MiPEHS

Michigan PFAS Exposure & Health Study

Phase 1

Summary Report

MDHHS

Michigan Department of Health & Human Services

MiPEHS is advancing the science on PFAS and health.

Michiganders whose drinking water was contaminated with per-and polyfluoroalkyl substances (**PFAS**) have many important questions and concerns about their health. The Michigan PFAS Exposure and Health Study (**MiPEHS**) was launched in response to these concerns. MiPEHS is **one of the first** longitudinal research projects on PFAS and health in the United States and is **the first** to measure 39 PFAS, plus branched isomers of PFOS, PFOA, and PFHxS. This research will advance scientific knowledge, which benefits all people – not just those who participate.

A few explanations before diving into this report:

- MiPEHS is described as **longitudinal** because it follows participants over time. This summary report follows the first phase, or the starting point, of MiPEHS.
    - The first phase of MiPEHS occurred in 2020–2021; Phase 2 began in early 2023; and Phase 3 will start in 2025.
- The word **concentration** is used in this report to describe how much PFAS was measured in serum. **Serum** is the fluid left over after blood cells and platelets are removed from a blood sample.
- While this report provides a summary of information from Phase 1, MiPEHS researchers will publish several scientific articles and reports during MiPEHS. A technical appendix (found at Michigan.gov/DEHBio) provides even more in-depth information than what is presented here.

Report Contents

Highlights

- **MiPEHS participants have very little or no PFAS currently in the water they are drinking.** Knowing both the past and current drinking water PFAS concentrations that participants were exposed to helps researchers better understand the concentration of PFAS currently in the blood of participants.
- Like most people in the U.S., **all MiPEHS participants** had detectable concentrations of several PFAS in their blood, including PFOS and PFOA. PFOS and PFOA are two of the most studied PFAS.
- On average, **MiPEHS participants had higher blood PFOS and PFOA concentrations** than the general U.S. population.
- The study areas included in MiPEHS each had different average blood PFOS and PFOA concentrations. **This means exposures were likely different in each community.**
- Blood PFAS concentrations change over time. Data from a group of MiPEHS participants that gave blood samples at an earlier time show that, **once exposure ends, blood PFOA and PFOS concentrations go down.**
- **There is more to come!** Researchers continue analyzing Phase 1 data while they plan for Phases 2 and 3. Preliminary results investigating the relationships between blood PFAS concentrations and health outcomes are ongoing and will be strengthened by data gained during Phases 2 and 3.

Over **1,000** people participated in MiPEHS Phase 1.

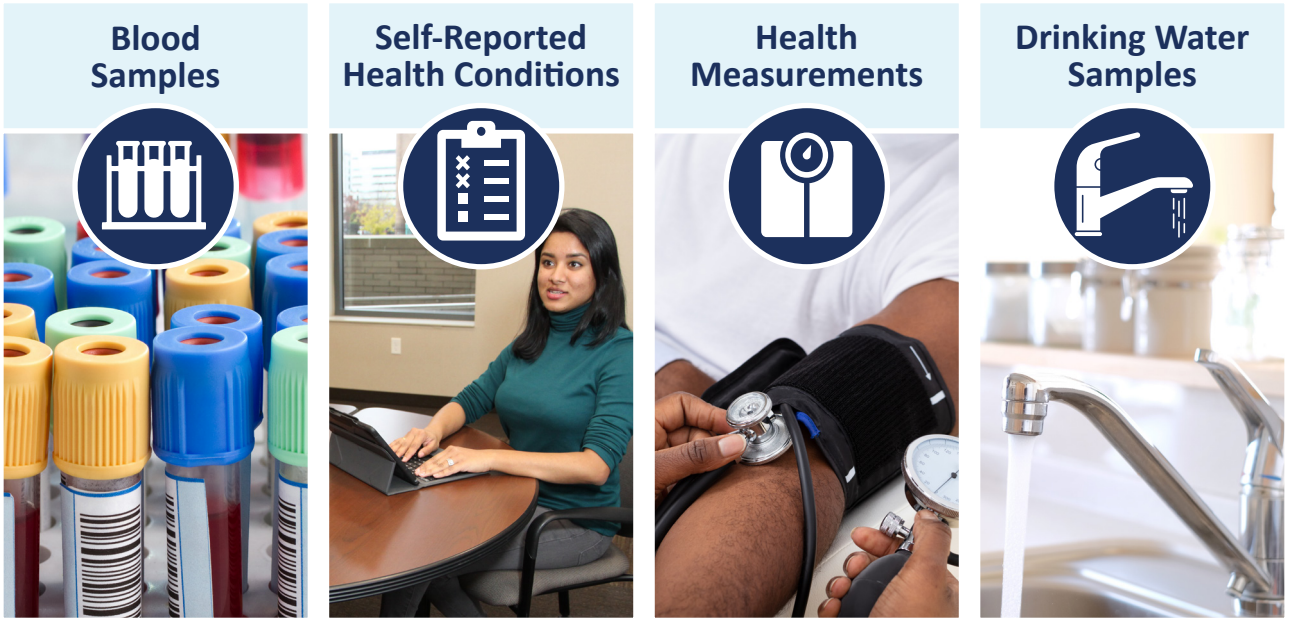
Belmont/Rockford Study Area	Parchment/Cooper Township Study Area
Number of Participants: **584**	Number of Participants: **470**
Number of Females: **308 (53%)**	Number of Females: **259 (55%)**
Number of Males: **268 (46%)**	Number of Males: **206 (44%)**
Average age: **49 years old**	Average age: **51 years old**
Youngest participant(s): **4 years old**	Youngest participant(s): **3 years old**
Oldest participant(s): **89+ years old**	Oldest participant(s): **89+ years old**

Note: Totals presented here do not always equal the total number of participants because some participants did not provide all their demographic information. Ages over 89 years are not reported to maintain participant privacy.

See pages 5 & 6 of the technical appendix for more details.

Information from MiPEHS will answer questions about PFAS and health.

MiPEHS Phases 1 through 3 are designed to answer questions about the relationship between blood PFAS concentrations and immune, cardiovascular, kidney, liver, reproductive, and thyroid health. These relationships will be described in peer-reviewed scientific journals, which will be made freely available.



Eligible MiPEHS participants 12 years and older provided up to two types of blood samples: samples from their vein which were tested for PFAS and health markers, and samples from a finger poke, which will be tested only for PFAS. Participants also completed body and blood pressure measurements and answered questions about their past and current health, as well as their past and current exposure to PFAS. Lastly, many households were asked to provide a sample of their drinking water.

MiPEHS participants helped MDHHS researchers collect information about the following:

38 unique health markers (examples: cholesterol and thyroid hormones)

39 PFAS in blood (examples: PFOA, PFOS, and PFHxS)

52 unique health questions (examples: diagnosis of diabetes, arthritis, or liver disease)

5 body measures (examples: blood pressure and body weight)

39 PFAS in water (examples: PFOA, PFOS, and PFHxS)

Polychlorinated biphenyls (**PCBs**) were measured in blood samples from adults that agreed to this testing during MiPEHS Phase 1 because PCBs have been found in the environment, including near the Parchment/Cooper Township study area. PCBs have been associated with some of the same health effects linked to PFAS exposure. By measuring both PCBs and PFAS, we will be able to understand if PCBs change the relationship between PFAS and health.

See page 15 of the technical appendix for more details.

MiPEHS participants' exposure to PFAS through drinking water was greatly reduced before they joined MiPEHS.

All MiPEHS participants with a **private drinking water well** were asked to provide a current sample of their household drinking water to be tested for PFAS.

Among MiPEHS participants who receive **municipal drinking water**, a representative group was also asked to provide a current sample of their home drinking water. This is because under certain conditions a small, but representative, group of municipal drinking water consumers can be used to understand all households on the municipal drinking water supply. These conditions were present in the City of Parchment municipal drinking water supply.

CURRENT DRINKING WATER

By the end of Phase 1, almost 400 households had provided a current drinking water sample for PFAS testing. The vast majority (around 99%) of these samples had PFAS concentrations that were below current health-based comparison levels.[1]

PAST DRINKING WATER

Historically, PFAS were detected above health-based comparison values in the drinking water of about 50% of MiPEHS households for which past drinking water information is available. MiPEHS researchers don't have past drinking water PFAS information for all MiPEHS participants. For this reason, the percentage above (about 50%) only comes from the more than 420 households with available past PFAS information.

These current drinking water PFAS test results are compared to past drinking water PFAS test results. Knowing both the past and current PFAS drinking water concentrations that participants experienced helps researchers better understand the PFAS concentrations currently in the blood of participants.

[1]MDHHS health-based comparison levels are the lowest of EGLE MCL or MDHHS (2019) public health drinking water comparison levels for PFAS.

Key Conclusions

- Around half of MiPEHS participants live in houses where PFAS contamination was previously found in the water they were drinking.
- Participants who gave a household drinking water sample for PFAS testing as part of MiPEHS had no or very little PFAS in the water they currently drink.

See page 16 of the technical appendix for more details.

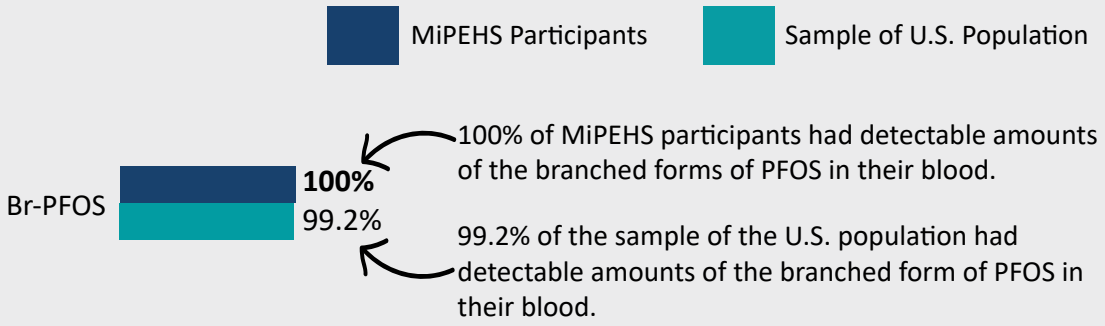
Like most people in the U.S., all MiPEHS participants had PFAS in their blood.

Understanding the information on the next page

Blood samples from MiPEHS participants were tested for 39 PFAS, which is more PFAS than most studies test for. On the next page, you will see what percentage of MiPEHS participants had each of the 39 PFAS in their blood. You can find the name of each PFAS to the far left of each column.

Among the general U.S. population, the Centers for Disease Control and Prevention (CDC) monitors 16 of the 39 PFAS measured in MiPEHS. For those 16 PFAS tested in both the general U.S. population and MiPEHS, you'll see how MiPEHS participants compare to the U.S. population. The CDC's National Health and Nutrition Examination Survey (**NHANES**) is the source of PFAS information for the general U.S. population, and is used as a comparison throughout this report.

For example:



Conclusion: All MiPEHS participants had detectable amounts of Br-PFOS in their blood, which is similar to the sampled U.S. population.

Key Conclusions

- Everyone who joined MiPEHS had some detectable amount of PFOA and PFOS in their blood. Some of those people had very little PFOA or PFOS in their blood and others had much more (see density plots in the next section). Almost everyone (over 99%) in the U.S. population also has detectable amounts of PFOA and PFOS in their blood.
- Not all PFAS tested for were found in the blood of every MiPEHS participant. Very few people who joined MiPEHS (fewer than 1%) had a detectable amount of PFHxA or Gen X, for example.
- Of the 39 PFAS tested for, the average MiPEHS participant had 15 PFAS detected in their blood. The number of PFAS detected in MiPEHS participants ranged from 3 to 35 PFAS.

See page 16 of the technical appendix for more details.

Which PFAS do we find in MiPEHS participants compared to the U.S. population?

	MiPEHS Participants	Sample of U.S. Population[1]
Br-PFOS	**100.0%**	99.2%
L-PFOS	**100.0%**	99.6%
Total-PFOS	**100.0%**	99.6%
L-PFOA	**99.9%**	99.6%
Total-PFOA	**99.9%**	99.6%
L-PFHxS	**99.1%**	NC
Total-PFHxS	**99.1%**	99.3%
PFNA	**98.7%**	92.5%
PFDA	**95.0%**	88.7%
PFHpS	**94.5%**	NC
MeFOSAA	**86.9%**	59%
PFUnA	**75.4%**	66.0%
PFecHS	**72.0%**	NC
PFHpA	**57.0%**	NC
PFPeS	**51.1%**	NC
PFBA	**44.6%**	11.1%
PFBS	**22.5%**	0.7%
Br-PFHxS	**19.6%**	NC
Br-PFOA	**16.0%**	10.0%
EtFOSAA	**13.3%**	NC
7:3 FTCA	**12.7%**	NC
5:3 FTCA	**11.5%**	NC
PFTriA	**11.2%**	NC
8:2FTS	**8.7%**	NC
PFDoA	**7.5%**	NC
9Cl-PF3ONS	**7.1%**	NC
PFDS	**4.4%**	NC
PFHxA	**0.6%**	23.7%
Gen X	**0.1%**	1.1%
6:2FTS, PFEESA, PFPeA, PFTeA, NFDHA, PFNS, 4:2FTS, ADONA, PFHxSA, PFOSA, 11Cl-PF3OUdS, 3:3 FTCA, PFBSA, PFMBA, PFPrS, PFMPA	**<1.0%**	NC

Notes

MiPEHS participants from all study areas are included in the calculation of the percentages reported here.

[1]U.S. population (age 12 years or older) is estimated from NHANES data collected in 2017–2018, or the most recent year available.

NC means no comparison and is used when PFAS were not tested or the percentage calculation is not yet available from NHANES.

Italicized PFAS were measured in two different forms, or shapes: linear (L-) and branched (Br-). For these three PFAS (PFOS, PFOA and PFHxS), we can measure the amount of each of these two forms, plus their *total*.

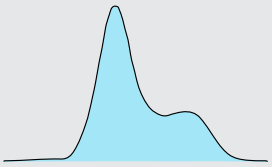
< means "less than." <1.0% reads as "less than 1.0%."

The abbreviations found on this page are defined on page 15 of this report.

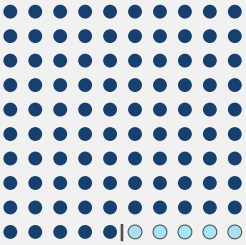
See page 19 of the technical appendix for more details.

On average, MiPEHS participants had higher blood PFOS and PFOA concentrations than the general U.S. population.

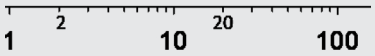
Understanding density plots used throughout this report



The shaded curves are **density plots**. The height of the shaded area tells you the relative amount of people in each category listed on the bottom of the plot. **A taller shaded area represents more people than a shorter shaded area.**



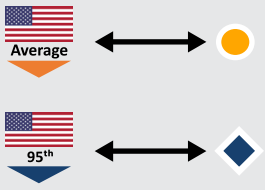
The **95th percentile** is the result that 95% of results are below and 5% of results are above. MiPEHS participants had a higher 95th percentile value than the U.S. population for PFOA and PFOS. This means the blood concentration that marks where the highest 5% of people fall is higher in MiPEHS participants compared to the U.S. population.



Results are shown on a logarithmic scale. A **logarithmic scale** is used to show a wide range of values in a compact way. On this type of scale, the distance between numbers is unequal and gets smaller as the numbers get bigger. See the numbers labeled on the bottom of each plot that span 0.1 to 1000 µg/L.

µg/L

Results are reported in **micrograms per liter** of blood (µg/L).



These plots compare the average and the 95th percentile concentrations of PFOS and PFOA from MiPEHS participants to a sample of people in the U.S. aged 12 years or older. The U.S. population averages and 95th percentiles come from the representative sample of people that joined the National Health and Nutrition Examination Survey (NHANES).

Note:

Comparing the results of MiPEHS participants to NHANES can help put into perspective the impact that PFAS exposure has had on the blood PFAS concentrations of MiPEHS participants. Comparing results to NHANES does not tell us what health problems individual MiPEHS participants may be at risk for based on their blood PFAS concentrations.

See page 19 of the technical appendix for more details.

Legend

MiPEHS participants

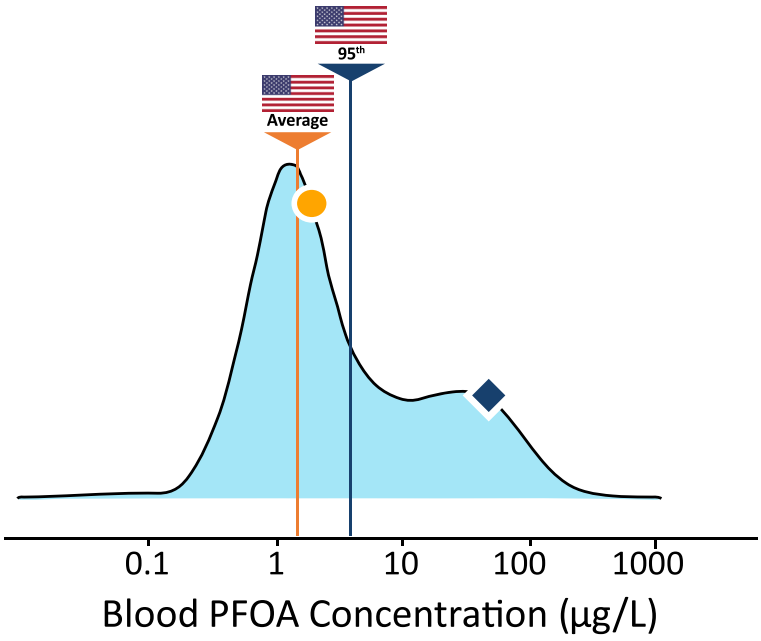
Average blood PFOA and PFOS concentration in **U.S. population from 2017 to 2018**

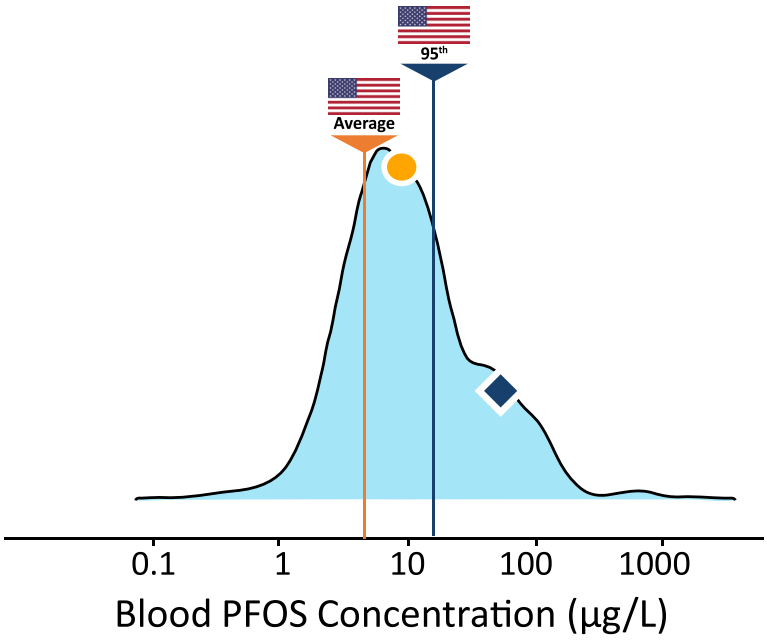
95th percentile of blood PFOA and PFOS concentrations in **U.S. population from 2017 to 2018**

Average blood PFOA and PFOS concentrations in **MiPEHS**

95th percentile of blood PFOA and PFOS concentrations in **MiPEHS**

Distribution of Blood PFOS and PFOA Concentrations among MiPEHS Participants





Key Conclusions

- The average concentrations of PFOA (3.21 µg/L) and PFOS (9.11 µg/L) in the blood of MiPEHS participants were **higher** than the average concentrations of PFOA (1.42 µg/L) and PFOS (4.25 µg/L) in the U.S. population.
- These results suggest that, as a group, MiPEHS participants tended to be more highly exposed to PFOS and PFOA compared to the general U.S. population.
- The high end of blood concentrations, represented by the 95th percentile, were also **higher** in MiPEHS participants for PFOA (65.8 µg/L compared to 3.77 µg/L) and PFOS (88.6 µg/L compared to 14.6 µg/L) than for other people in the U.S. population.

See page 29 of the technical appendix for more details.

The average and 95th percentile blood PFOS and PFOA concentrations were different for participants in each MiPEHS study location.

Understanding the density plots on these pages

See page **8** of this report for more information about how to read density plots.

Results are shown on a logarithmic scale in micrograms per liter of blood (µg/L); see the numbers labeled on the bottom of each plot that span 0.1 to 1000.

Shaded areas are density plots; the height of the shaded area tells you the relative amount of people with the corresponding blood PFOS or PFOA concentration (labeled on the bottom of the plot).

The 95th percentile is the result that 95% of results are below and 5% of results are above.

The Legend on page **10** applies to all plots on pages **10** and **11**.

Legend

MiPEHS participants

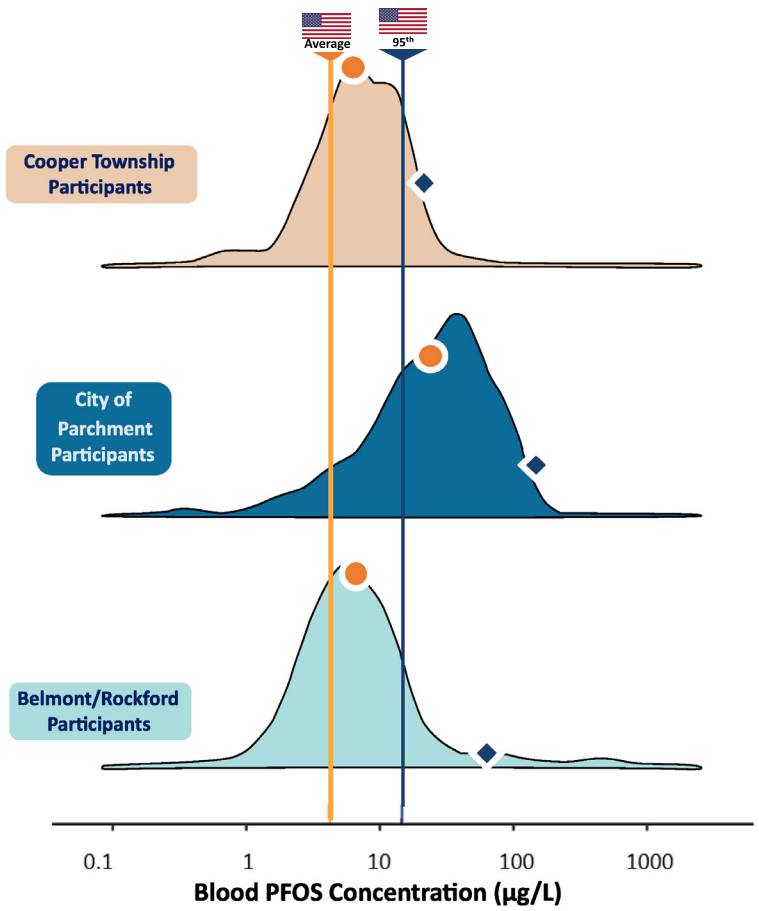
Average blood PFOS or PFOA concentration in **U.S. population from 2017 to 2018**

95th percentile of blood PFOS or PFOA concentrations in **U.S. population from 2017 to 2018**

Average blood PFOS or PFOA concentrations in **MiPEHS**

95th percentile of blood PFOS or PFOS concentrations in **MiPEHS**

Distribution of PFOS blood concentrations in MiPEHS participants from each location



Key Conclusions

Orange Symbols

Average

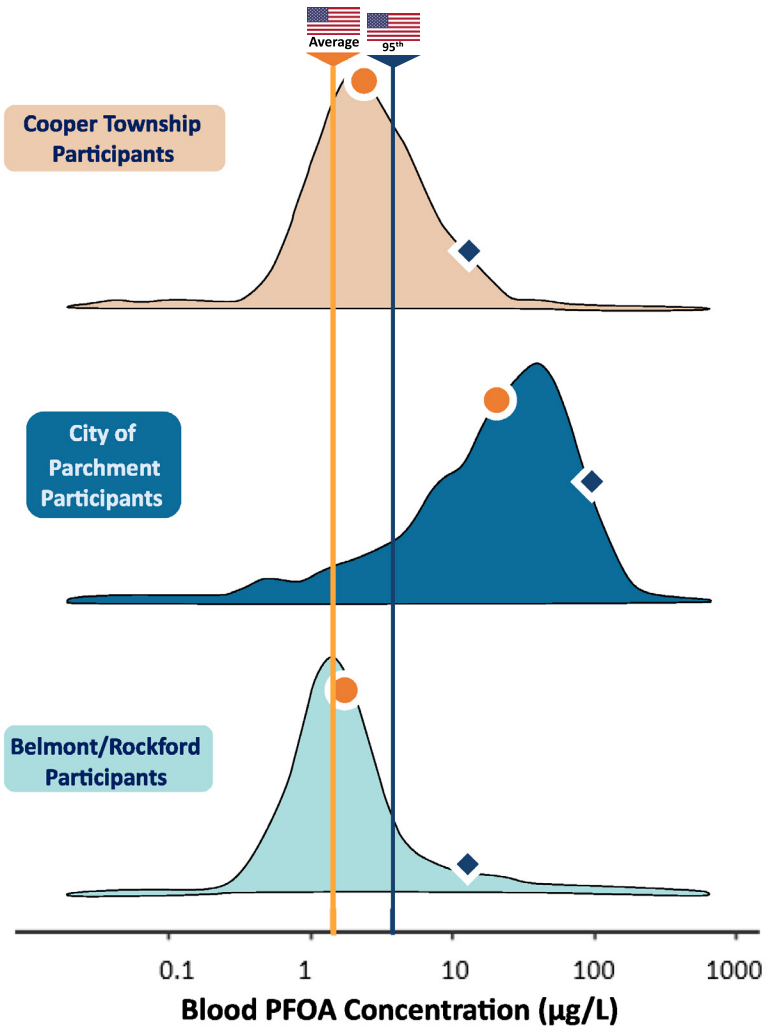
On average, MiPEHS participants have higher blood PFOS and PFOA concentrations than the general U.S. population.

Not every MiPEHS participant has more PFOS and PFOA in their blood compared to the average from the U.S. Many have much less. See this by looking at how much of the shaded area is on the left of the orange reference line.

More participants from the City of Parchment had elevated blood PFOS and PFOA concentrations compared to the other study areas. See how more of the dark blue shaded area is to the right of the orange reference line compared to the other plots.

See page 29 of the technical appendix for more details.

Distribution of PFOA blood concentrations in MiPEHS participants from each location



A closer look:

The 95th Percentile of PFOA blood concentration for City of Parchment MiPEHS participants is shown to the left.

Look at the middle shaded plot on this page for blood PFOA concentrations from City of Parchment participants.

Follow the blue diamond all the way to the numbers at the bottom. The blue diamond on the City of Parchment participants plot corresponds to 104 µg/L. That means 5% of City of Parchment participants have 104 µg/L or more PFOA in their blood.

Compare the blue diamond to the blue line for the U.S. population on the same plot which is found at 3.77 µg/L. That means 5% of the U.S. population has 3.77 µg/L or more PFOA in their blood.

Key Conclusions

Blue Symbols ◆ 95th

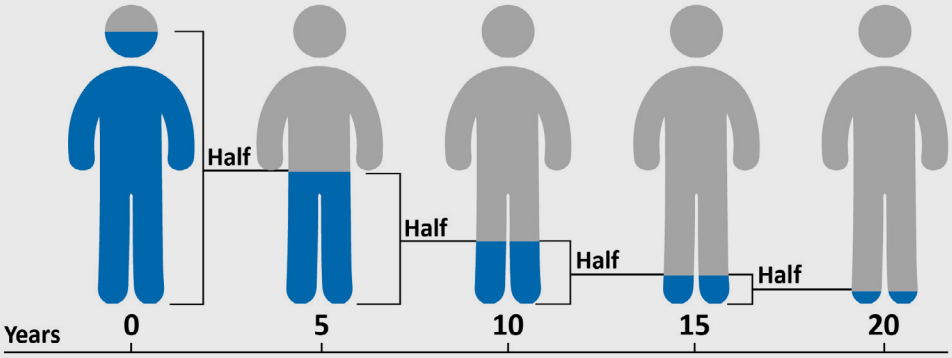
The 95th percentiles of blood PFOS and PFOA concentrations from MiPEHS participants are higher in all three study areas than they are in the U.S. population.

The biggest difference in 95th percentiles in MiPEHS compared to the U.S. population is seen in the City of Parchment study area.

See pages 30-34 of the technical appendix for more details.

Blood PFAS concentrations change over time, and information is gained when people participate in all three MiPEHS phases.

PFAS leave the body. PFAS are sometimes called "forever chemicals" because they do not break down easily in the environment or the human body. However, PFAS do not stay in the body forever – concentrations of PFAS in blood start to go down once exposure ends. PFAS leave the body on a regular basis (for example, in urine or blood) because of normal bodily processes. This results in PFAS concentrations going down.



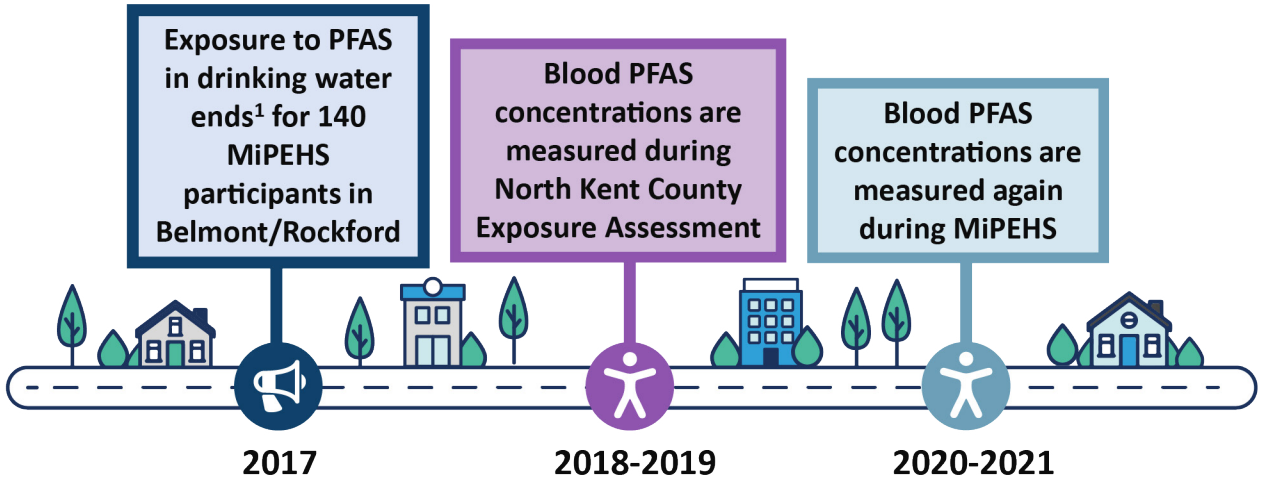
One way to understand how quickly PFAS leave the body is by looking at a calculation called half-life. The **half-life** is calculated by measuring the amount of time it takes for half of the PFAS in your body to leave through normal bodily processes. As the example to the left shows, a half-life of five years means that half (or 50%) of the PFAS in blood will be gone after five years, then half of the remaining amount will be gone in another five years, and so on.

The time it takes for half to leave your body is different for each PFAS. Some, like PFOS, leave the body slowly (half is gone about every 5.5 years on average). Others, like PFBA, leave the body quickly (half is gone about every 72 hours on average). The half-life for each PFAS may be shorter or longer than average depending on your own unique body and the amount of PFAS you were exposed to.

MiPEHS will measure PFAS in blood several times.

For many people in MiPEHS, PFAS exposure ended or was greatly reduced when they changed their water source or started using a water filter. Therefore, we expect to see blood PFAS concentrations go down over time. This is exactly what happened when we compared the blood PFOA concentrations of MiPEHS participants to an earlier project, the North Kent County Exposure Assessment (NKCEA), which took place in the Belmont/Rockford area. The half-life of these PFAS explains this reduction.

See the timeline below and the graph on the next page to learn how this group of MiPEHS participants saw their blood PFOA concentrations go down. **All MiPEHS participants can watch their own blood PFAS concentrations change over time by joining Phases 2 and 3 of MiPEHS in 2023 and 2025.**



[1]PFAS contamination is discovered, exposure mitigation occurs, and remediation efforts begin.

See pages 30-34 of the technical appendix for more details.

Understanding the plot on this page

See page **8** of this report for more information about how to read density plots.

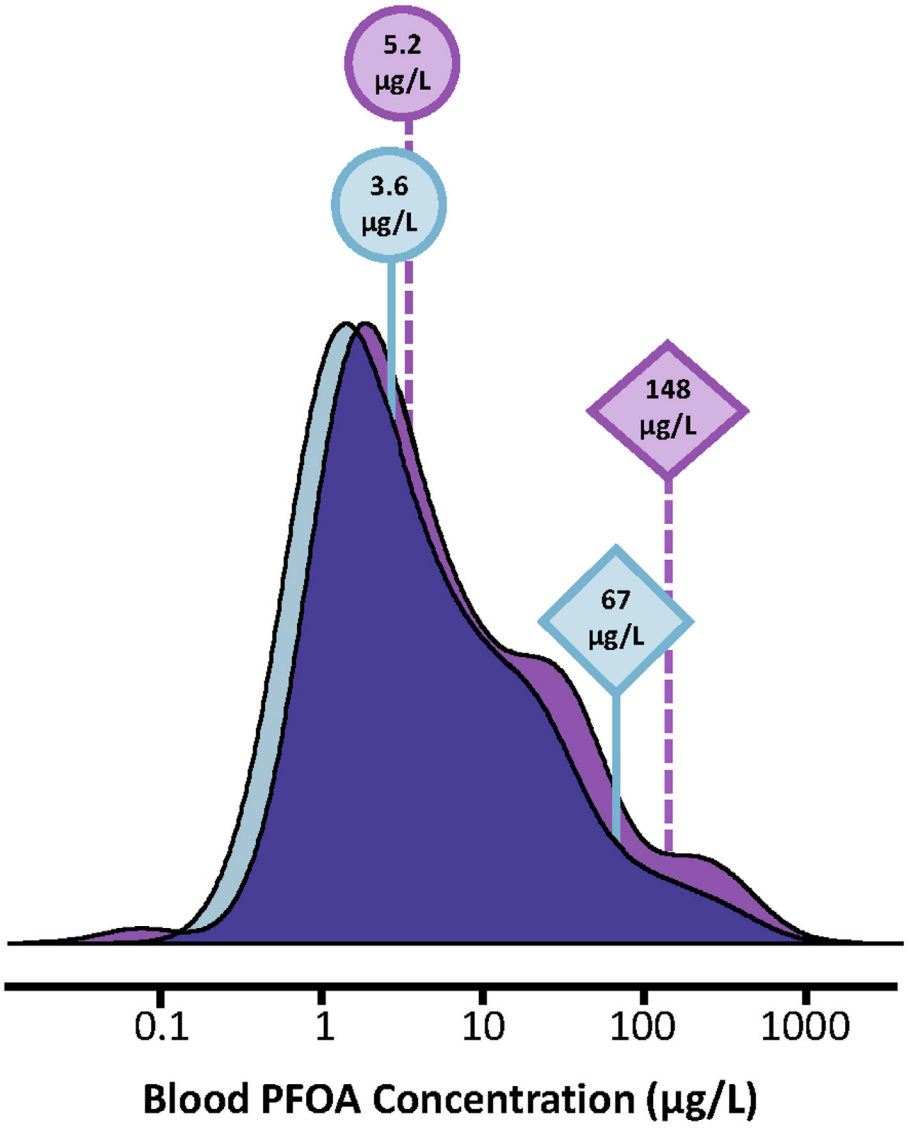
The height of the shaded area corresponds to the relative amount of people with the blood PFOA concentration listed on the bottom of the plot.

Blood PFOA concentration is shown for MiPEHS participants who had their blood tested **before** MiPEHS, as part of the North Kent County Exposure Assessment (NKCEA;) and had their blood tested **during** MiPEHS ( ).

Legend

- Blood PFOA concentrations measured during **MiPEHS**
- Blood PFOA concentrations measured during **NKCEA**
- Average amount of blood PFOA concentrations in **2018-2019**
- Average amount of blood PFOA concentrations in **2020-2021**
- 95th percentile of blood PFOA concentrations in **2018-2019**
- 95th percentile of blood PFOA concentrations in **2020-2021**

Distribution of Blood PFOA Concentrations in Participants of NKCEA and MiPEHS



Key Conclusions

Ninety-four percent of participants who joined both NKCEA and MiPEHS saw their PFOA blood concentrations go down with time. The decline for PFOA is shown in the plot on this page as a shift to the LEFT from NKCEA ( ) to MiPEHS ( ).

For some other PFAS, there was no decline or even a small increase in blood concentrations over time. Depending on the PFAS, this happened in just a few individuals or the whole study population.

These patterns of change over time are not unique to MiPEHS and these trends are seen worldwide.

Unchanging or increasing blood PFAS concentrations over time can mean many things. One possibility is that some sources of exposure may not yet be identified.

Data comparing NKCEA to MiPEHS for other PFAS can be found in the technical report on pages 32-36.

See page 39 of the technical appendix for more details.

MiPEHS will continue for several years.

MiPEHS Phase 1 (2020–2021)

This summary report shares the first analyses conducted on data gathered during MiPEHS Phase 1. Additional analyses, including those that more closely examine health effects, are ongoing and will be submitted for publication in peer-reviewed scientific journals. MDHHS will make all published reports and articles freely available. They will be linked to the MiPEHS website (Michigan.gov/DEHBio).

Some blood samples collected during MiPEHS Phase 1 are still being tested. Not all results are back from the laboratory, including blood concentrations of PCBs, PFAS collected from fingertips and placed on special paper, or PFAS accessed from leftover newborn bloodspot samples stored at BioTrust. As those analyses are completed, participants will receive individual results in the mail. Those data will be added to the Phase 1 data set for ongoing analysis and publication.

No individual results or identifying information about any participant will ever be included in published reports or articles.

MiPEHS Phases 2 (2023) and 3 (2025)

MiPEHS is a longitudinal study. There are two more study phases. Enrollment for the second study phase began in January 2023. If participants join all three phases, we will be able to examine how certain PFAS in blood change over time, how certain health markers change over time, and more. Some of the questions that MiPEHS asks will be answered best by combining data from all three phases, so some conclusions will have to wait until all data collection phases have ended.

This report was prepared by the MDHHS Division of Environmental Health following Phase 1 and released in April 2023.

Learn more about MiPEHS by going to Michigan.gov/DEHBio, calling 844-464-7327, or emailing MDHHS-PFASHealthStudy@Michigan.gov.

A technical appendix describes all calculations and summaries presented here, in more detail. View the Technical Appendix to the Summary Report at Michigan.gov/DEHBio.

See page 46 of the technical appendix for more details.

List of Abbreviations

11Cl-PF3OUDS	11-Chloroeicosalfluro-3-oxaundecane-1-Sulfonic Acid
3:3 FTCA	2H,2H,3H,3H-perfluorohexanoic Acid (3-perfluoropropyl propanoic acid)
4:2 FTS	4:2 Flurotelomer Sulfonic Acid
5:3 FTCA	2H,2H,3H,3H-perfluorooctanoic Acid (3-perfluoropentyl propanoic acid)
6:2 FTS	6:2 Flurotelomer Sulfonic Acid
7:3 FTCA	2H,2H,3H,3H-perfluorodecanoic Acid (3-perfluoroheptyl propanoic acid)
8:2 FTS	8:2 Flurotelomer Sulfonic Acid
9Cl-PF3ONS	9-chlorohexadecafluro-3-oxanone-1-sulfonic Acid
ADONA	4,8-dioxa-3H-perfluorononanoic Acid
EtFOSAA	N-Ethyl Perfluorooctane Sulfonamidoacetic Acid
GenX (HFPO-DA)	Hexafluoropropylene Oxide Dimer
NFDHA	Nonafluoro-3,6-dioxaheptanoic Acid
MeFOSAA	N-methylperfluorooctanesulfonamidoacetic Acid
PFBA	Perfluorobutanoic Acid
PFBS	Perfluorobutane Sulfonic Acid
PFBSA	Perfluorobutane Sulfonamide
PFDA	Perfluorodecanoic Acid
PFDoA	Perfluorododecanoic Acid
PFDS	Perfluorodecane Sulfonic Acid
PFecHS	Perfluoroalkylethylcyclohexane Sulfunate
PFEESA	Perfluoro(2-ethoxyethane) Sulfonic Acid
PFHpA	Perfluoroheptanoic Acid
PFHpS	Perfluroheptanesulfonic Acid
PFHxA	Perfluorohexanoic Acid
PFHxS	Perfluorohexane Sulfonic Acid
PFHxSA	Perfluorohexane Sulfonamide
PFMBA	Perfluoro-4-methoxybutanoic Acid
PFMPA	Perfluoro-3-methoxypropanoic Acid
PFNA	Perfluorononanoic Acid
PFNS	Perfluorononane Sulfonic Acid
PFOA	Perfluorooctanoic Acid
PFOS	Perfluorooctane Sulfonic Acid
PFOSA	Perfluorooctane Sulfonamide
PFPeA	Perfluoropentanoic Acid
PFPeS	Perfluoropentane Sulfonic Acid
PFPrS	Perfluoropropane Sulfonic Acid
PFTeA	Perfluoroetradecanoic Acid
PFTriA	Perfluorotridecanoic Acid
PFUnA	Perfluoroundecanoic Acid

Thank you!

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MiPEHS
Michigan PFAS Exposure & Health Study

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MDHHS
Michigan Department of Health & Human Services