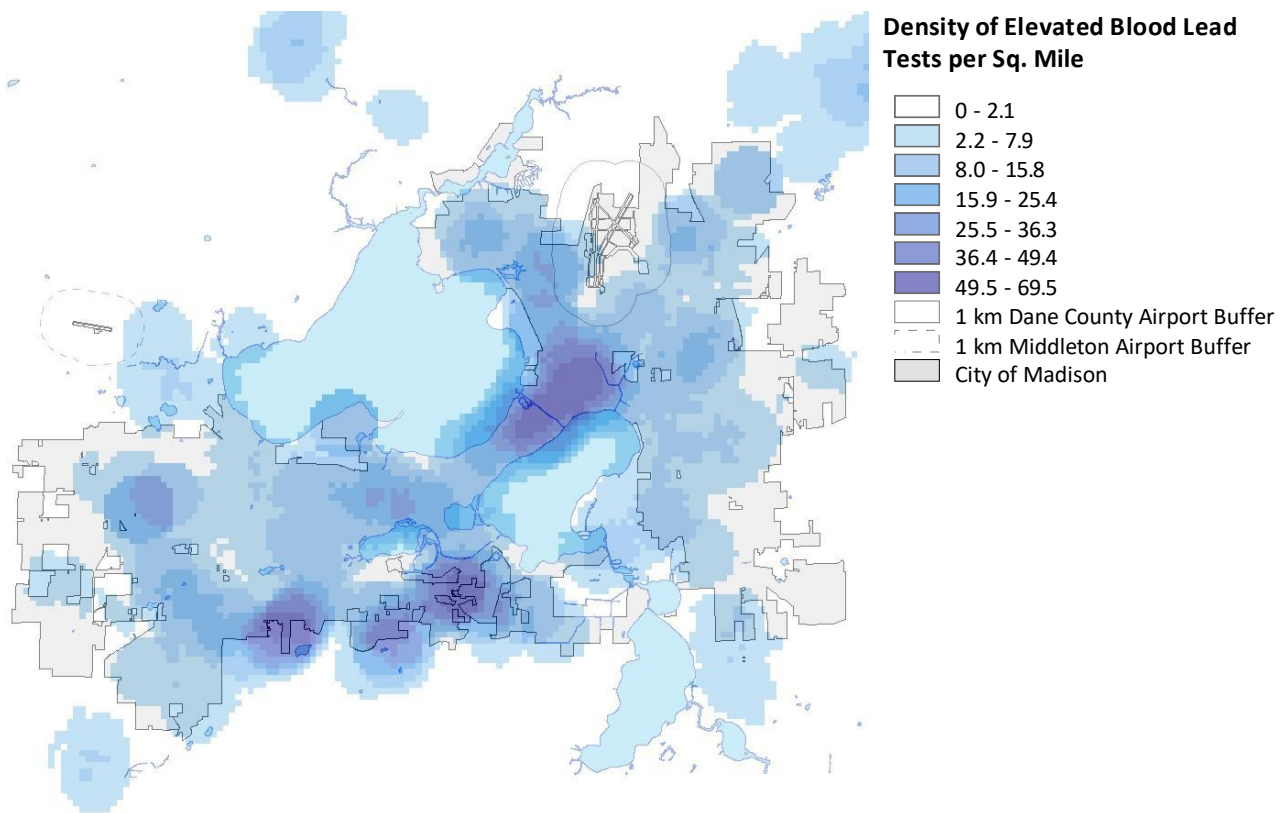
- Prevent exposure to lead
 - We monitor for the prevalence of lead poisoning in the community and provide recommendations to prevent lead poisoning
 - We enforce the City of Madison lead ordinance, to make sure that property owners and contractors follow safe work practices when painting or remodeling older housing
- Support childhood screening for lead poisoning
 - We assure lead screening is available to those unable to be screened by a private medical provider
 - We provide education and consultation to medical providers about childhood lead poisoning
- Help families when a child is lead poisoned.
 - When a child has a reported blood lead level of 10 µg/dL or greater, we conduct a lead risk assessment of the child's primary residence and risk assessment of other properties as appropriate.
 - A full risk assessment entails testing of surfaces with dust wipes and an x-ray fluorescence machine

A review of the blood lead testing results reported to the State of Wisconsin from over 1600 individual children in the City and the Town of Middleton from 2010 – 2020 indicated one case of childhood lead poisoning ($\geq 5 \mu\text{g}/\text{dL}$ of lead) within 1 km of the Middleton Municipal Airport (Figure 1). This single case cannot necessarily be attributed to leaded avgas emission without evaluating other potential sources of lead exposure this child may have come into contact with, including lead paint chips, lead contaminated dust, and lead containing water pipes or solder. Follow-up was completed on this child, and an inspection of the home was not warranted due to previous exposure at a location that preceded their Middleton residence.

These other types of lead exposures were the primary cause in an additional eight cases of childhood lead poisoning ($\geq 5 \mu\text{g}/\text{dL}$ of lead) identified throughout the Town and City of Middleton (outside 1 km risk area from Morey Field) during the same 2010 – 2020 timeframe for a total of nine children.

Figure 2 provides a visual of the distribution of children with elevated blood lead levels, using $3.5 \mu\text{g}/\text{dL}$ as a level. While blood poisoning is currently defined as greater than $5 \mu\text{g}/\text{dL}$, an elevated level was used as a conservative level in order to visually pick up clusters. The highest density of children with elevated blood lead levels tended to correlate with areas with older housing stock; however, this was not able to be quantified.

Figure 2: Density of children with elevated blood lead levels, Madison, WI and surrounding area, 2010-2020



The map above represents 1,217 children living in Madison and the surrounding area with at least one elevated blood lead level during this 11-year period. The results of all children tested in the area, and comparison areas, are shown in the table below.

Highest Blood Lead Level among Children Living in Madison & Surrounding Area, 2010-2020

Area	# Tested	# Normal Blood Lead	# Elevated Blood Lead	# Lead Poisoning
Madison & Surrounding Area	34,389	33,172 (96.5%)	1,217 (3.5%)	453 (1.3%)
Madison	25,202	24,207 (96.1%)	995 (3.9%)	387 (1.5%)
Within 1 km of Dane Co. Airport	440	424 (96.4%)	16 (3.6%)	4 (0.9%)
Middleton	1,699	1,668 (98.2%)	31 (1.8%)	9 (0.5%)
Within 1 km of Middleton Airport	20	17 (85%)	3 (15%) [^]	1 (5%) [^]

[^] Interpret percentages based on numerators of 5 or less when the denominator is small with caution.

* Normal Blood Lead is <3.5 µg/dL; Elevated Blood Lead is ≥ 3.5 µg/dL; Lead Poisoning is ≥ 5 µg/dL

Conclusion

Although the primary drivers of childhood lead poisoning in Dane County remain exposure to paint chips and contaminated dust in older homes, exposure to leaded avgas emissions presents a potential contributing source of lead exposure to children as demonstrated by studies across the country.

Following a review of the relevant literature and analysis of lead testing results of children from the City and Town of Middleton during 2010 – 2020, the available data do not indicate a clustering of lead poisoning among children living near the Middleton Municipal Airport. However, the Wisconsin Department of Health Services does not include living near an airport as a reason to be tested for lead, which limits the amount of data we can analyze. The finding is further contextualized by the low density of residences within 1km of the airport.

However, this does not diminish the fact that lead contamination from the use of leaded avgas does contribute to environmental levels of lead in the community alongside other current and/or historical sources of lead. The exposures to these combined sources potentially contribute to the elevated blood lead levels in children reported to the State of Wisconsin. The level of lead contamination and contribution from the Middleton Municipal Airport to the risk of environmental lead exposure could change if the airport expands, or residential structures and neighborhoods are expanded closer to this airport; in this case, additional analysis would be warranted.

Find additional information about childhood lead services provided by Public Health Madison & Dane County [on our website](#).

Action to mitigate air lead emissions

Communities and municipalities across the United States have implemented various mitigation strategies to reduce the potential impact of environmental lead contamination from airports that support the operation of piston-engine small aircraft. These strategies include, but not limited to:⁸

- Increasing the size and location of airport run-up areas
- Limiting the length of time an aircraft can remain idling in run-up areas

- Placing restrictions on the use of leaded avgas
- Conducting educational initiatives of the pilots, airport staff, and aircraft technicians about the potential health implications from environmental lead contamination
- Increase availability of unleaded fuel options at airports

Additionally, the Federal Aviation Administration (FAA) announced the “Eagle Initiative” in 2022 to reduce air lead emissions. This initiative is a combined effort of government and industry resources to improve the technology and modification of small aircraft engines, increase octane levels of unleaded fuels, and develop infrastructure and commercial viability to allow the transition to unleaded fuels for piston-engine aircraft by 2030.¹⁹

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References

References

1. Agency for Toxic Substances and Disease Registry. (2019). Where is lead found. Available at: https://www.atsdr.cdc.gov/csem/leadtoxicity/lead_found.html
2. United States Environmental Protection Agency. (2022). Biomonitoring – Lead. Available at: <https://www.epa.gov/americaschildrenenvironment/biomonitoring-lead>
3. United States Environmental Protection Agency. (2022). Use of lead free pipes, fittings, fixtures, solder, and flux for drinking water. Final “lead free” rule. Available at: <https://www.epa.gov/sdwa/use-lead-free-pipes-fittings-fixtures-solder-and-flux-drinking-water>
4. Centers for Disease Control and Prevention. (2022). Overview of childhood lead poisoning prevention. Available at: <https://www.cdc.gov/nceh/lead/overview.html>
5. Public Health Madison & Dane County. (2022). Lead poisoning. Available at: <https://www.publichealthmdc.com/environmental-health/environmental-hazards/lead-poisoning>
6. Miranda, M.L., Anthopolos, R., & Hastings, D. (2011). A geospatial analysis of the effects of aviation gasoline on childhood blood lead levels. *Environmental Health Perspectives*, 119(10), 1513 – 1516.
7. Federal Aviation Administration. (2022). Aviation gasoline. Available at: <https://www.faa.gov/about/initiatives/avgas>
8. National Academies of Sciences, Engineering, and Medicine 2021. Options for Reducing Lead Emissions from Piston-Engine Aircraft. Washington, DC: The National Academies Press. <https://doi.org/10.17226/26050>.
9. United States Environmental Protection Agency. (2022). 2017 National Emissions Inventory (NEI) data. Available at: <https://www.epa.gov/air-emissions-inventories/2017-national-emissions-inventory-nei-data>
10. United States Environmental Protection Agency. (2020). Model-extrapolated estimates of airborne lead concentrations at U.S. airports. Available at: <https://nepis.epa.gov/Exe/ZyPDF.cgi/P100YG52.PDF?Dockey=P100YG52.PDF>
11. United States Environmental Protection Agency. (2022). Proposed finding that lead emissions from aircraft engines that operate on leaded fuel cause or contribute to air pollution that may be reasonably be anticipated to endanger public health and welfare. Available at: <https://www.govinfo.gov/content/pkg/FR-2022-10-17/pdf/2022-22223.pdf>
12. United States Environmental Protection Agency. (2022). Regulations for lead emissions from aircraft. Available at: <https://www.epa.gov/regulations-emissions-vehicles-and-engines/regulations-lead-emissions-aircraft>
13. Zahran S, Iverson T, McElmurry SP, et al. (2017). The effect of leaded aviation gasoline on blood lead in children. *Journal of the Association of Environmental and Resource Economists*, 4(2). <https://doi.org/10.1086/691686>
14. Mountain Data Group. 2021. Leaded aviation gasoline exposure risk at Reid-Hillview Airport in Santa Clara County, California. <https://news.sccgov.org/sites/g/files/exjcpb956/files/documents/RHV-Airborne-Lead-Study-Report.pdf>
15. Trinity Consultants. (2022). Screening level assessment of ambient lead concentrations around the Middleton Wisconsin Municipal Airport. Available at: https://town.middleton.wi.us/vertical/Sites/%7B97A50AAB-3824-4833-ACEA-EF2B9A14C856%7D/uploads/C29_Lead_Report_031822.pdf
16. EPA. NAAQS Table. <https://www.epa.gov/criteria-air-pollutants/naaqs-table>
17. Trinity Consultants (2022) Measurement of ambient lead concentrations around the Middleton Wisconsin Municipal Airport-Morey Field (C29) https://town.middleton.wi.us/vertical/Sites/%7B97A50AAB-3824-4833-ACEA-EF2B9A14C856%7D/uploads/C29_Airport_Lead_Report_091522-3_email.pdf

18. Wisconsin Department of Health Services. 2022. Wisconsin Blood Lead Screening Recommendations. <https://www.dhs.wisconsin.gov/lead/links/wibloodleadscreeningrecommendations.pdf>
19. Federal Aviation Administration. (2022). FAA, Industry chart path to eliminate lead emissions from general aviation by the end of 2030. Available at: <https://www.faa.gov/newsroom/faa-industry-chart-path-eliminate-lead-emissions-general-aviation-end-2030>