# PEATT Pilot Project
# PFAS Testing
# in the
# Warrington, Warminster and Horsham areas
# Pennsylvania Department of Health

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# What is PFAS?

- Perfluoroalkyl and Polyfluoroalkyl Substances
  - Human-made chemicals
  - Used in protective surfaces and things that have water-repellant coatings

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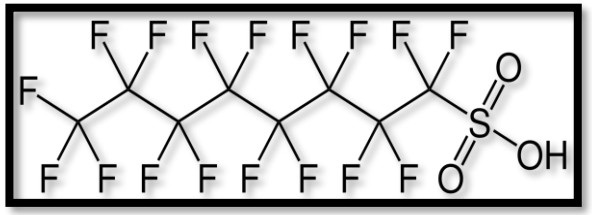
# What is PFAS?

- To be classified as a Perfluoroalkyl or Polyfluoroalkyl Substance…
- Must have carbon-fluorine bonds- very strong




  - The longer the “chain” the stronger the compound
  - More resistant to environmental breakdown

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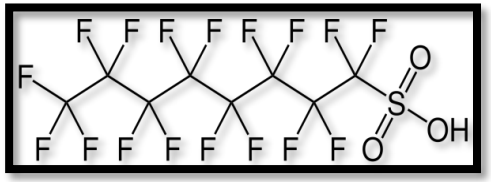
# What is PFAS?

- **Per**fluoroalkyl Substances have all C-F bonds (**completely** fluorinated)




  - Perfluorooctanocic acid (PFOA)
  - Perfluorooctane sulfonic acid (PFOS)
  - Perfluorohexanesulfonic acid (PFHxS) and
  - Perfluorononanoic acid (PFNA)

    are all **"Pers"**

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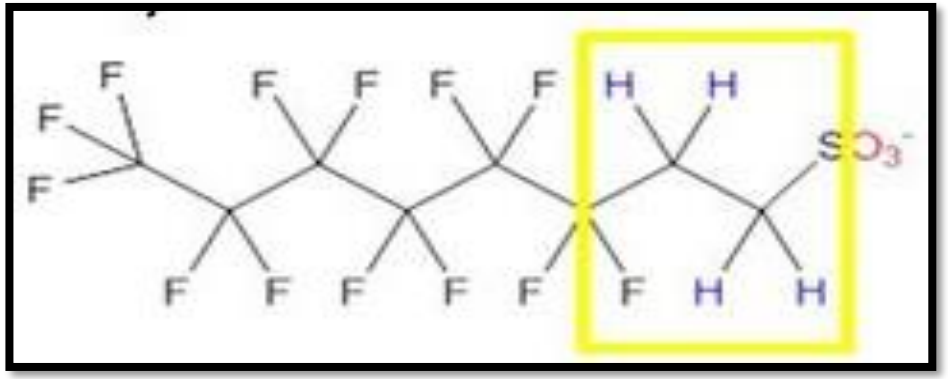
# What is PFAS?

- **Poly**fluoroalkyl Substances have some C-F bonds and some Hydrogen bonds (**partially** fluorinated)
  - Weak spots in chain
  - Eventually degrade to **"pers"**

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# What is PFAS?

- PFOS and PFOA are two long-chain compounds
- Being phased out of commercial production in U.S. and Europe
  - Still in some imported goods
- Being replaced by shorter-chain “replacement” or “substitute” compounds in manufacturing and industrial processes (e.g. GenX compounds)

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# PFAS Exposure in Southeastern PA

- Military and firefighter training
  - PFAS in the foam

- Former Naval Air Station Joint Reserve Base Willow Grove and Horsham Air Guard Station (HAGS)
  - 2014: Found contamination in 2 public water systems
  - 5 public wells taken out of service
  - 2016 additional wells removed, private well owners given bottled water

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# PFAS Exposure in Southeastern PA

## Former Naval Air Warfare Center (NAWC) Warminster

- 2013: Detected PFAS contamination in groundwater and public water systems
- 2014: Removed 3 public wells from service; private well owners given bottled water
- 2015: PFAS found in 93 out of 100 private wells within 1-3 mile radius
- July 2016 all contaminated wells removed from service (in compliance with new EPA health advisory levels)

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# EPA Health Advisory Levels

**Prior to May 2016 - Provisional Health Advisory Levels (PHAL)**

- 0.2 microgram per liter (ug/L) for PFOS and 0.4 ug/L for PFOA (200 and 400 parts per trillion, respectively)

**May 2016 - Lifetime Health Advisory Level (LHAL)**

- 70 parts per trillion or 0.07 ug/L for PFOS and PFOA combined.

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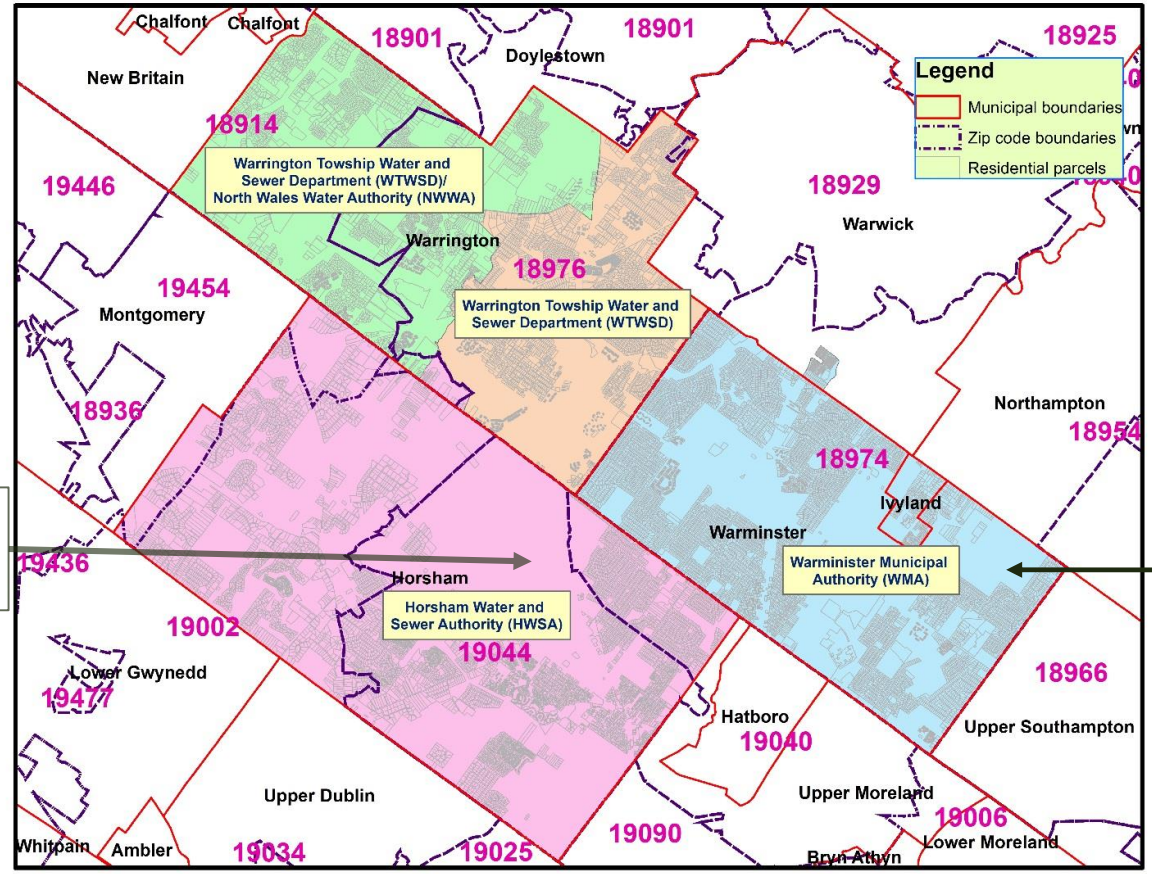
# PFAS Exposure in Southeastern PA

- Affected area = population of 84,184 (2010 census)
- 32,595 households in water service area




Horsham Air Guard Station

Naval Air Warfare Center

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# PFAS Exposure in Community

- PFAS levels in community drinking water
- 1,440 ppt - about 21 times higher than the LHAL (70 ppt) found in a municipal well in Warminster Municipal Authority (WMA) area
- Assumed to have been exposed for a long time - nearly 50 years
- Wide range of exposure:
  - Some municipal wells had no levels of PFAS
  - Some municipal wells much higher than national guideline
  - Found PFAS in 93 private wells near NAWC.

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# PEATT Pilot Project

- Received competitive grant funds from the Association of State and Territorial Health Officials (ASTHO) along with New York state
- Testing the PFAS Exposure Assessment Technical Toolkit for the CDC/ATSDR
- May 2018 - Sent eligibility forms and letters to 600 randomly chosen households in Warminster, Horsham, Warrington area zip codes served by public water systems contaminated with PFAS
- 276 households returned forms - 584 potential participants
- 305 individuals returned their paperwork to DOH - questionnaires and signed consent forms

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# PEATT Pilot Project

- Initial Eligibility Letters-
  - Response rate of 46% (276/600 households)
- 235 participants who completed paperwork **AND** gave blood samples-
  - Response rate of 40% (235/584 participants)
  - Participants represented 118 households out of the 276 who responded

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# PEATT Pilot Project

- Weekly clinics in Bucks and Montgomery Counties to draw the blood samples
- From May through September 2018
- 235 samples obtained and sent to Wadsworth Laboratory in the New York State Health Department
- Wadsworth returned all results so far to DOH, and all 235 participants have been notified of their individual results as well as a preliminary comparison to the overall community group

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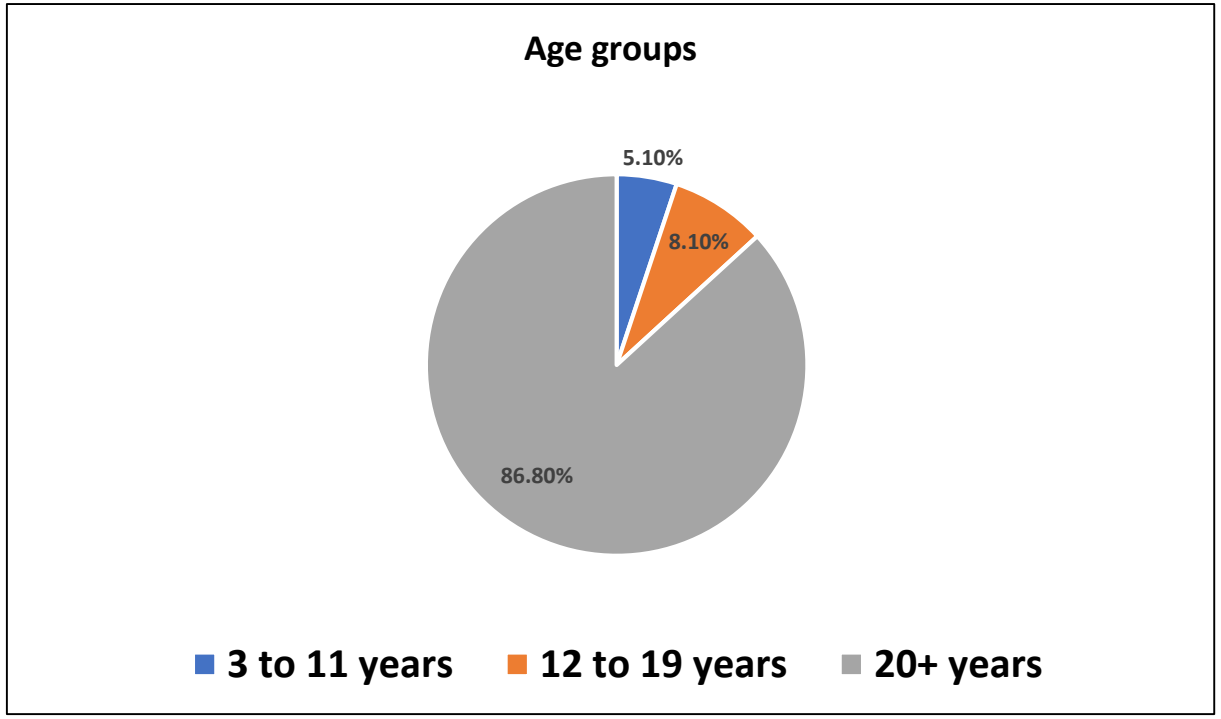
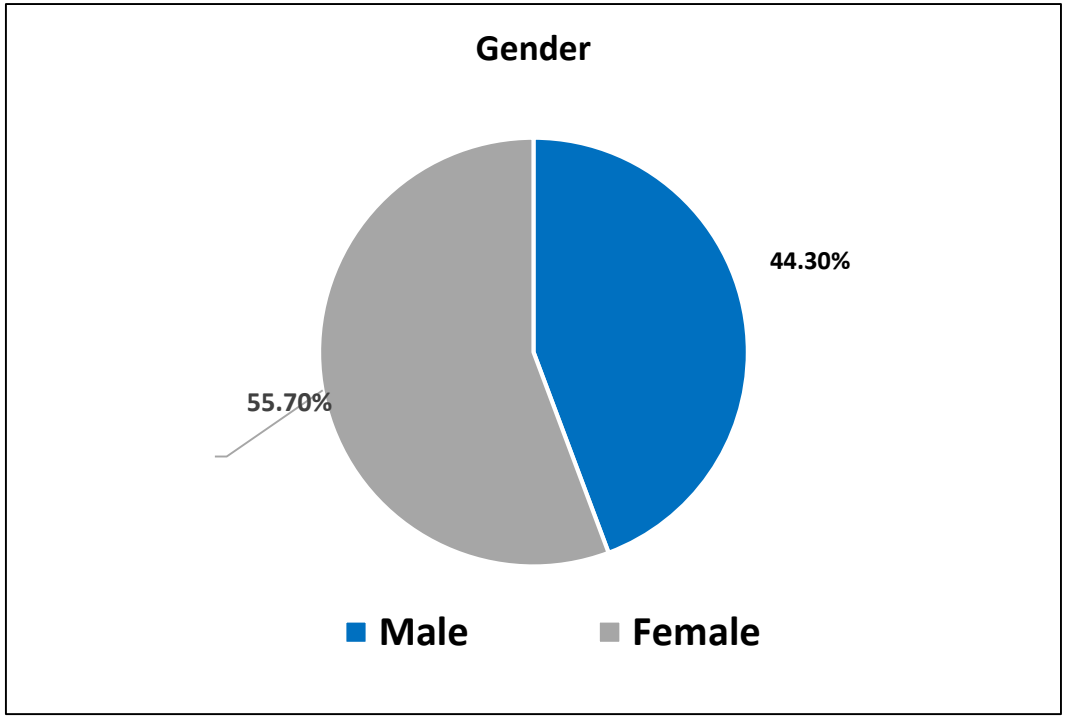
# Study Demographics

Mostly adults 20+ years old




More females than males




- Average age – 49 years
- 66% had college education or higher
- 12% were ever employed on a military base

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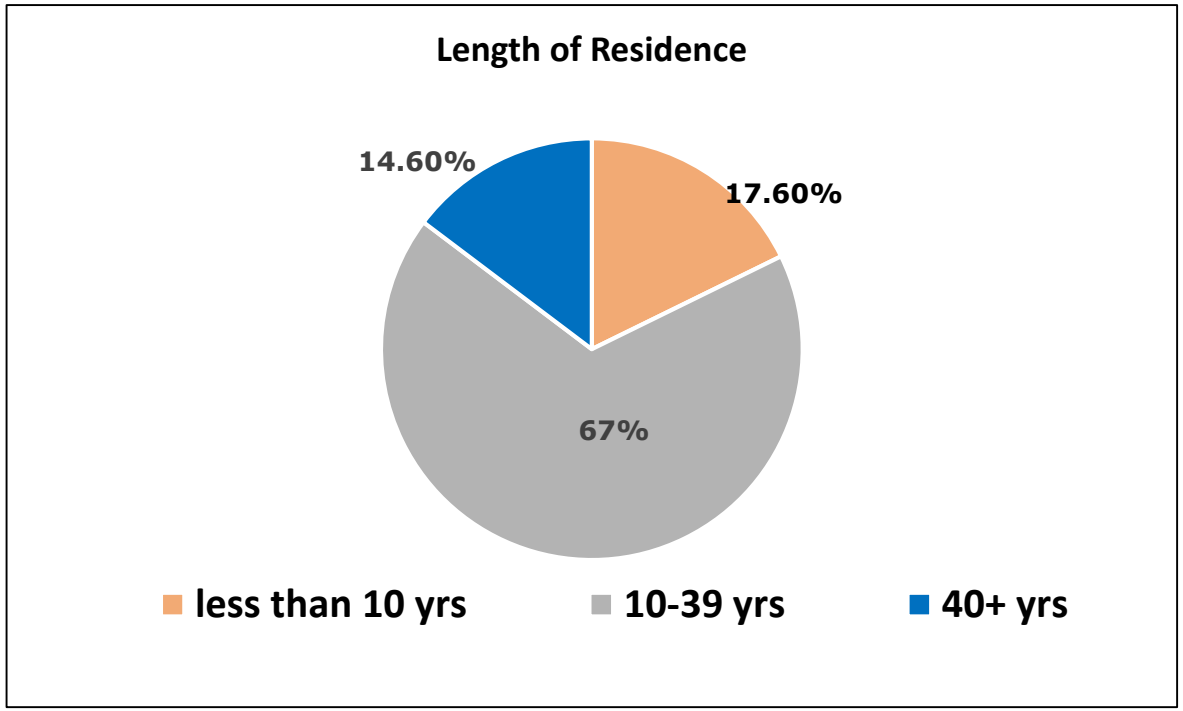
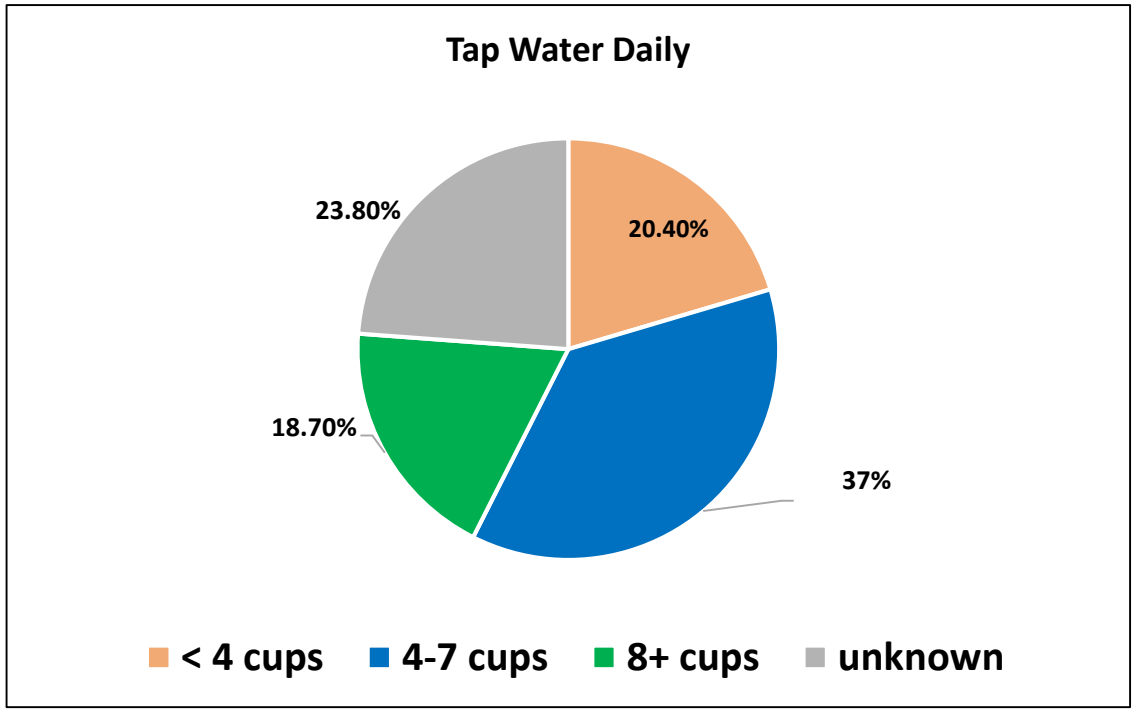
# Study Demographics

Most are long-term residents (>10 years)




Estimated Tap Water Consumed Daily




- 82% used public water

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# Reading Individual Results (first letter)

## For an ADULT age 20 or older (unit: microgram/L)

Match the colored columns

Your number was in ***italicized bold*** if it **exceeded** the 95th percentile

| PFAS chemicals measured in your blood | Concentration found in your blood | US Population - Age groups | | | | | |
|---|---|---|---|---|---|---|---|
| | | 3-11 years | | 12-19 years | | 20 plus years | |
| | | Geometric mean | 95th percentile | Geometric mean | 95th percentile | Geometric mean | 95th percentile |
| Perfluorooctanoic acid (PFOA) | 3.52 | 1.92 | 4.19 | 1.66 | 3.47 | 1.98 | 5.60 |
| Perfluorooctanesulfonic acid (PFOS) | 9.60 | 3.88 | 11.00 | 3.54 | 9.30 | 5.22 | 19.50 |
| Perfluorohexane sulfonic acid (PFHxS) | ***8.37*** | 0.84 | 3.12 | 1.27 | 6.30 | 1.36 | 5.50 |
| Perfluorononanoic acid (PFNA) | 0.80 | 0.79 | 3.26 | 0.60 | 2.00 | 0.69 | 2.00 |
| Perfluorobutanesulfonic acid (PFBuS) | ND | * | <0.10** | * | <0.10** | * | <0.10** |
| Perfluorodecanoic acid (PFDeA) | ND | * | 0.37 | 0.14 | 0.40 | 0.19 | 0.80 |
| Perfluorododecanoic acid (PFDoA) | ND | * | <0.10** | * | 0.20 | * | 0.20 |
| Perfluoroheptanoic acid (PFHpA) | ND | * | 0.21 | * | 0.20 | * | 0.10 |
| Perfluorooctane sulfonamide (PFOSA) | ND | * | <0.10** | * | <0.10** | * | <0.10** |
| 2-(N-Methyl-perfluorooctane sulfonamido) acetic acid (MeFOSAA) | ND | * | 1.02 | * | 0.60 | * | 0.60 |
| Perfluoroundecanoic acid (PFUA) | ***0.95*** | * | 0.28 | * | 0.20 | * | 0.50 |

This is the NHANES average

95% of population is below this number

ND or * means "non detect"- levels are so tiny they cannot be detected (<0.01)

**Above results from NHANES 2013-2014, except PFOSA which is from 2011-2012.**

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# Reading Community Results (second letter)

## For an ADULT age 20 or older (unit: microgram/L)

This is the national average

This is the community average

| PFAS chemicals measured | Your Results | U.S. Population Results by Age Group | | Warminster, Warrington, and Horsham Community | |
|---|---|---|---|---|---|
| | | 20+ Years Old | | 20+ Years Old | |
| | | Average | 95th Percentile | Average | 95th Percentile |
| Perfluorooctanoic acid (PFOA) | 2.96 | 1.98 | 5.60 | 3.32 | 9.99 |
| Perfluorooctanesulfonic acid (PFOS) | 11.4 | 5.22 | 19.50 | 11.50 | 36.25 |
| Perfluorohexane sulfonic acid (PFHxS) | ***7.44*** | 1.36 | 5.50 | 7.63 | 48.05 |
| Perfluorononanoic acid (PFNA) | 0.79 | 0.69 | 2.00 | 0.78 | 1.61 |
| Perfluorodecanoic acid (PFDeA) | ND | 0.19 | 0.80 | 0.36 | 0.53 |
| Perfluoroheptanoic acid (PFHpA) | ND | * | 0.10 | 0.35 | 0.35 |
| 2-(N-Methyl-perfluorooctane sulfonamido) acetic acid (MeFOSAA) | ND | * | 0.60 | 0.36 | 0.35 |
| Perfluoroundecanoic acid (PFUA) | ND | * | 0.50 | 0.36 | 0.35 |

Your number was in ***italicized bold*** if you **exceeded** the 95th percentile

ND or * means "non detect"- levels are so tiny they cannot be detected (<0.01)

**Above results from NHANES 2013-2014**

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# Results

- Tested for 11 PFAS compounds (all **per**fluorinated)
  - 4 compounds were commonly detected
    - PFOS (100%)
    - PFHxS (99.0%)
    - PFOA (98.7%)
    - PFNA (78.1%)
    - All four detected in 79% of participants

Note: PFOS, PFOA and PFHxS are main components found in Aqueous Film Forming Foams (AFFF)
PFHxS has longer half-life in the body
PFOA used in non-stick surface coatings and water and stain resistant coatings
PFNA levels on the rise, biodegradation product during polyvinyl fluoride production/application

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# Results

- Of the remaining 7 compounds-
  - PFDeA was found in 14 participants
  - MeFOSAA was found in 9 participants
  - PFUA in 8 participants
  - PFHpA in 1 participant

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# Results Overall

- PFAS levels in the community and at national level
  - Average blood levels were higher compared to NHANES's average levels
    - 94% had higher levels of PFHxS
    - 81% had higher levels of PFOS
    - 75% had higher levels of PFOA
    - 59% had higher levels of PFNA
  - This is consistent with other studies on PFAS exposure through drinking water

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# Results Overall

- Four most commonly found PFAS

| | Community Results | | | | NHANES Results (2013-2014) | |
|---|---|---|---|---|---|---|
| PFAS Compound | **Average** | 95% Confidence Interval | Median | Range | **Average** | 95% Confidence Interval |
| PFOA | **3.13** | 2.81-3.50 | 3.06 | 0.55-24.8 | **1.94** | 1.76-2.14 |
| PFOS | **10.24** | 8.86-11.83 | 9.86 | 1.02-105.00 | **4.99** | 4.50-5.52 |
| PFHxS | **6.64** | 5.51-7.99 | 6.61 | 0.54-116.00 | **1.35** | 1.20-1.52 |
| PFNA | **0.74** | 0.67-0.80 | 0.76 | 0.50-2.56 | **0.68** | 0.61-0.74 |

Results shown in ug/L. Range excludes <LOD

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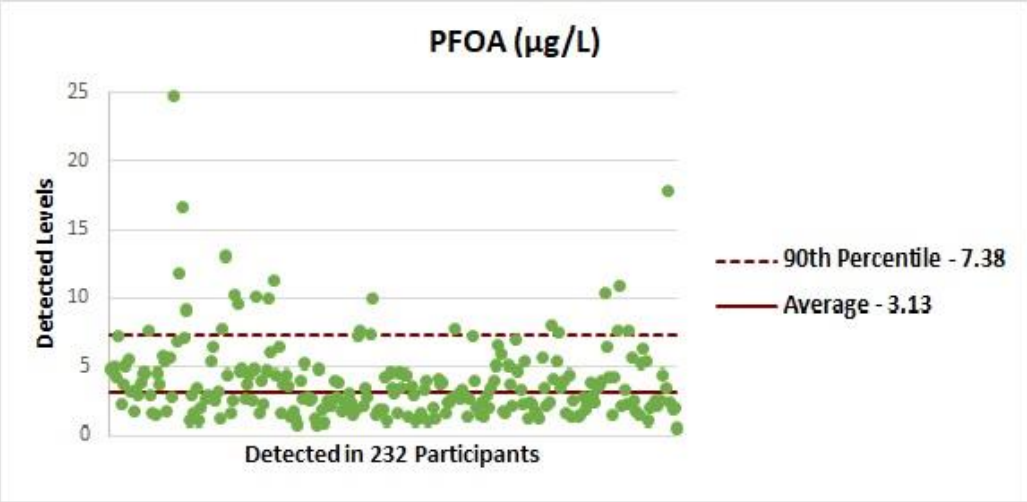
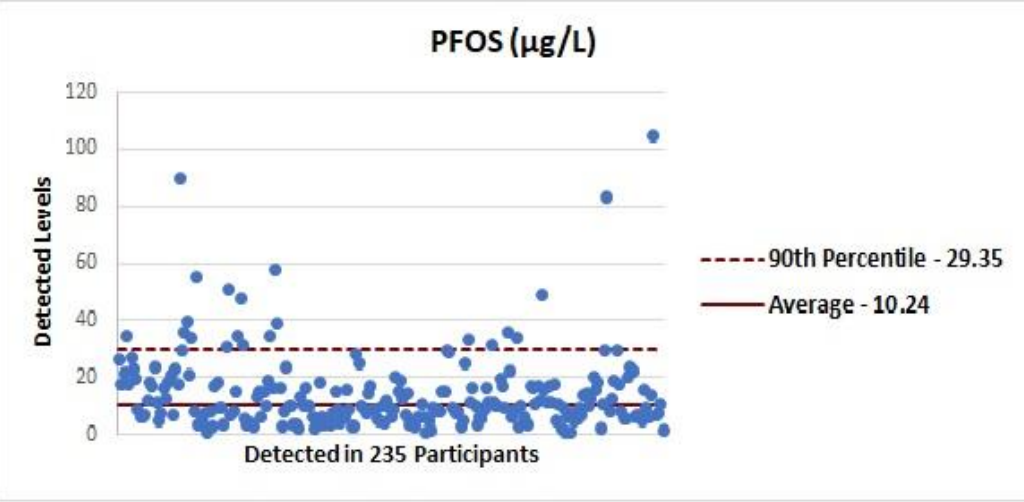
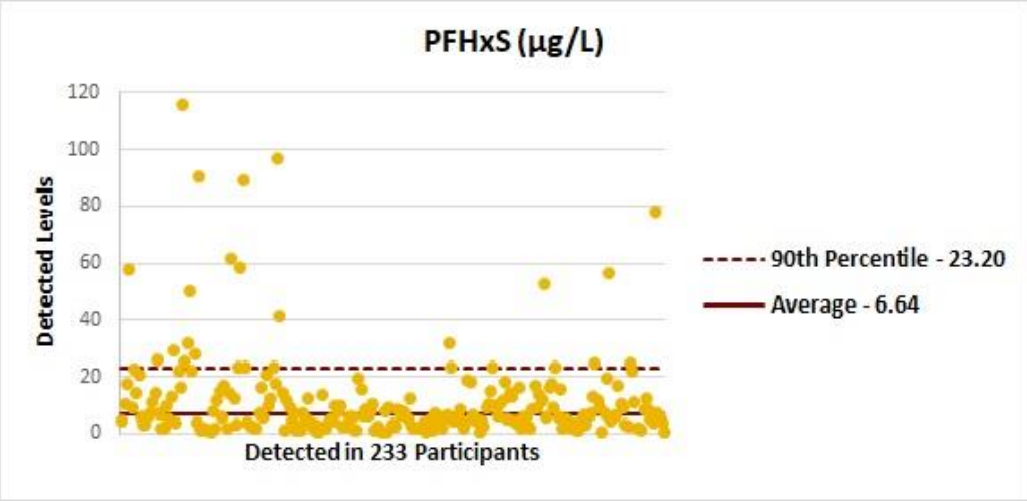
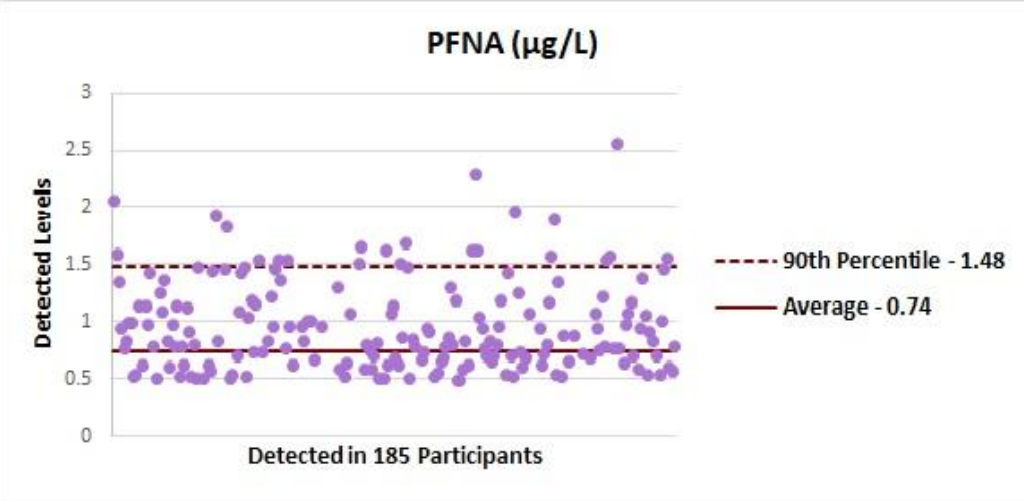
# Distribution of serum PFAS levels

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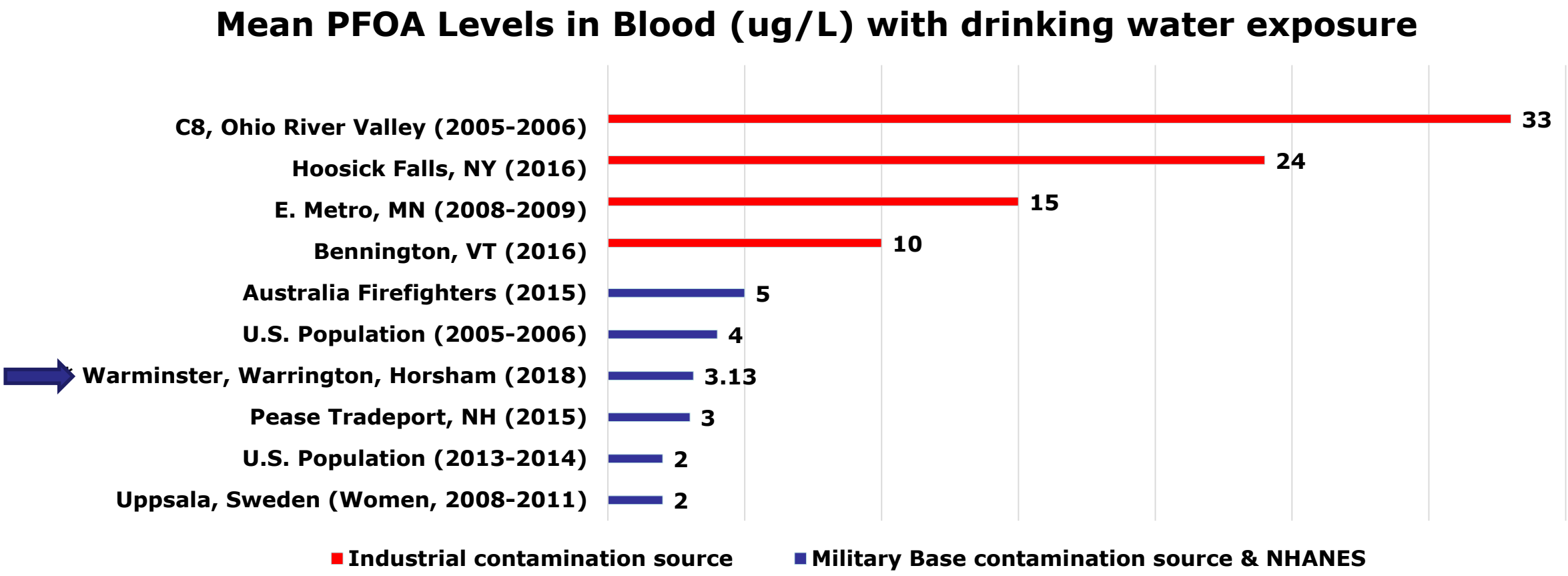
# PFOA Blood Levels in Other Studies




Holzer et al. 2008, Rotander et al. 2015, Gyllenhammar et al. 2015, Daly et al. 2018

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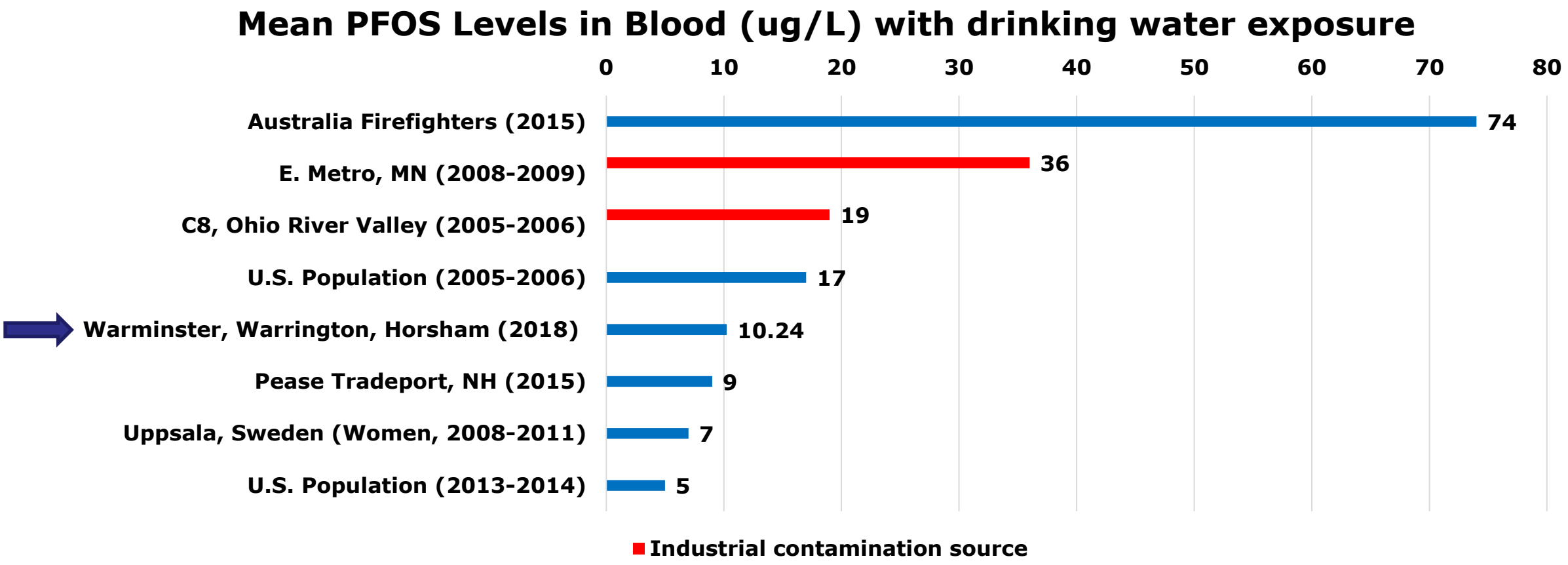
# PFOS Blood Levels in Other Studies




Holzer et al. 2008, Rotander et al. 2015, Gyllenhammar et al. 2015, Daly et al. 2018

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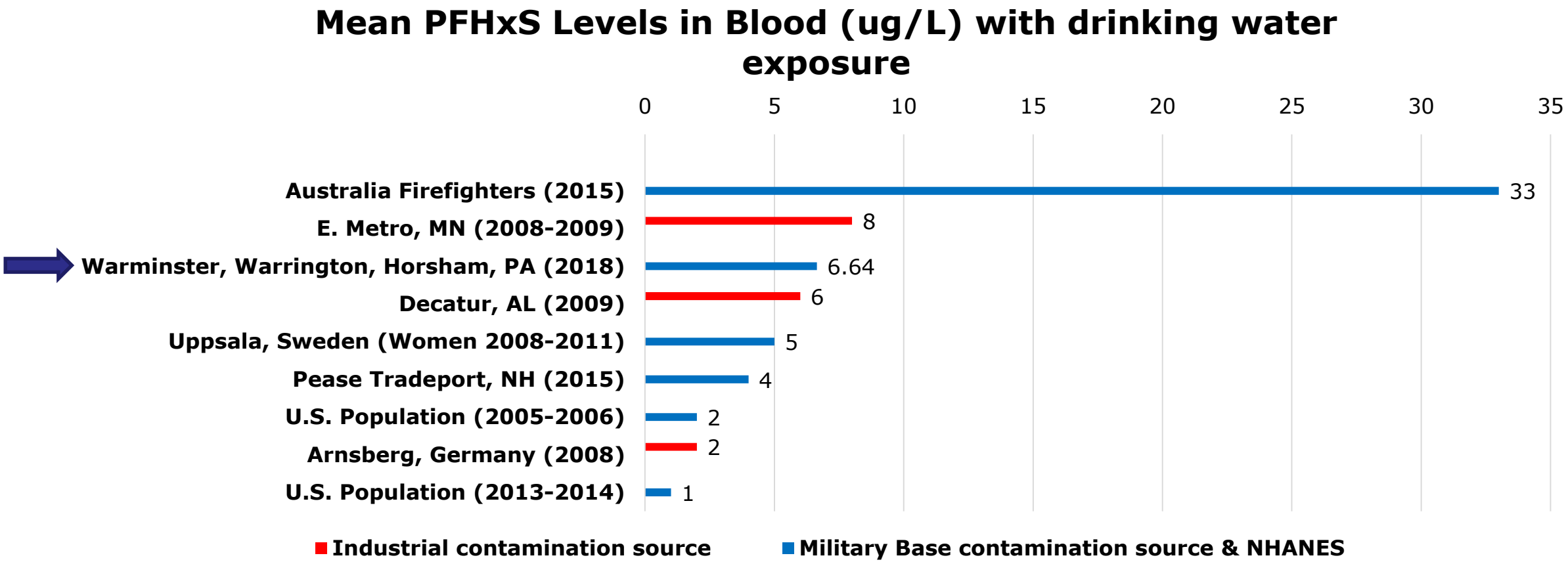
# PFHxS Blood Levels in Other Studies




Holzer et al. 2008, Rotander et al. 2015, Gyllenhammar et al. 2015, Daly et al. 2018

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# Results by Age Category

- In general PFOA, PFOS, PFHxS and PFNA levels increased with age (statistically significant between age groups)
- In most age groups, community results exceeded NHANES levels for each compound
- Exception- lower PFNA in 3-11 and 12-19 age groups

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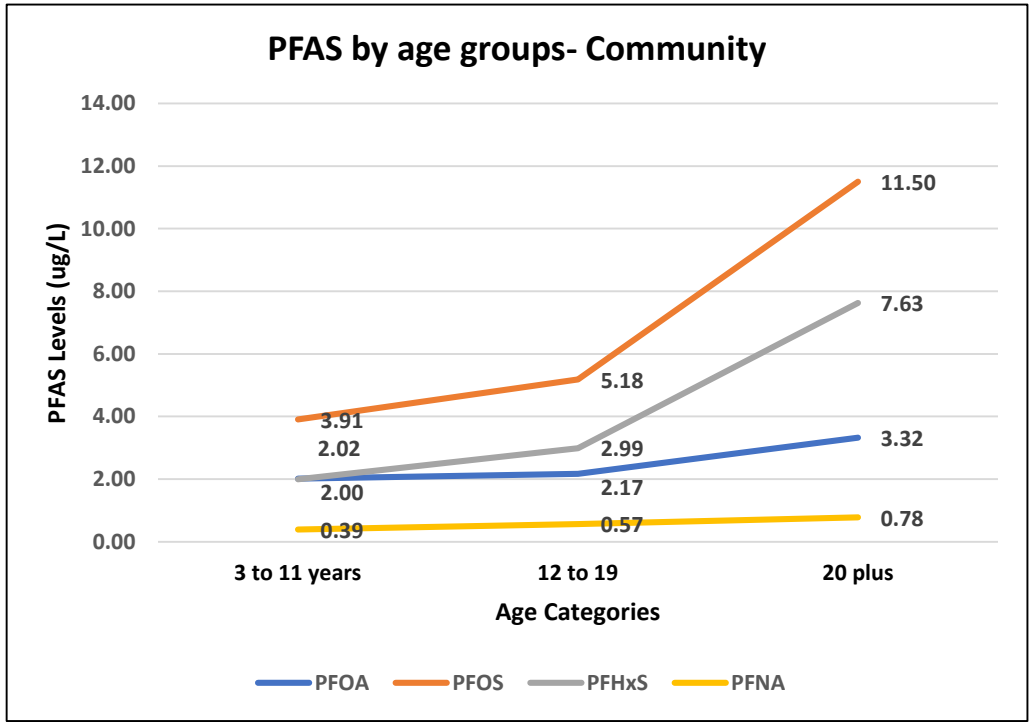
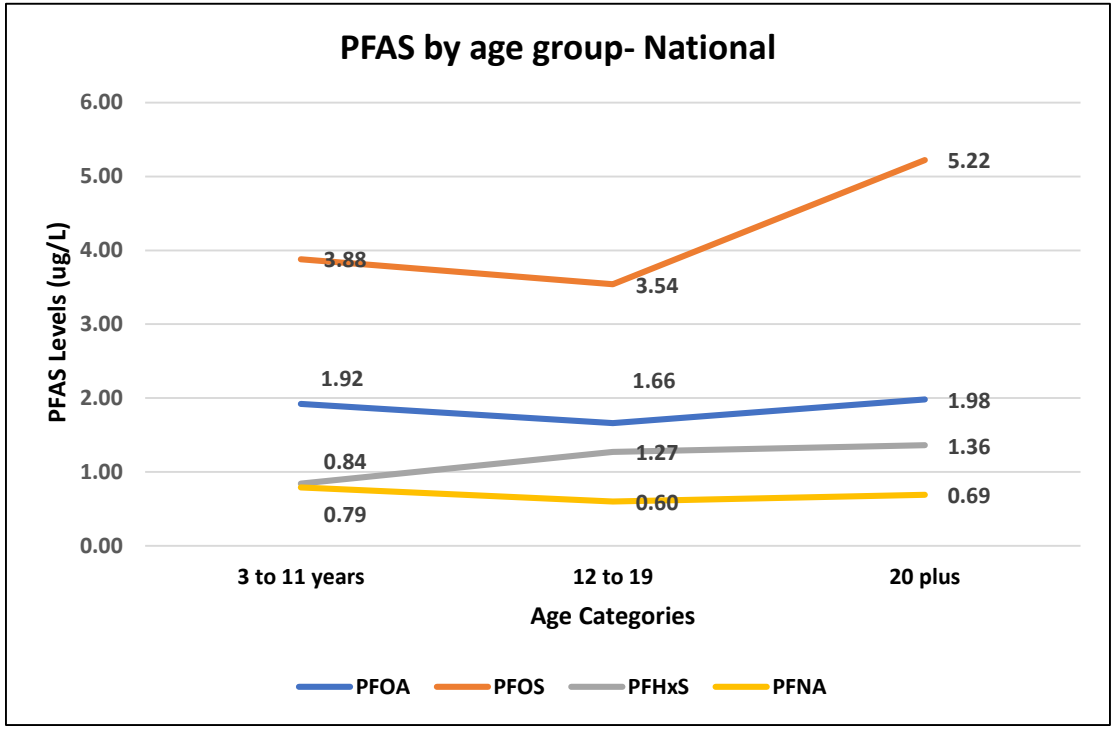
# Results by Age Category

## Community Results compared to National (NHANES 2013-2014) Results




Results shown in ug/L

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# Results by Age Category

**Community Results compared to National (NHANES) Results**

| | Community Results | | | | | | NHANES Results (2013-2014) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Age | | | | | | Age | | | | | |
| | 3-11 years | | 12-19 years | | 20+ years | | 3-11 years | | 12-19 years | | 20+ years | |
| PFAS Compound | **Average** | 95% C.I. | **Average** | 95% C.I. | **Average** | 95% C.I. | **Average** | 95% C.I. | **Average** | 95% C.I. | **Average** | 95% C.I. |
| PFOA | **2.02** | 1.66-2.45 | **2.17** | 1.70-2.78 | **3.32** | 2.96-3.72 | **1.92** | 1.75-2.12 | **1.66** | 1.50-1.84 | **1.98** | 1.79-2.19 |
| PFOS | **3.91** | 3.02-5.07 | **5.18** | 3.93-6.83 | **11.50** | 10.08-13.12 | **3.88** | 3.53-4.27 | **3.54** | 3.17-3.96 | **5.22** | 4.70-5.81 |
| PFHxS | **2.00** | 1.24-3.23 | **2.99** | 2.19-4.09 | **7.63** | 6.41-9.08 | **0.84** | 0.76-0.94 | **1.27** | 1.06-1.53 | **1.36** | 1.21-1.53 |
| PFNA | **0.39** | 0.35-0.43 | **0.57** | 0.43-0.76 | **0.78** | 0.72-0.84 | **0.79** | 0.68-0.93 | **0.60** | 0.49-0.73 | **0.69** | 0.63-0.75 |

Results shown in ug/L

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# Results by Gender

- Males had higher PFAS levels than females
  - (Not statistically significant)
- Exception – PFNA
- Consistent with other studies
- Attributed to female elimination routes
  - Breast feeding
  - Transfer to fetus during pregnancy
  - Menstruation

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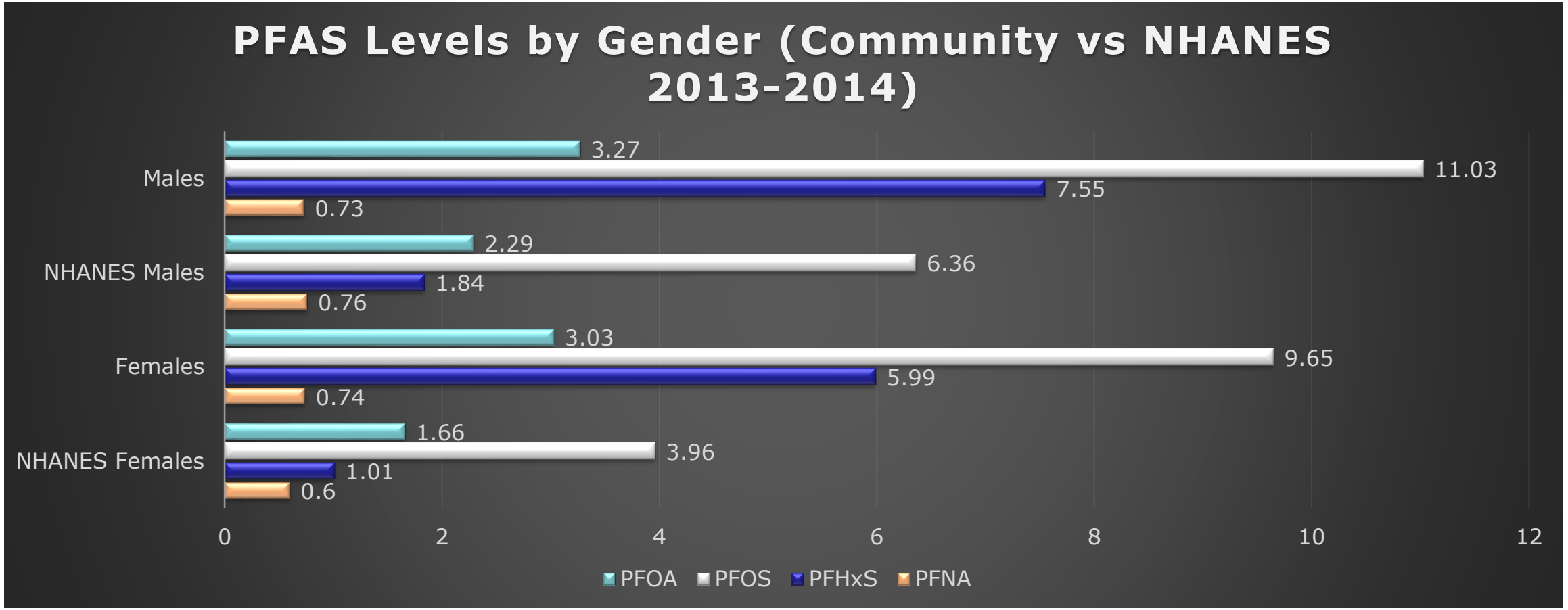
# Results by Gender




Difference between male and female participants not statistically significant (P>0.05 for all four compounds)

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# Results by Length of Residence

- Longer residence time correlated with higher PFAS blood concentrations (Statistically significant between categories)

- Only measured by *current* residence, not total time (former addresses) in the area

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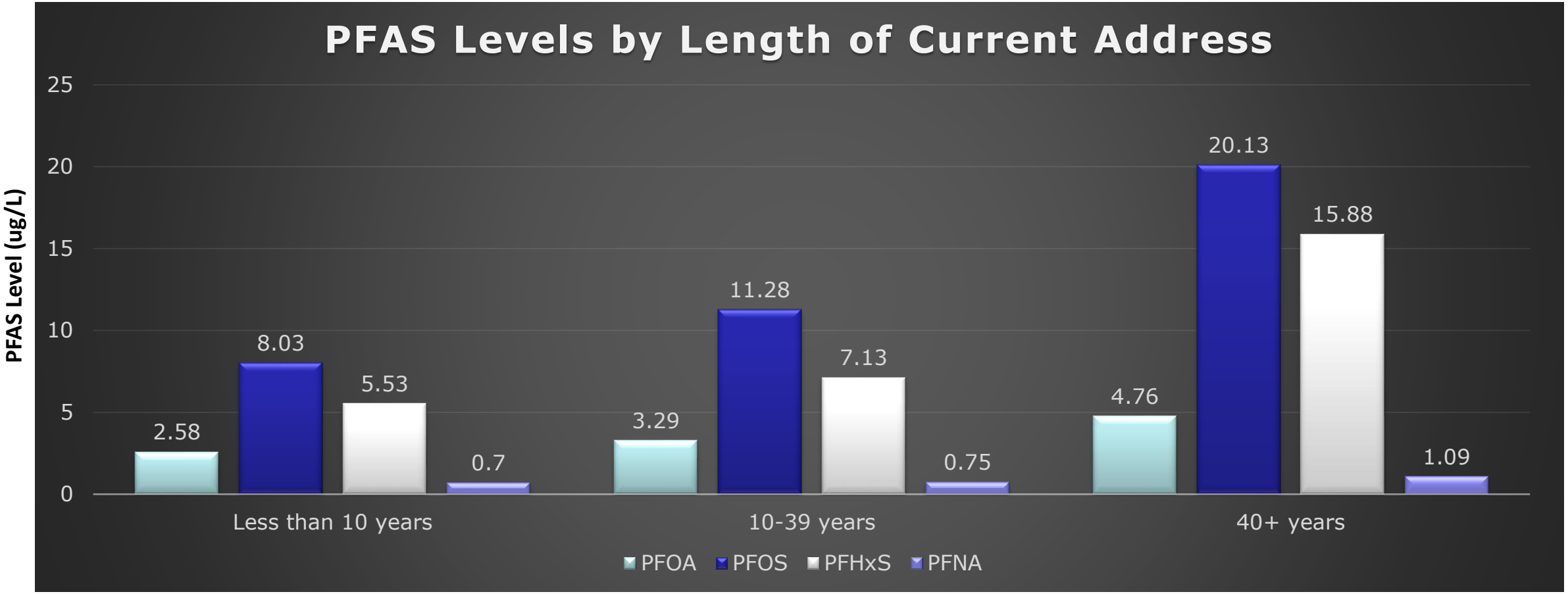
# Results by Length of Residence




Note: Unadjusted results

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# Results by Tap Water Consumed

- There was some correlation between the estimated quantity of tap water consumed and PFAS levels.
- (Significant difference for PFOA and PFNA compounds)
  - Less than 4 cups/day category had lower levels than 4-7 cups/day category
  - 4-7 cups/day had higher levels than 8 or more cups/day category

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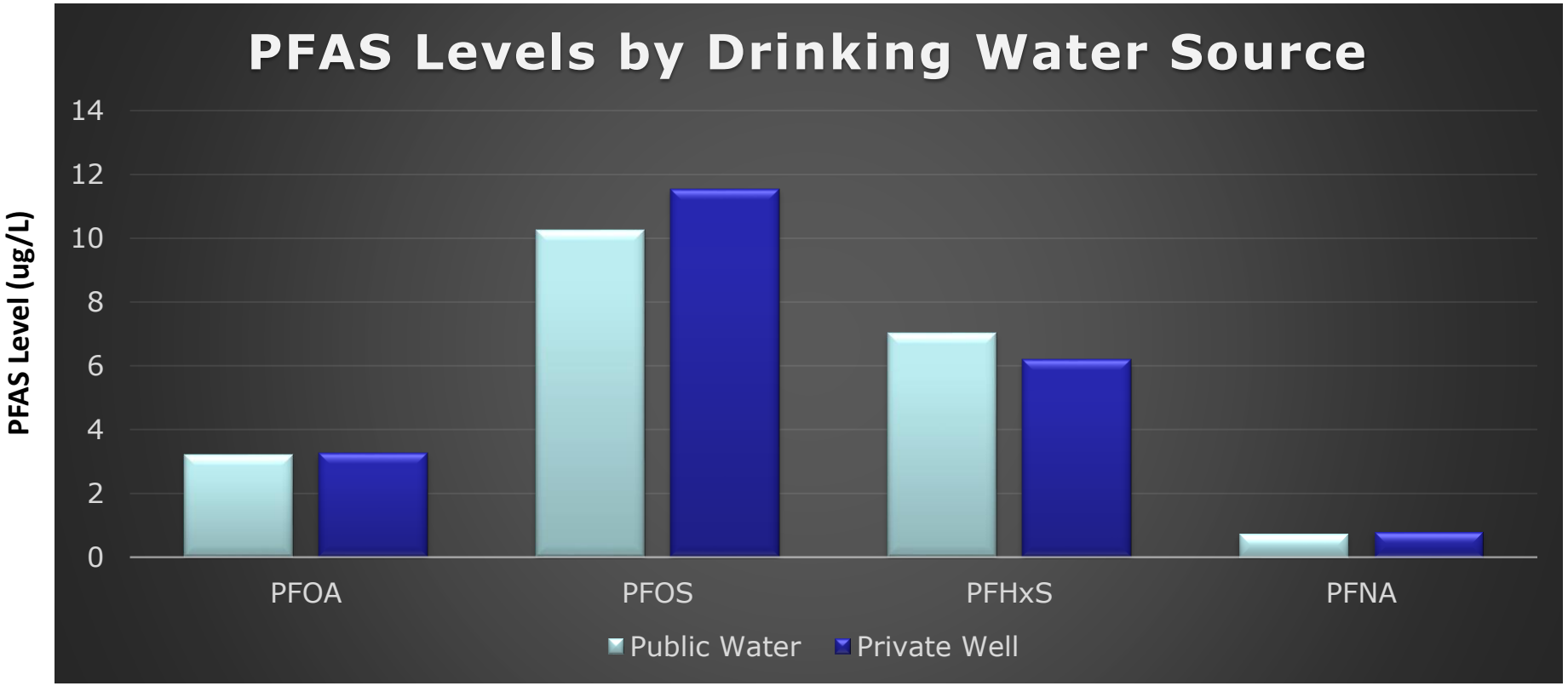
# Results by Water Source

Overall, private well users had slightly higher levels of PFOA, PFOS, and PFNA than public water users, but not PFHxS




Differences in levels not statistically significant (P>0.05 for all)

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# Results by Military Base Employment

- Participants who worked on a military base showed higher levels of PFOA, PFOS, and PFHxS, but not PFNA
  - (Not statistically significant between categories)

- PFNA is not as predominant a compound as PFOS, PFOA, or PFHxS in firefighting foam (AFFF)

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# Results by Military Base Employment

| Ever Employed on a Military Base | | | | | | |
|---|---|---|---|---|---|---|
| **PFAS** | **Yes** | | | **No** | | |
| | **Average** | 95% CI | Range | **Average** | 95%CI | Range |
| **PFOA** | **3.52** | 2.69-4.61 | 1.21-16.80 | **3.30** | 2.91-3.75 | 0.55-24.80 |
| **PFOS** | **12.90** | 9.36-17.78 | 2.53-57.80 | **11.36** | 9.84-13.12 | 1.02-105.00 |
| **PFHxS** | **10.32** | 6.79-15.69 | 1.01-96.90 | **7.33** | 6.07-8.86 | 0.54-116.00 |
| **PFNA** | **0.77** | 0.62-0.94 | 0.51-1.58 | **0.79** | 0.72-0.86 | 0.50-2.56 |

Results shown in ug/L. Range excludes <LOD

Differences in levels not statistically significant (P>0.05 for all)

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# PFAS Compounds Bioaccumulate

- PFAS not stored in fat, but binds to both plasma and liver proteins (main bioaccumulation reservoirs)
- Continued exposure to even low levels in drinking water can substantially increase total human exposure
- Chronic drinking water exposure may increase serum PFAS concentration by 100-times the concentration of PFAS in drinking water; more pronounced in children

Hoffman et al. 2011, Post et al. 2012, Guelfo et al. 2018

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# Health Effects Associated with PFAS

- Health studies:
  - Occupationally exposed populations
  - Populations exposed via contaminated drinking water

- Health effects include:
  - Altered thyroid function
  - Altered immune function
  - Cancers
  - Elevated cholesterol
  - Endocrine disruption

www.atsdr.cdc.gov/pfas/health-effects.html

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# C8 (PFAS) Science Panel (2005-2013)

C8 panel was a group of public health scientists established as part of a class action lawsuit settlement following PFOA contamination of the Ohio river by the DuPont company in Parkersburg, WV.

The Science Panel concluded that there was a probable link to C8 (PFAS) exposure for the following health conditions:

- Diagnosed high cholesterol
- Ulcerative colitis
- Thyroid disease
- Pregnancy-induced hypertension
- Testicular cancer, kidney cancer

C8 Project Panel Study 2012 www.c8sciencepanel.org/prob_link.html

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# Cancer Risk

## US EPA classified PFOA as likely carcinogenic to humans

- Studies and incidence reports show mixed results and are inconclusive
  - Barry et al. found kidney and testicular cancers with increased blood levels of PFOA
  - Incidence report for Kent County, Michigan showed no consistent elevation in cancer incidence except for prostate cancer
  - DOH cancer data review showed no consistent pattern in cancer incidence

USEPA, 2006, Post, 2012, Barry et al. 2013, Bruton and Blum, 2017

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# Altered Thyroid Function

- Association between clinical hypothyroidism and serum PFOA levels in children (C8)
- Positive association with increased PFOS serum levels and Thyroid Stimulating Hormone (TSH)
  - Higher levels of TSH generally indicates a lower thyroid hormone level
- Significant sex difference in the associations of TSH with PFNA and PFHxS

Blake et al. 2018

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# Other Concerns

- Dyslipidemia (altered cholesterol levels)
  - Reported in multiple studies
  - Generally higher or abnormal levels of total cholesterol in association with higher PFAS serum concentration
- Higher PFAS levels are associated with higher age at puberty
- Mixed results regarding weight or BMI in children

Post et al 2012, Rappazzo 2017, Blake et al 2018

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# PEATT Results by Health Condition

- Participant responses (149 out of 235)
  - Only 63 percent listed any health conditions
- Five main categories
  - Growth-related conditions
  - Women's reproduction
  - Endocrine disruption
  - Cancer
  - Elevated cholesterol

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# Results by Health Condition*

- Elevated cholesterol most frequently reported
- Those reporting elevated cholesterol also had higher PFAS levels (all 4 compounds)
- Those reporting endocrine disruption had higher levels of PFOA and PFHxS
- Those with cancer had higher levels of PFOA and PFNA

* Unadjusted results

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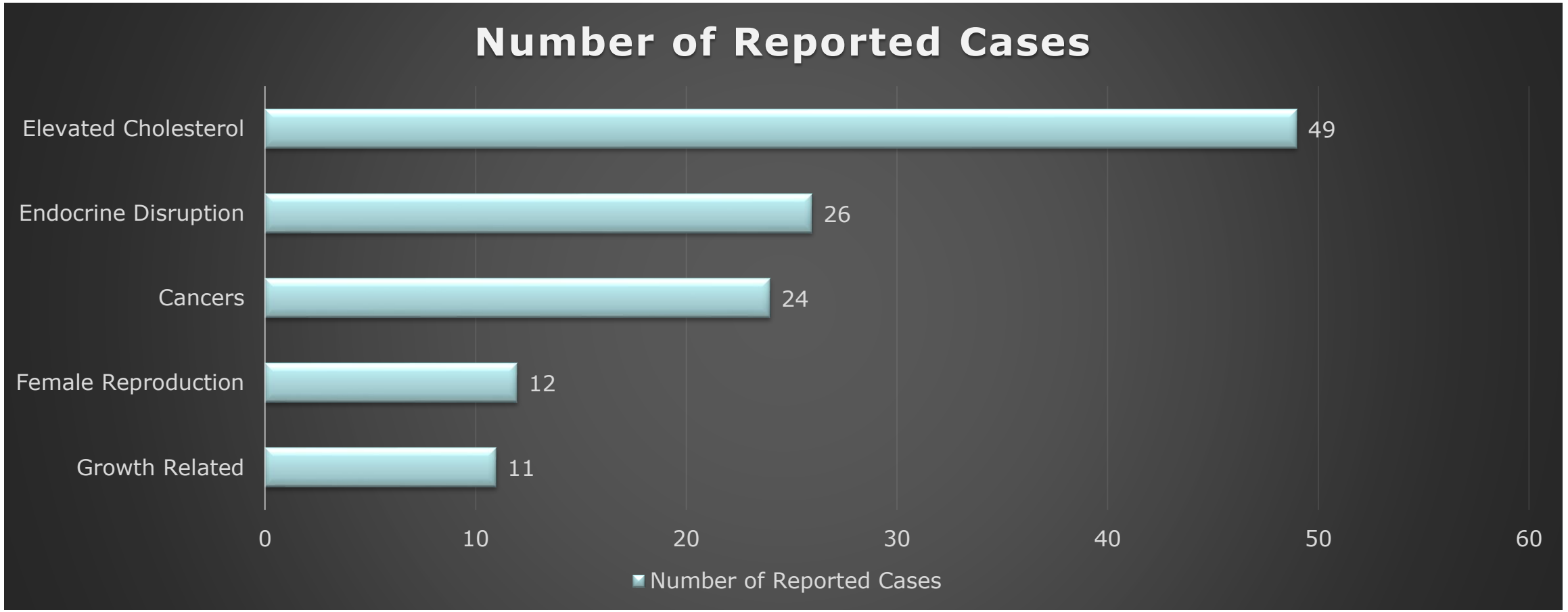
# Results by Main Categories of Health Condition

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# Participants above 90th Percentile

- A subgroup of 25 out of the 235 participants
- These 25 at least two of the four PFAS compounds at levels higher than 90th percentile value of community

| PFAS Compound | 90th Percentile Values (ug/L) for the community |
|---|---|
| **PFOA** | **7.38** |
| **PFOS** | **29.35** |
| **PFHxS** | **23.20** |
| **PFNA** | **1.48** |

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# Participants above 90th Percentile

Average age = 61
Range (males 48-76, females 20-81)

22 individuals lived in community 18 years or more and used public water

5 individuals worked on a military base

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# Elimination Rate/Half-life

- PFOA = 2-4 years
- PFOS = 5-6 years
- PFHxS = 8-9 years

- General serum concentrations run higher in men than women
- Women excrete PFAS in breastmilk and during menstruation
- Children have higher PFAS concentrations due to maternal transfer and nursing, as well as environmental intake (dust, carpeting, consumer products)

Olsen et al. 2007, ATSDR, 2017, Blake et al. 2018

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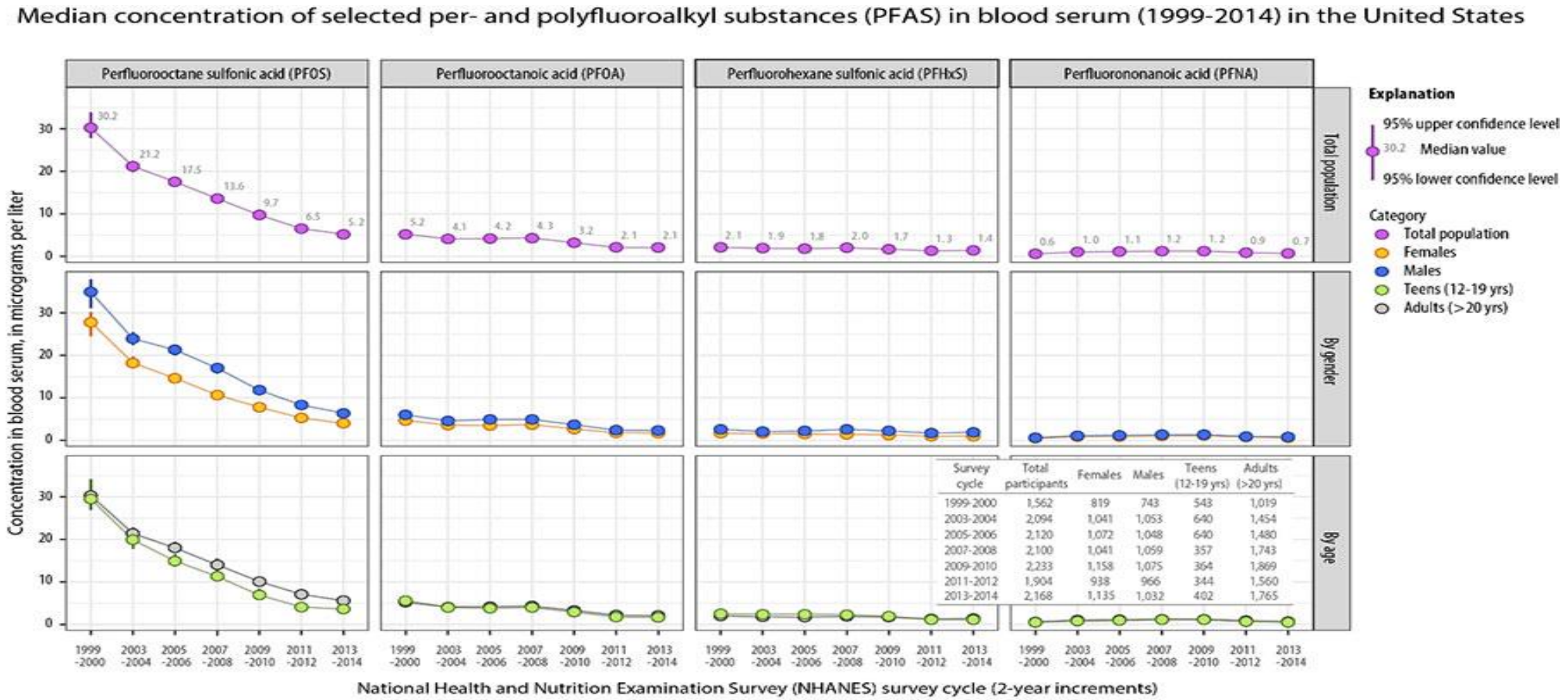
# PFAS Levels in U.S. Population Over Time

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Source: ATSDR, 2018

# Our Partners

- Centers for Disease Control and Prevention (CDC)
- Association of State and Territorial Health Officials (ASTHO)
- Agency for Toxic Substances and Disease Registry (ATSDR)
- Bucks County Health Department
- Montgomery County Health Department
- New York State Health Department Laboratory
- Department of Environmental Protection (DEP)

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# Knowledge Gaps

- Key knowledge gaps in the following areas:
  - Toxicology
    - Need more longitudinal Epidemiological studies
  - Regulation – Need to develop MCLs
    - Primarily apply to PFOS/PFOA- need more research on complex mixtures & emerging contaminants
  - Protocols for environmental sampling and analysis
  - Need more research to understand fate and transport

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# Ongoing Work

- ATSDR is working to provide health-based guidelines on tolerable levels in water
- Department of Defense is funding 10-million dollar national study on PFAS - exposure assessment and health assessment
- DOH attending webinars/continuing education on PFAS research and remediation
- National Toxicology Program (NTP) - actively funding research studies
  - Investigating PFC chain length and toxicity relationships
  - Doing invitro studies on
    - Brain neurotoxicity, immune effects, behavioral disorders, cellular toxicity
    - TOX21- testing for toxicity in human/animal cells through robotics screening facility

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# Contact Information

**Should you have any questions or concerns, feel free to contact us at env.health.concern@pa.gov or by phone at 717-787-3350**

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# PEATT Pilot Project Team

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