Defense Health Agency – Public Health

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DoD Firefighter Per- and Polyfluoroalkyl Substances (PFAS) Blood (Serum) Surveillance Report and Trend Analysis, FY 2024

October 1, 2023–September 30, 2024

Prepared July 1, 2025

DCPH-P-EDC-TR-195-2025

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Executive Summary

Background

Since October 2020, the Department of Defense (DoD), tasked under the National Defense Appropriations Authorization Act 2020 (Section 707) and codified in DoD Manual (DoDM) 6055.05, has offered blood testing to DoD firefighters at their annual exams for the purpose of determining their exposure to per- and polyfluoroalkyl substances (PFAS). The objective of this report is to describe the blood PFAS levels in the DoD firefighter population. Blood PFAS levels are determined using the Centers for Disease Control and Prevention (CDC) analytical methodology and reported using the same univariate statistics used by the CDC to describe blood PFAS levels in the general population.

This report summarizes the blood PFAS analytical results obtained from the analysis of DoD firefighter blood tested in fiscal years (FY) 2023–2024. Summary statistics calculated and included in this report include compound-specific and aggregated geometric means, a maximum result value, and a 95th confidence interval about the geometric mean. These results and selected PFAS results from FY 2021 through FY 2023 were further evaluated for overall trends, and trends by age and sex. The report describes the total number of DoD firefighters tested by service, age, and sex, for Total Blood PFAS and individual PFAS compounds. Please note that the purpose of evaluating the Total Blood PFAS in DoD firefighters is arbitrary and included in this report to provide a single value to evaluate PFAS blood levels from all PFAS compounds. However, it should not be used to assess the potential risk of adverse health outcomes that might be associated with PFAS in firefighters.

The blood PFAS levels in DoD firefighters reflect their total exposure to PFAS from all potential routes of exposure (e.g., consumption of food and water, inhalation of vapors and particulates in air, and skin contact) and all potential sources of PFAS (i.e., work and non-work exposures). Currently, DoD firefighter blood analytical results for PFAS, by themselves, do not allow for the determination of the magnitude and timing of PFAS exposures or the likely source of PFAS exposures. Planned implementation of a Firefighter Exposure Questionnaire (FEQ) in FY 2026 will provide important information necessary for determining potential occupational exposures in DoD firefighters.

Key Results

In FY 2024, linear perfluorooctane sulfonic acid (PFOS) and perfluorohexane sulfonic acid (PFHxS) were the PFAS analytes with the highest geometric mean blood PFAS concentrations. PFOS and PFHxS are known to have long half-lives and may remain in the body longer than other PFAS analytes, which is consistent with published literature. PFAS geometric means presented in this report are similar to the most recent (2017–2018) National Health and Nutrition Examination Survey (NHANES) report of blood PFAS levels detected in the general population. Also consistent with published literature, male firefighters generally had higher blood PFAS levels than female firefighters, and older DoD firefighters generally had higher geometric mean blood PFAS concentrations than younger firefighters. Results from the trend analysis showed a statistically significant downward trend for most PFAS analytes across FYs 2021–2024.

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Acknowledgments/Contributions

Defense Centers for Public Health – Portsmouth, EpiData Center
Navy and Marine Corps Force Health Protection Command, Environmental Health Directorate, Environmental Programs Department
Office of the Assistant Secretary of Defense for Health Affairs

Background

PFAS are a large and complex class of synthetic fluorinated chemicals that confer water, oil, and grease resistant properties to manufactured goods like textiles and food packaging.[1,2] Industries widely use PFAS to provide these properties to manufactured goods, protect materials from damage by corrosive chemicals and high heat, insulate electrical components, reduce friction, and for use as a surfactant in industrial processes. Small amounts of certain surfactant PFAS are used in aqueous film forming foams (AFFF) to quickly extinguish hydrocarbon fueled fires and keep them from reigniting. AFFF is a mission-critical fire suppressant for the DoD because it quickly extinguishes fires, saving lives and materials.[3]

Many PFAS are highly resistant to degradation in the environment. They are called "forever chemicals" because they are very persistent in the environment and are detected in air, water, soils, and sediments around the world.[4] These same PFAS are also highly resistant to degradation by living organisms and can accumulate in their bodies by binding to certain tissue proteins and predominately blood proteins.[5] These PFAS have a long half-life in the human body, measured in years, because they are actively reabsorbed from the gut and kidneys.[6] Because of this, an individual's exposure to PFAS is generally best measured by assessing their level in blood.

Currently, there are no established health-based reference levels for PFAS in blood. Some observational studies have reported an association between high levels of certain PFAS in human blood and the occurrence of adverse health outcomes including decreased vaccine response, disruption of thyroid hormone status, certain cancers (e.g., kidney and testis), pre-eclampsia and hypertension in pregnant women, decreased birth weight, and effects in the liver (i.e., dyslipidemia, increased serum cholesterol, and changes in liver enzymes). [7] The CDC is conducting a large research effort to determine whether there are health effects in people exposed to PFAS.[8,9] The CDC reports that several PFAS (i.e., PFHxS, PFOS, perfluorooctanoic acid [PFOA], and perfluorononanoic acid [PFNA]) are found in the serum of nearly all U.S. people tested.[5] While blood PFAS levels are the most useful measure of an individual's total exposure to PFAS, they cannot identify the time, magnitude, frequency, or source of exposure and cannot be used to determine any potential health effects associated with PFAS exposures.[10]

Beginning on October 1, 2020, DoD firefighters were offered blood testing to assess six target PFAS analytes (i.e., perfluorobutane sulfonic acid [PFBS], perfluoroheptanoic acid [PFHpA], PFHxS, PFNA, and linear isomers of PFOA and PFOS). These blood samples were sent to a single, Clinical Laboratory Improvement Amendments (CLIA) certified laboratory for analysis using a proprietary analytical methodology. On May 1, 2023, the DoD implemented the CDC PFAS analytical methodology and expanded the number of target PFAS analytes to be assessed in DoD firefighter blood to include the following: PFBS, PFHpA, PFHxS, PFNA, perfluorodecanoic acid (PFDA), perfluoroundecanoic acid (PFUnDA), perfluoroheptane sulfonic acid (PFHpS), perfluorohexanoic acid (PFHxA), 2-(N-Methyl-perfluorooctane sulfonamido) acetic acid (MeFOSAA), 4,8-dioxa-3H-perfluorononanoic acid (ADONA), perfluorododecanoic acid (PFDoDA), and both linear and branched chain isomers of PFOA and PFOS.[10] These target PFAS analytes have been associated with historical AFFF formulations and/or identified in firefighters' blood.[10] Using the CDC analytical methodology

allows a direct comparison of DoD firefighter blood PFAS levels to those of age-matched individuals in the general U.S. population for select years (assessed by the CDC and reported in NHANES).[11] The blood PFAS levels in DoD firefighters measured before May 1, 2023, using the proprietary analytical methodology, are not comparable to those obtained by the CDC from the general population and reported in NHANES due to differences in these analytical methodologies.

The focus of this report is the blood (serum) PFAS analytical results from DoD firefighters tested from October 1, 2023 through September 30, 2024. These results are compared to the most recently reported blood PFAS levels in the U.S. general population reported in NHANES.[11] PFAS analytes with a calculated geometric mean were used to evaluate PFAS accumulation in DoD firefighters by sex and age. DoD firefighter serum levels of three PFAS (i.e., the linear isomer of PFOA, PFHxS, and PFNA), whose geometric mean levels were determined to be comparable between proprietary and CDC analytical methodologies, were assessed for trend over FYs 2021–2024. DoD firefighter serum levels of target blood PFAS analytes, assessed using the CDC analytical methodology, were assessed for trend over FYs 2023–2024.

A glossary of terms and abbreviations used throughout this report, including all analytes, is provided in Appendix A.

Methods

Data Source and Analytical Methodology

PFAS blood testing was offered to DoD firefighters at their annual occupational health examinations. This report presents blood PFAS test results reported from October 1, 2023 through September 30, 2024 (FY 2024). All DoD firefighter blood PFAS sample testing was performed by the National Medical Service (NMS) Labs, a CLIA-certified laboratory. The use of a CLIA-certified laboratory allows for the individual DoD firefighter's laboratory report to be attached to their medical record.

The DoD adopted the CDC analytical methodology for analyzing all DoD firefighter blood PFAS samples collected after May 1, 2023. Concurrently, the DoD adopted an expanded target PFAS analyte list to characterize DoD firefighter PFAS exposures more fully. The expanded target PFAS analyte list includes MeFOSAA, PFHxS, PFHpS, PFHxA, PFNA, PFDA, PFUnDA, PFDoDA, ADONA, and both linear and branched isomers of PFOS and PFOA. The limit of detection (LOD) for the CDC analytical methodology is 0.1 nanograms per milliliter (ng/mL). Prior to May 1, 2023, NMS Labs used a proprietary analytical methodology to assess six PFAS analytes in firefighter blood serum: PFBS, PFHpA, PFHxS, PFNA, and linear isomers of PFOS and PFOA. The LOD for this proprietary analytical methodology was 0.05 ng/mL.

Historic blood PFAS analytical data from DoD firefighters tested during FYs 2021, 2022, and 2023 using the proprietary analytical method were used to conduct statistical trending of three PFAS target analytes (i.e., linear PFOA, PFHxS, and PFNA). The results of the proprietary analysis of these three PFAS analytes were determined to be comparable to the results obtained from the CDC analytical methodology. DoD firefighter demographic information was obtained from the Defense Enrollment Eligibility Reporting System and the Defense Manpower Data Center.

For various reasons, a DoD firefighter's blood PFAS levels may have been sampled and analyzed more than once during a reporting period. Some individuals were tested multiple times within a FY or had two valid test panels from the same collection date with different PFAS analyte values (not

duplicates). For these individuals, the following approach was used to determine which tests to retain for analysis:

- If 2 or more tests were conducted within 30 days from each other during the same FY (a virtual duplicate), a relative percent difference (RPD) was calculated for the 2 results:
    - If the RPD of the multiple test results was greater than 20%, it was assumed that 1 of the analytical results was in error, and the later test result was arbitrarily selected for use in all subsequent data evaluations.
    - If the RPD was less than 20%, the samples were considered to be duplicates and the highest analytical result was used in all subsequent data evaluations.
- If a firefighter had multiple blood PFAS test results in the same FY which were more than 30 days apart, all blood PFAS test results were included in this analysis. While this provides multiple contributions from a single individual to the sampled firefighter population, the inclusion of all individual samples is unlikely to significantly impact population statistics and reflects changes in blood PFAS levels resulting from potential exposure to and clearance/elimination of PFAS during the interval between the samples.

Total Blood PFAS Measures

Individual PFAS analytes reported in FY 2024 include: MeFOSAA, PFHxS, PFHpS, PFHxA, PFNA, PFDA, PFUnDA, PFDoDA, ADONA, both linear and branched isomers of PFOS and PFOA, and Total isomers of PFOS and PFOA.

The measure of Total Blood PFAS was computed as the sum of PFAS analytes for which a geometric mean could be calculated. The Total Blood PFAS level was used to estimate a DoD firefighter's total exposure to PFAS from all sources. The Total Blood PFAS excludes Total PFOA and Total PFOS, as these measures duplicate their respective, individual linear and branched analyte tests included in Total Blood PFAS.

Total Blood PFAS used in the FYs 2021–2024 trend analysis includes only linear PFOA, PFHxS, and PFNA measured by both the proprietary and CDC analytical methodologies. These analytes were selected because split samples did not yield statistically different results when assessed using either of these analytical methodologies. Although the linear isomer of PFOS is common to both testing methodologies, it was not included because the proprietary and CDC analytical methods detected statistically dissimilar concentrations in split blood samples.[12] Due to differences in individual PFAS toxicities (e.g., different dose-responses for different effects in various target tissues), Total Blood PFAS levels cannot be used, at this time, to determine the potential risk to human health.[7]

Statistical Analyses

This analysis followed the same statistical procedures as the CDC in reporting blood PFAS levels. The analysis of FY 2024 samples included univariate statistics (total number of tests performed, geometric mean, and maximum concentration levels) for each of the target PFAS analytes.[13] Analytical results below the LOD (0.1 ng/mL) or with a test result of "None Detected" were reported as "less than the Limit of Detection" or "<LOD." To compute geometric means for CDC analytical methodology results, values below LOD were calculated as the LOD divided by the square root of two (0.085 ng/mL). If more than 40% of a PFAS analyte's test results were below the LOD, a geometric mean was not calculated. Blood PFAS results were stratified by age group (in years) and sex (male or

female) to evaluate differences of PFAS analyte concentrations in these groups. The analyses of individual PFAS by age group and sex are presented in Appendices B–D.

A trend analysis of DoD firefighter blood PFAS levels was performed over FYs 2021–2024. This analysis evaluated Total Blood PFAS as the sum of the individual analytes of PFHxS, linear PFOA, and PFNA over this time frame. Blood PFAS levels were log transformed due to the non-normal distributions of these concentration data. Only DoD firefighters with blood PFAS tests results in each year (FYs 2021–2024) were included in this trend analysis (n=1,382). Linear mixed effects models were conducted to determine whether the differences in blood PFAS levels in FYs 2021–2024 were statistically significant.

A second trend analysis was conducted to compare the blood PFAS levels from DoD firefighters participating in the blood PFAS testing in both FYs 2023 and 2024. This analysis also evaluated Total Blood PFAS, which was calculated as the sum of individual PFAS analytes for which a geometric mean could be determined (i.e., PFHxS, PFHpS, linear and branched PFOS, linear PFOA, and PFNA). A Wilcoxon signed-rank test was used to evaluate whether there was a statistically significant difference for individual PFAS analytes and Total Blood PFAS between FYs 2023 and 2024. The Wilcoxon signed-rank test was used due to the non-normal distribution of the concentration data. Only DoD firefighters with data in each year (FYs 2023 and 2024) were included in this second trend analysis (N=1,830).

Results

Tables 1 and 2 provide the blood PFAS analytical results of 8,150 firefighters who participated in blood PFAS testing in FY 2024. Table 1 displays the unique number and percentage of DoD firefighters participating in blood PFAS testing by service. Table 2 displays the number of valid PFAS laboratory serum samples tested and the univariate statistics (i.e., geometric mean, 95% confidence interval [CI] on the geometric mean, and the maximum detected level) for the target PFAS analytes tested in FY 2024. Valid test results include numeric test values and results below the LOD, while invalid test results include records where the test was cancelled or not performed.

Table 2 also includes the PFAS analytes, along with the geometric means and their associated 95% CIs reported in the latest CDC-NHANES report.[14] The latest CDC-NHANES report characterizes the blood PFAS levels in less than 2,000 individuals randomly selected for blood PFAS analyses in 2017–2018 (with the exception of PFDoDA, collected in 2015–2016). Comparing DoD firefighter blood PFAS levels in FY 2024 with those individuals reported by the CDC in NHANES is appropriate from an analytical perspective. However, caution should be exercised, as blood PFAS levels continue to decrease in each subsequent year of analytical testing, and the CDC-NHANES blood PFAS levels reported in 2015–2018 are from samples generally collected 6 to 8 years earlier than those reported here for DoD firefighters. Additionally, the firefighter results in Table 2 have not been adjusted for age and sex. A geometric mean was not determined for the following 7 PFAS analytes since 40% of the test results were below the LOD: MeFOSAA, PFHxA, branched PFOA, PFDA, PFUnDA, PFDoDA, and ADONA.

Welch's t-tests were conducted to compare geometric means of DoD firefighters in FY 2024 with the CDC NHANES sample (2017–2018). DoD firefighters had a statistically significantly higher geometric mean for PFHxS ($p<.001$) and statistically significantly lower geometric means for PFHpS, branched PFOS, Total and branched PFOA, and PFNA ($p<.001$ for all). There was no statistically significant difference in geometric means for Total PFOS and linear PFOS. Due to the difference in collection dates between the samples, these results have limitations and should be interpreted with caution.

Figures 1 through 16 provide a graphical representation of the fraction of DoD firefighters with specific blood PFAS analytical results for all target PFAS analytes assessed and Total Blood PFAS. To visualize the distribution of individual PFAS analyte blood analytical results, the x-axis values are truncated, and histogram bar widths (concentration bins) are arbitrarily assigned to provide visual resolution to each distribution.

Table 3 displays the number and percentage of DoD firefighters tested during FY 2024 by age group. Age groups were categorized to reflect approximately 15% of the tested population using 5-year intervals. Figure 17 displays the Total Blood PFAS levels by age group. Figure 18 shows the geometric means of PFAS analytes by age group. Appendix B presents more detail regarding the age distribution of blood PFAS analyte levels depicted in Figure 18.

Table 4 provides the number and distribution of DoD firefighters tested during FY 2024 by sex. Figure 19 shows Total Blood PFAS levels by sex, and Figure 20 displays the geometric means of blood PFAS analyte levels by sex. Appendix C includes more detail on the distribution of blood PFAS analyte levels by sex.

Table 5 shows the breakdown of DoD firefighters tested during FY 2024 by age group and sex. Figure 21 illustrates the Total Blood PFAS levels in DoD firefighters by age group, stratified by sex. Figures 22 and 23 show geometric means of blood PFAS analytes, stratified by sex. Appendix D includes tables with the total number of valid tests, geometric means, and maximum concentration levels for PFAS analytes (excluding those PFAS for which a geometric mean was not calculated) by age group for both female and male firefighters during FY 2024.

Table 6 displays the total number of valid tests and geometric means for the three PFAS analytes (PFHxS, PFNA, and linear PFOA) used to estimate the Total Blood PFAS levels in DoD firefighters tested in FYs 2021–2024. Results from the linear mixed effects models indicates a statistically significant downward trend ($p<.001$) for each of these PFAS analytes and Total Blood PFAS over FYs 2021–2024.

Table 7 contains the total number of valid tests and geometric means for PFAS analytes (PFHxS, PFHpS, linear PFOS, branched PFOS, Total PFOS, linear PFOA, Total PFOA and PFNA) and Total Blood PFAS levels for firefighters tested in FYs 2023 and 2024. Results of the Wilcoxon signed-rank test for Total Blood PFAS and the following individual PFAS analytes decreased significantly from FY 2023 to FY 2024 ($p<.001$ for all): PFHpS, branched PFOS, linear PFOA, and PFNA. Results showed no statistically significant difference in blood PFAS levels for PFHxS and linear PFOS over this time frame.

FY 2024 PFAS Testing by Service Branch

Table 1. Participating DoD Firefighters Tested for PFAS by Service Branch, FY 2024 (October 1, 2023–September 30, 2024)

Service Branch	Total Participants Tested	Percent (%)
Air Force	3,490	42.8
Army	857	10.5
Marine Corps	897	11.0
Navy	836	10.3
Unknown/Other*	2,070	25.3
Total	**8,150**	**100.0**

Data Sources: LabCorp, Defense Enrollment Eligibility Reporting System (DEERS), and the Defense Manpower Data Center (DMDC).
Abbreviations: DoD, Department of Defense; PFAS, per- and polyfluoroalkyl substances; FY, fiscal year.
*All firefighters classified as "Unknown/Other" were civilians.
Includes service members (SMs) and civilian firefighters.
Prepared by the EpiData Center, Defense Centers for Public Health - Portsmouth on April 08, 2025.

PFAS Analyte Univariate Statistics and Measures of Central Tendency

Table 2. PFAS Laboratory Testing Among Participating DoD Firefighters in FY 2024 (October 1, 2023–September 30, 2024) Compared to CDC NHANES Report (2015–2018)

Analyte	Total Valid Tests	Below Limit of Detection (%)[a]	95th Percentile (ng/mL)[b]	No. of Firefighters >95th Percentile	Maximum Value (ng/mL)	Geometric Mean (ng/mL)[c,d]	CDC NHANES** Geometric Mean (ng/mL)[c,d]
MeFOSAA	8,427	96.93	<LOD	259	5.60	*	0.13 (0.12–0.14)
PFHxS	8,428	0.72	7.80	415	240.00	1.70 (1.66–1.73)	1.11 (1.03–1.21)
PFHpS	8,427	35.91	0.65	415	14.00	0.15 (0.15–0.16)	0.23 (0.20–0.28)
Total PFOS	8,428	1.57	17.80	421	236.00	4.13 (4.04–4.21)	4.50 (4.15–4.89)
Linear PFOS	8,428	1.61	14.00	398	180.00	3.21 (3.15–3.28)	3.11 (2.86–3.38)
Branched PFOS	8,428	3.11	3.80	397	56.00	0.95 (0.94–0.97)	1.31 (1.18–1.44)
PFHxA	8,427	99.98	<LOD	2	0.12	*	*
Total PFOA	8,420	0.67	2.2	368	17.00	0.91 (0.90–0.92)	1.45 (1.35–1.56)
Linear PFOA	8,427	0.66	2.20	368	17.00	0.91 (0.90–0.92)	1.36 (1.26–1.46)
Branched PFOA	8,420	99.93	<LOD	6	0.96	*	*
PFNA	8,428	2.31	0.71	407	6.30	0.29 (0.28–0.29)	0.42 (0.37–0.47)
PFDA	8,426	56.42	0.32	393	9.10	*	0.20 (0.18–0.22)
PFUnDA	8,428	77.43	0.23	416	3.50	*	0.13 (0.12–0.14)
PFDoDA	8,428	99.10	<LOD	76	3.60	*	*
ADONA	8,428	100.00	<LOD	0	<LOD	*	*

Data Sources: LabCorp, CDC NHANES (2017–2018, 2015–2016 for PFDoDA).

[a]Percent of the samples with a value below the applicable limit of detection (LOD) of 0.1 ng/mL.

[b]Represents the point at which 5% of the serum samples in the cohort exceeds that value.

[c]95% Confidence Limits were calculated for the geometric mean.

[d]Welch's t-tests were conducted to compare geometric means of these samples. DoD firefighters had a statistically significantly higher geometric mean for PFHxS ($p<.001$) and statistically significantly lower geometric means for PFHpS, branched PFOS, Total PFOA, branched PFOA and PFNA ($p<.001$ for all). There was no statistically significant difference in geometric means at the $p<.01$ level for Total PFOS and linear PFOS. Due to the difference in collection dates between the samples, these results have limitations and should be interpreted with caution.

*Not calculated: proportion of results below LOD was too high to provide a valid result.

**Data includes individuals aged 20 years and over for most recent survey years (2015–2018).

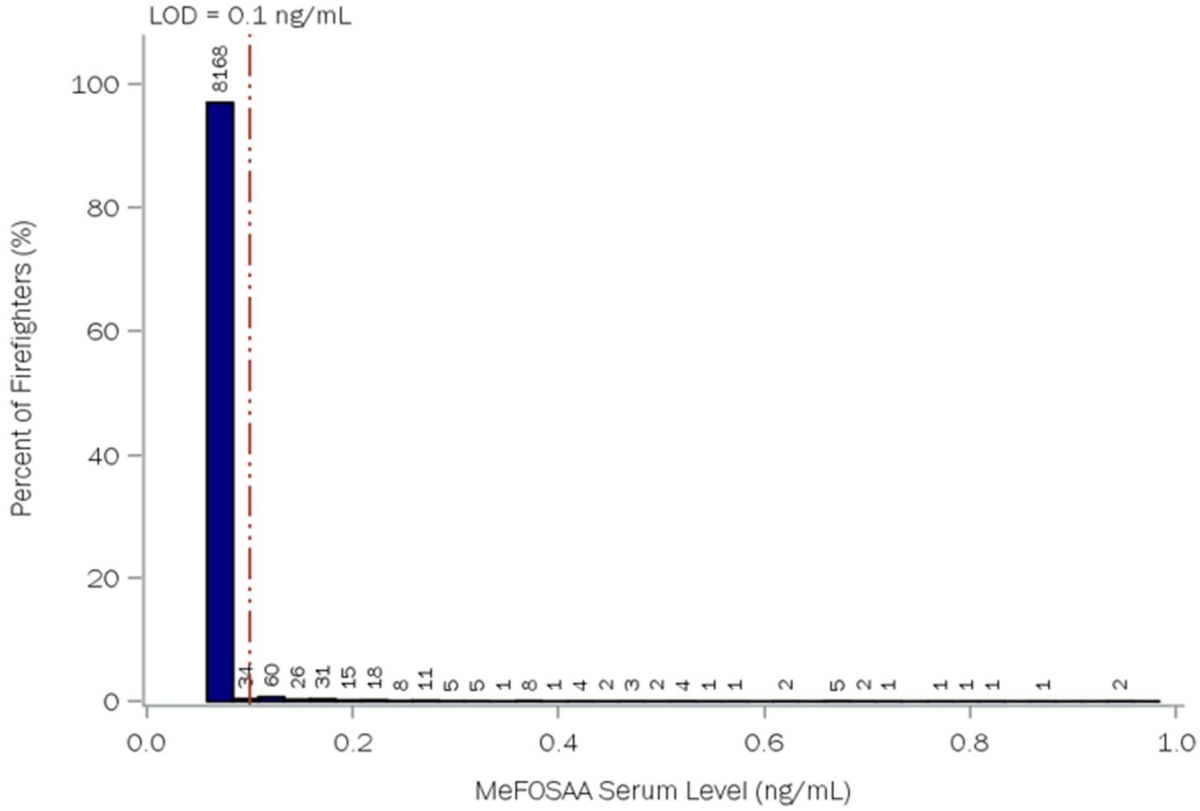
Abbreviations: PFAS, per- and polyfluoroalkyl substances; DoD, Department of Defense; CDC, Centers for Disease Control and Prevention; NHANES, National Health and Nutrition Examination Survey; FY, fiscal year; MeFOSAA, 2-(N-methyl-perfluorooctane sulfonamido) acetic acid; PFHxS, perfluorohexane sulfonic acid; PFHpS, perfluoroheptane sulfonic acid; PFOS, perfluorooctane sulfonic acid; PFHxA, perfluorohexanoic acid; PFOA, perfluorooctanoic acid; PFNA, perfluorononanoic acid; PFDA, perfluorodecanoic acid; PFUnDA, perfluoroundecanoic acid; PFDoDA, perfluorododecanoic acid; ADONA, 4,8-dioxa-3H-perfluorononanoic acid.

Includes service members (SMs) and civilian firefighters.

Prepared by the EpiData Center, Defense Centers for Public Health - Portsmouth on April 08, 2025.

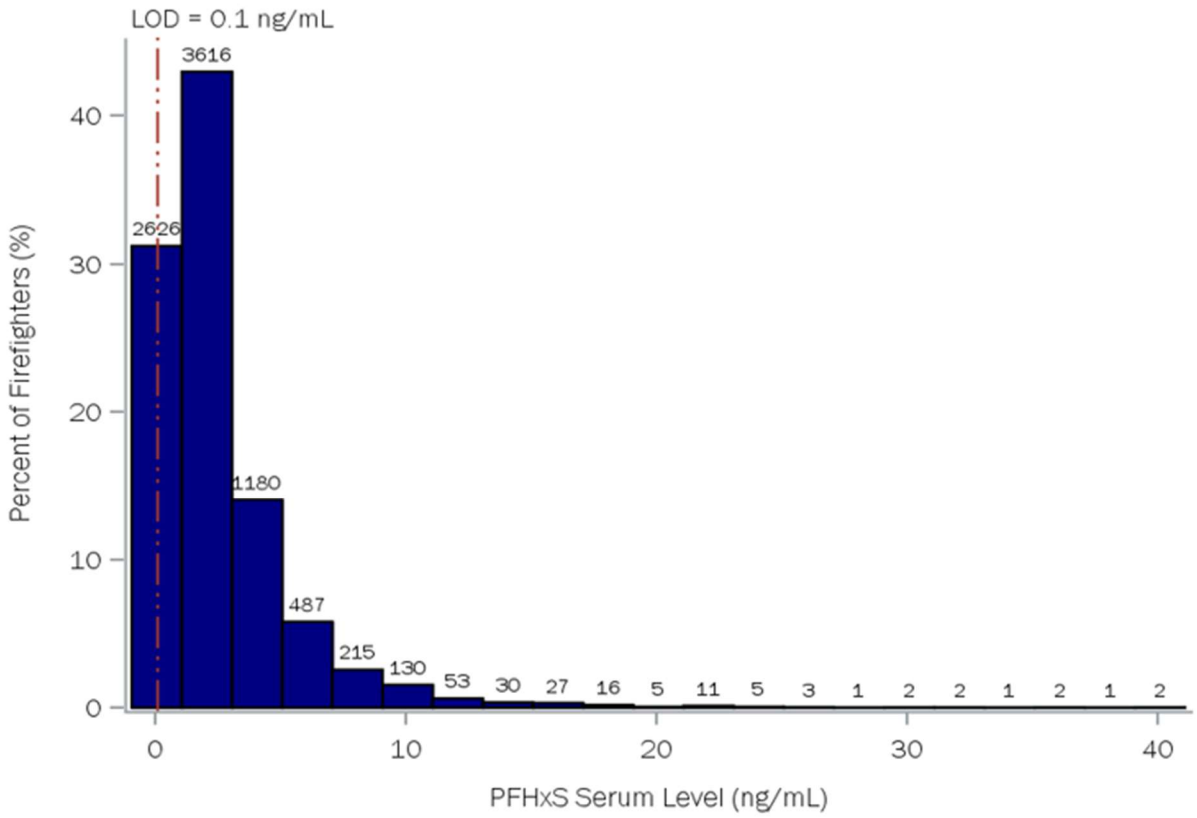
Percent Distribution of Analytical Results by PFAS Analyte

Figure 1. Percent Distribution of MeFOSAA Testing Results Among Participating DoD Firefighters (n=8,427), FY 2024 (October 1, 2023–September 30, 2024)



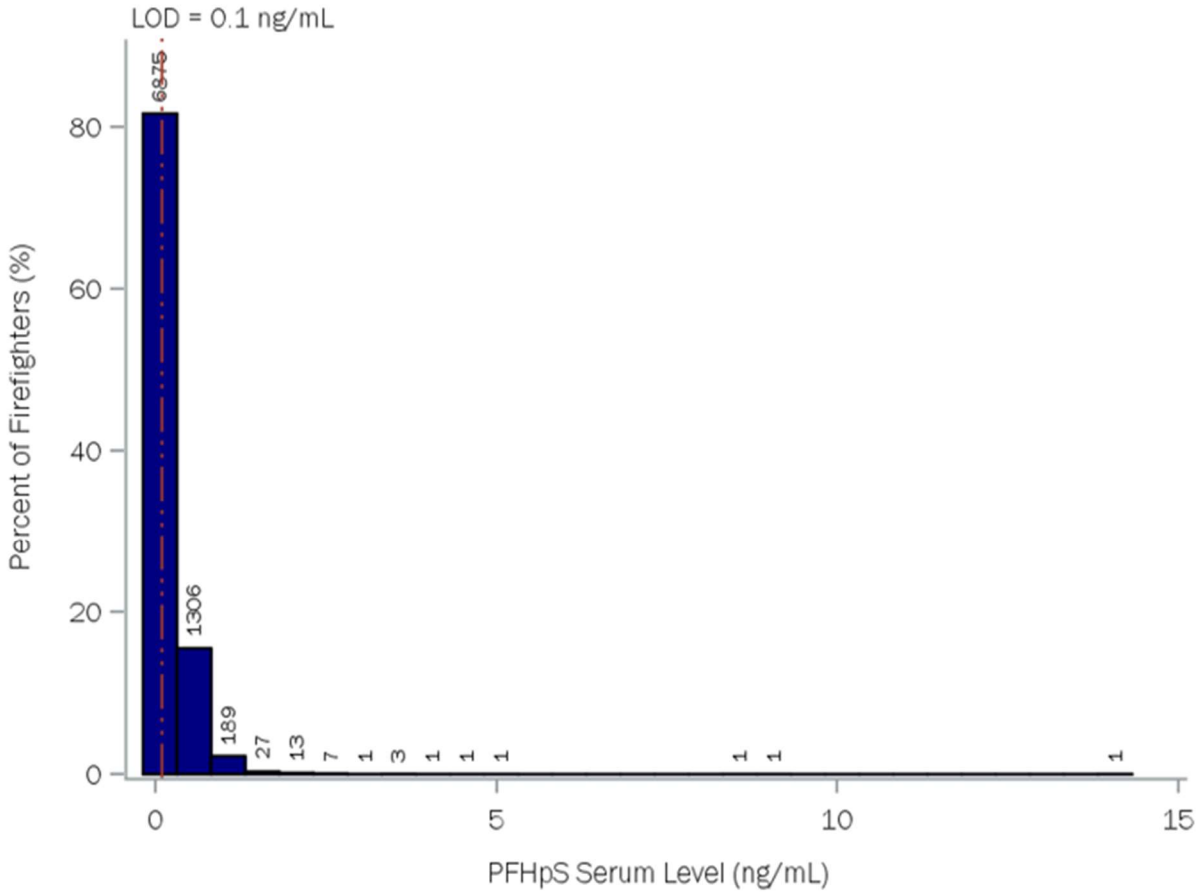
Data Source: LabCorp.
Abbreviations: MeFOSAA, 2-(N-methyl-perfluorooctane sulfonamido) acetic acid; DoD, Department of Defense; FY, fiscal year; PFAS, per- and polyfluoroalkyl substances.
Figure includes service members (SMs) and civilian firefighters.
The distribution of firefighters with blood MeFOSAA serum is displayed in histogram bars (concentration bins) reflecting measured concentrations that are equal to or less than 1 ng/mL. The truncation of the x-axis and width of concentration bins were arbitrarily assigned to provide visual resolution to the distribution. There were 3 values above 1 ng/mL.
The number of records below the limit of detection (LOD)=8,168 (96.93%). The LOD is 0.1 ng/mL.
Prepared by the EpiData Center, Defense Centers for Public Health - Portsmouth on April 12, 2025.

Figure 2. Percent Distribution of PFHxS Testing Results Among Participating DoD Firefighters (n=8,428), FY 2024 (October 1, 2023–September 30, 2024)



Data Source: LabCorp.
Abbreviations: PFHxS, perfluorohexane sulfonic acid; DoD, Department of Defense; FY, fiscal year; PFAS, per- and polyfluoroalkyl substances.
Figure includes service members (SMs) and civilian firefighters.
The distribution of firefighters with blood PFHxS serum is displayed in histogram bars (concentration bins) reflecting measured concentrations that are equal to or less than 40 ng/mL. The truncation of the x-axis and width of concentration bins were arbitrarily assigned to provide visual resolution to the distribution. There were 13 values above 40 ng/mL.
The number of records below the limit of detection (LOD)=61 (0.72%). The LOD is 0.1 ng/mL.
Prepared by the EpiData Center, Defense Centers for Public Health - Portsmouth on April 12, 2025.

Figure 3. Percent Distribution of PFHpS Testing Results Among Participating DoD Firefighters (n=8,427), FY 2024 (October 1, 2023–September 30, 2024)



Data Source: LabCorp.

Abbreviations: PFHpS, perfluoroheptane sulfonic acid; DoD, Department of Defense; FY, fiscal year; PFAS, per- and polyfluoroalkyl substances.

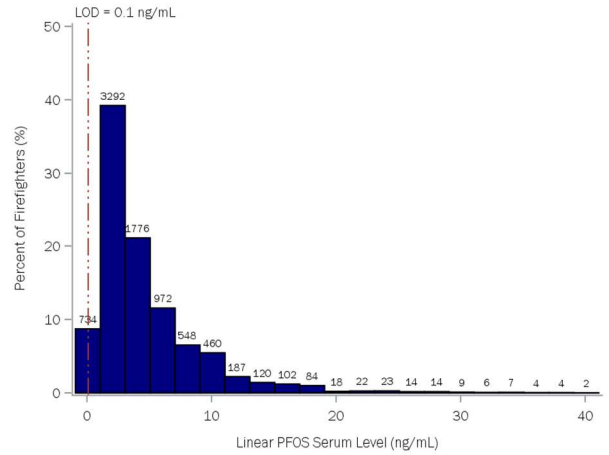
Figure includes service members (SMs) and civilian firefighters.

The distribution of firefighters with blood PFHpS serum is displayed in histogram bars (concentration bins) reflecting measured concentrations that are equal to or less than 15 ng/mL. The truncation of the x-axis and width of concentration bins were arbitrarily assigned to provide visual resolution to the distribution.

The number of records below the limit of detection (LOD)=3,026 (35.9%). The LOD is 0.1 ng/mL.

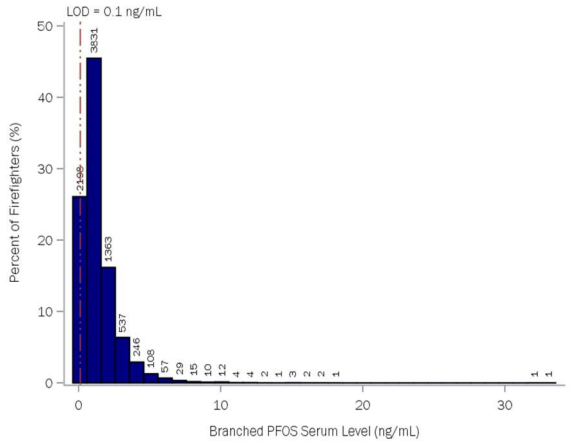
Prepared by the EpiData Center, Defense Centers for Public Health - Portsmouth on April 12, 2025.

Figure 4. Percent Distribution of Linear PFOS Isomers Testing Results Among Participating DoD Firefighters (n=8,428), FY 2024 (October 1, 2023–September 30, 2024)



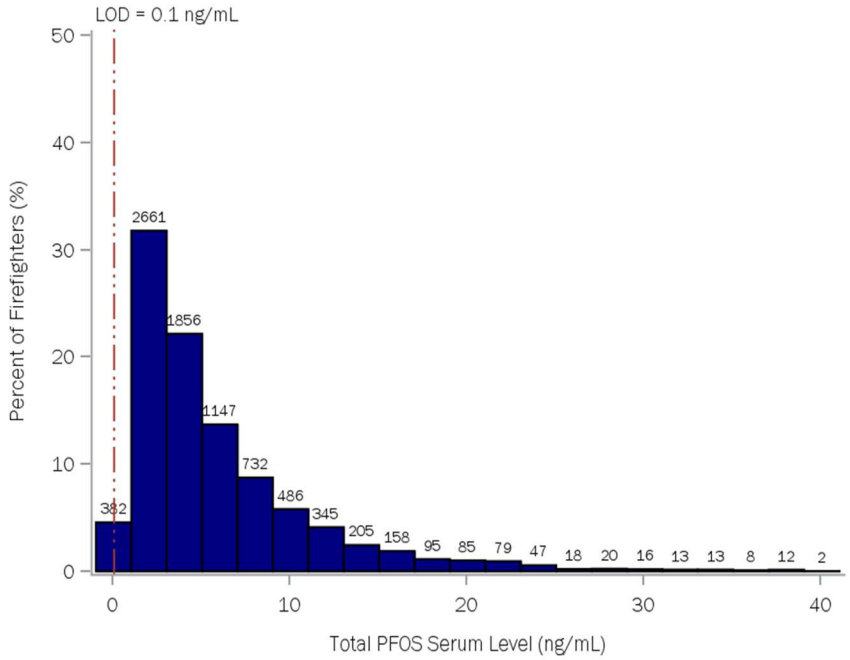
Data Source: LabCorp.
Abbreviations: PFOS, perfluorooctane sulfonic acid; DoD, Department of Defense; FY, fiscal year; PFAS, per- and polyfluoroalkyl substances.
Figure includes service members (SMs) and civilian firefighters.
The distribution of firefighters with blood linear PFOS Isomers serum is displayed in histogram bars (concentration bins) reflecting measured concentrations that are equal to or less than 40 ng/mL. The truncation of the x-axis and width of concentration bins were arbitrarily assigned to provide visual resolution to the distribution. There were 30 values above 40 ng/mL.
The number of records below the limit of detection (LOD)=136 (1.61%). The LOD is 0.1 ng/mL.
Prepared by the EpiData Center, Defense Centers for Public Health - Portsmouth on April 12, 2025.

Figure 5. Percent Distribution of Branched PFOS Isomers Testing Results Among Participating DoD Firefighters (n=8,428), FY 2024 (October 1, 2023–September 30, 2025)



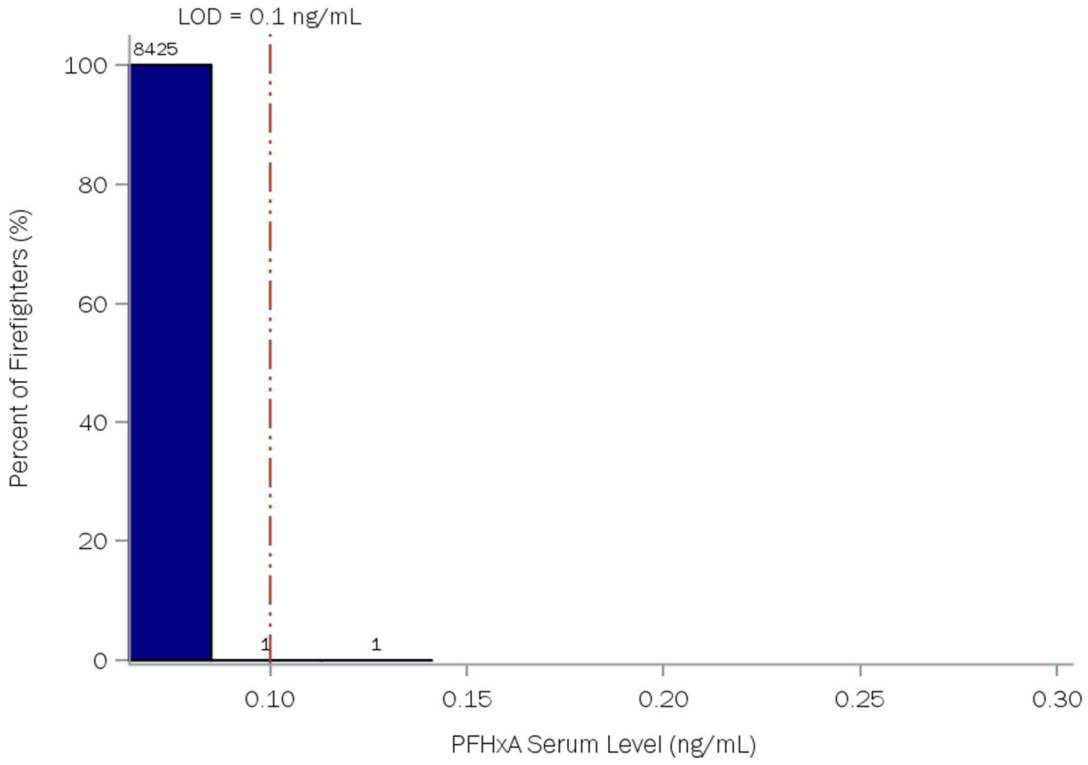
Data Source: LabCorp.
Abbreviations: PFOS, perfluorooctane sulfonic acid; DoD, Department of Defense; FY, fiscal year; PFAS, per- and polyfluoroalkyl substances.
Figure includes service members (SMs) and civilian firefighters.
The distribution of firefighters with blood branched PFOS Isomers serum is displayed in histogram bars (concentration bins) reflecting measured concentrations that are equal to or less than 40 ng/mL. The truncation of the x-axis and width of concentration bins were arbitrarily assigned to provide visual resolution to the distribution. There was 1 values above 40 ng/mL.
The number of records below the limit of detection (LOD)=262 (3.11%). The LOD is 0.1 ng/mL.
Prepared by the EpiData Center, Defense Centers for Public Health - Portsmouth on April 12, 2025.

Figure 6. Percent Distribution of Total PFOS Testing Results Among Participating DoD Firefighters (n=8,428), FY 2024 (October 1, 2023–September 30, 2024)



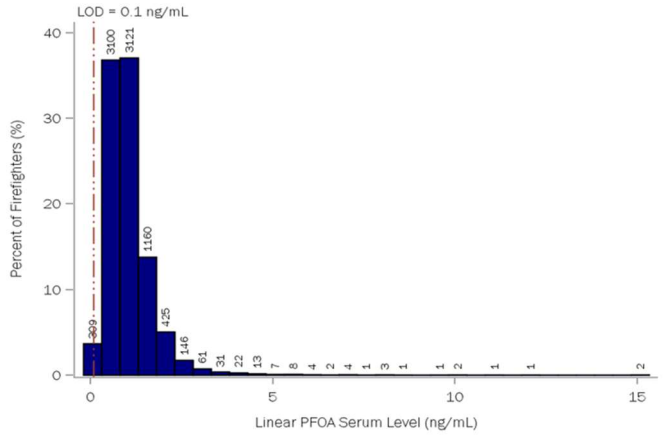
Data Source: LabCorp.
Abbreviations: PFOS, perfluorooctane sulfonic acid; DoD, Department of Defense; FY, fiscal year; PFAS, per- and polyfluoroalkyl substances.
Figure includes service members (SMs) and civilian firefighters.
The distribution of firefighters with blood Total PFOS serum is displayed in histogram bars (concentration bins) reflecting measured concentrations that are equal to or less than 40 ng/mL. The truncation of the x-axis and width of concentration bins were arbitrarily assigned to provide visual resolution to the distribution. There were 48 values above 40 ng/mL.
The number of records below the limit of detection (LOD)=132 (1.57%). The LOD is 0.1 ng/mL.
Prepared by the EpiData Center, Defense Centers for Public Health - Portsmouth on April 12, 2025.

Figure 7. Percent Distribution of PFHxA Testing Results Among Participating DoD Firefighters (n=8,427), FY 2024 (October 1, 2023–September 30, 2024)



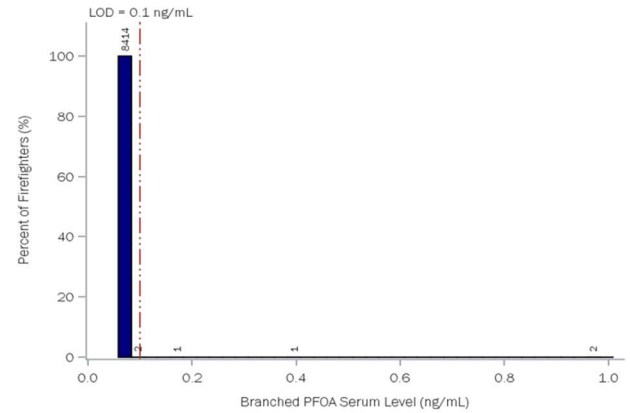
Data Source: LabCorp.
Abbreviations: PFHxA, perfluorohexanoic acid; DoD, Department of Defense; FY, fiscal year; PFAS, per- and polyfluoroalkyl substances.
Figure includes service members (SMs) and civilian firefighters.
The distribution of firefighters with blood PFHxA serum is displayed in histogram bars (concentration bins) reflecting measured concentrations that are equal to or less than 0.30 ng/mL. The truncation of the x-axis and width of concentration bins were arbitrarily assigned to provide visual resolution to the distribution.
The number of records below the limit of detection (LOD)=8,425 (99.98%). The LOD is 0.1 ng/mL.
Prepared by the EpiData Center, Defense Centers for Public Health - Portsmouth on April 12, 2025.

Figure 8. Percent Distribution of Linear PFOA Isomers Testing Results Among Participating DoD Firefighters (n=8,427), FY 2024 (October 1, 2023–September 30, 2024)



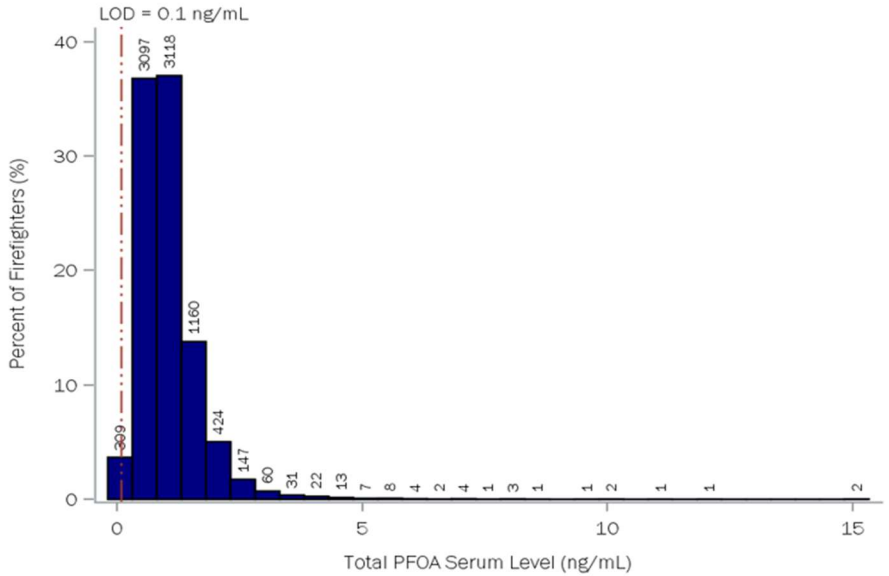
Data Source: LabCorp.
Abbreviations: PFOA, perfluorooctanoic acid; DoD, Department of Defense; FY, fiscal year; PFAS, per- and polyfluoroalkyl substances.
Figure includes service members (SMs) and civilian firefighters.
The distribution of firefighters with blood linear PFOA Isomers serum is displayed in histogram bars (concentration bins) reflecting measured concentrations that are equal to or less than 15 ng/mL. The truncation of the x-axis and width of concentration bins were arbitrarily assigned to provide visual resolution to the distribution. There were 2 values above 15 ng/mL.
The number of records below the limit of detection (LOD)=56 (0.66%). The LOD is 0.1 ng/mL.
Prepared by the EpiData Center, Defense Centers for Public Health - Portsmouth on April 12, 2025.

Figure 9. Percent Distribution of Branched PFOA Isomers Testing Results Among Participating DoD Firefighters (n=8,420), FY 2024 (October 1, 2023–September 30, 2024)



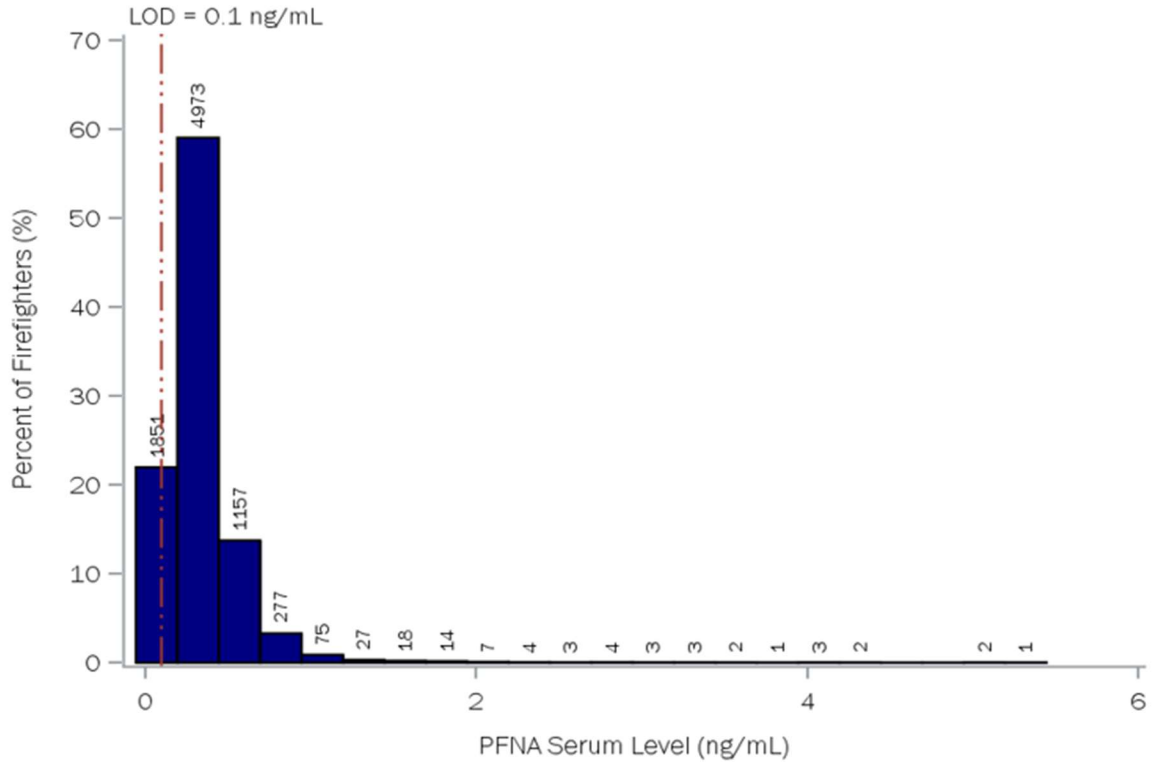
Data Source: LabCorp.
Abbreviations: PFOA, perfluorooctanoic acid; DoD, Department of Defense; FY, fiscal year; PFAS, per- and polyfluoroalkyl substances.
Figure includes service members (SMs) and civilian firefighters.
The distribution of firefighters with blood branched PFOA Isomers serum is displayed in histogram bars (concentration bins) reflecting measured concentrations that are equal to or less than 1.0 ng/mL. The truncation of the x-axis and width of concentration bins were arbitrarily assigned to provide visual resolution to the distribution.
The number of records below the limit of detection (LOD)=8,414 (99.93%). The LOD is 0.1 ng/mL.
Prepared by the EpiData Center, Defense Centers for Public Health - Portsmouth on April 12, 2025.

Figure 10. Percent Distribution of Total PFOA Testing Results Among Participating DoD Firefighters (n=8,420), FY 2024 (October 1, 2023–September 30, 2024)



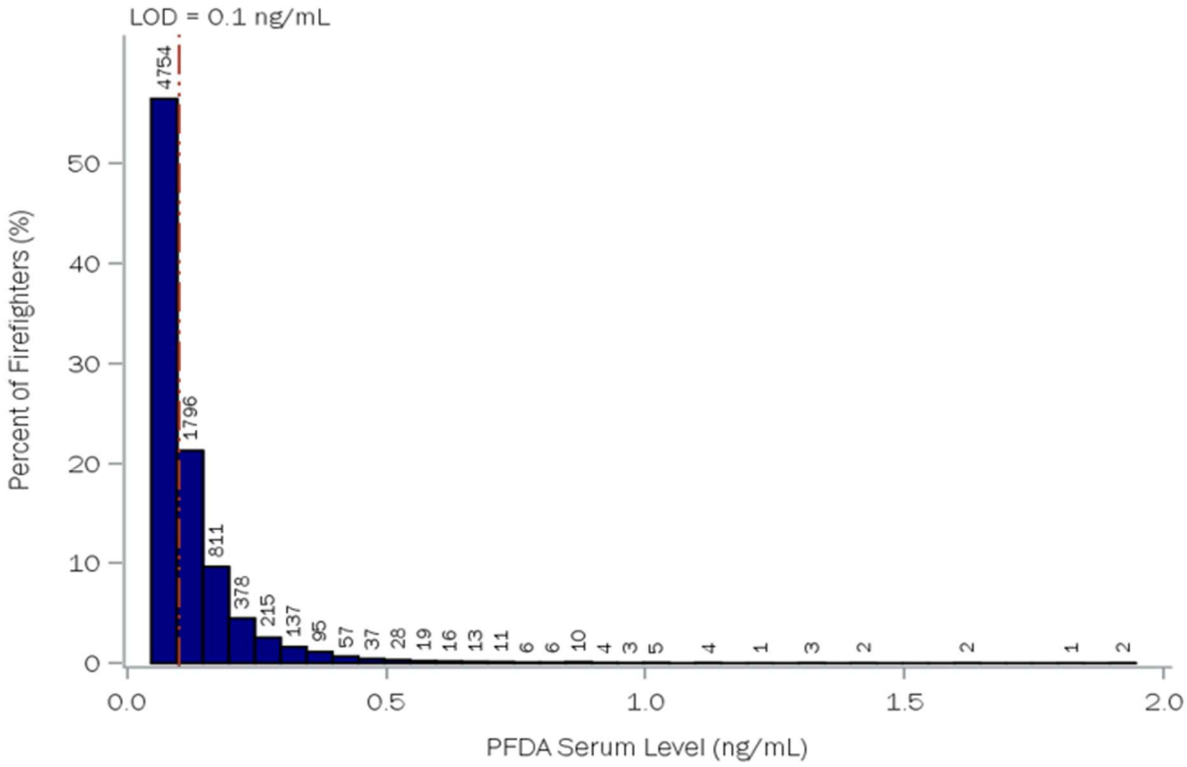
Data Source: LabCorp.
Abbreviations: PFOA, perfluorooctanoic acid; DoD, Department of Defense; FY, fiscal year; PFAS, per- and polyfluoroalkyl substances.
Figure includes service members (SMs) and civilian firefighters.
The distribution of firefighters with blood Total PFOA serum is displayed in histogram bars (concentration bins) reflecting measured concentrations that are equal to or less than 15 ng/mL. The truncation of the x-axis and width of concentration bins were arbitrarily assigned to provide visual resolution to the distribution. There were 2 values above 15 ng/mL.
The number of records below the limit of detection (LOD)=56 (0.67%). The LOD is 0.1 ng/mL.
Prepared by the EpiData Center, Defense Centers for Public Health - Portsmouth on April 12, 2025.

Figure 11. Percent Distribution of PFNA Isomers Testing Results Among Participating DoD Firefighters (n=8,428), FY 2024 (October 1, 2023–September 30, 2024)



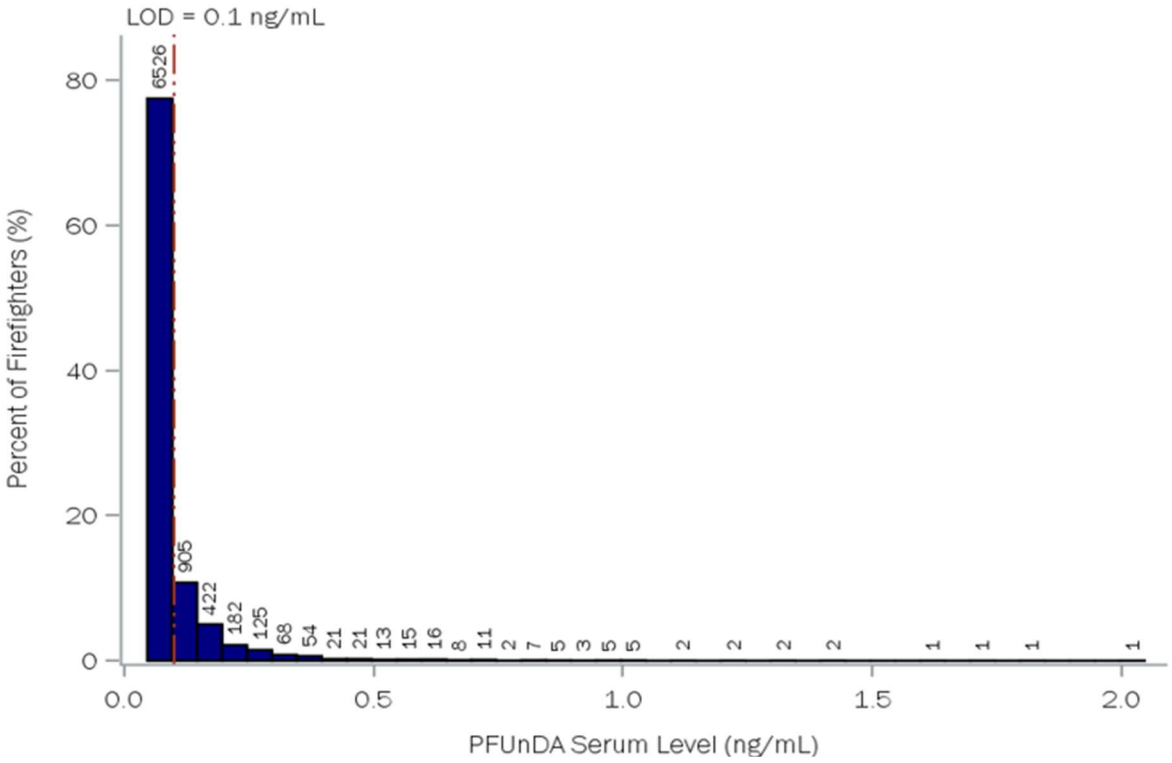
Data Source: LabCorp.
Abbreviations: PFNA, perfluorononanoic acid; DoD, Department of Defense; FY, fiscal year; PFAS, per- and polyfluoroalkyl substances.
Figure includes service members (SMs) and civilian firefighters.
The distribution of firefighters with blood PFNA serum is displayed in histogram bars (concentration bins) reflecting measured concentrations that are equal to or less than 6 ng/mL. The truncation of the x-axis and width of concentration bins were arbitrarily assigned to provide visual resolution to the distribution. There was 1 value above 6 ng/mL.
The number of records below the limit of detection (LOD)=195 (2.31%). The LOD is 0.1 ng/mL.
Prepared by the EpiData Center, Defense Centers for Public Health - Portsmouth on April 15, 2025.

Figure 12. Percent Distribution of PFDA Testing Results Among Participating DoD Firefighters (n=8,426), FY 2024 (October 1, 2023–September 30, 2024)



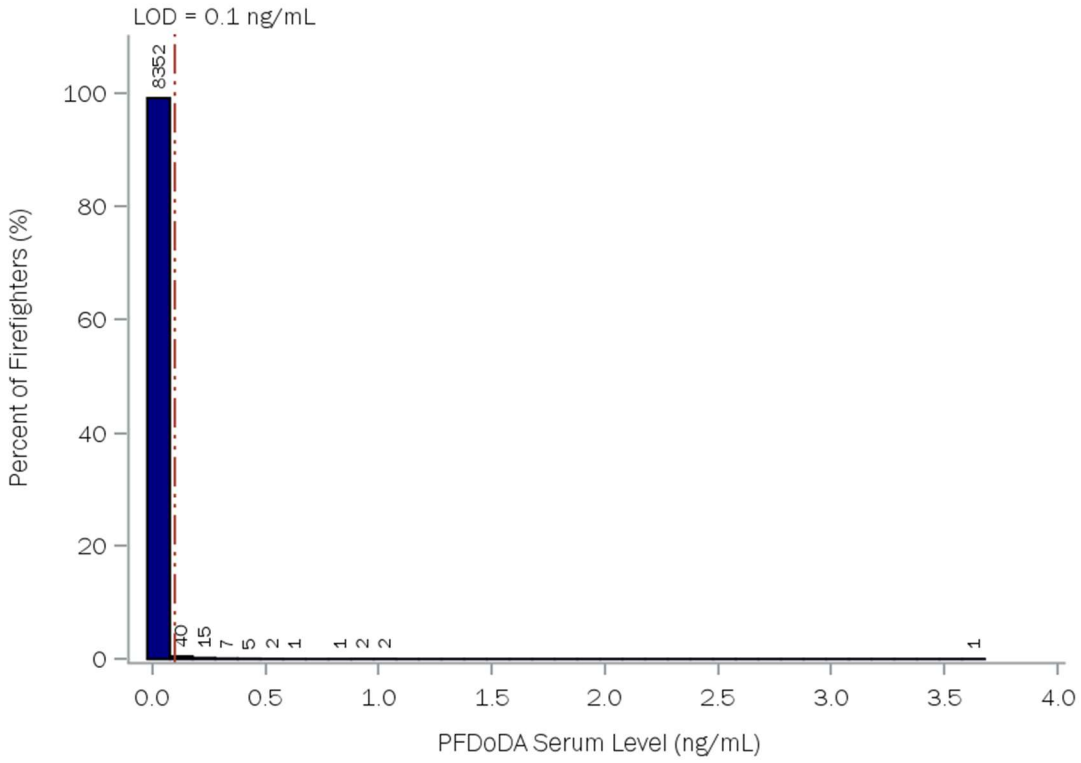
Data Source: LabCorp.
Abbreviations: PFDA, perfluorodecanoic acid; DoD, Department of Defense; FY, fiscal year; PFAS, per- and polyfluoroalkyl substances.
Figure includes service members (SMs) and civilian firefighters.
The distribution of firefighters with blood PFDA serum is displayed in histogram bars (concentration bins) reflecting measured concentrations that are equal to or less than 2 ng/mL. The truncation of the x-axis and width of concentration bins were arbitrarily assigned to provide visual resolution to the distribution. There were 10 values above 2 ng/mL.
The number of records below the limit of detection (LOD)=4,754 (56.42%). The LOD is 0.1 ng/mL.
Prepared by the EpiData Center, Defense Centers for Public Health - Portsmouth on April 15, 2025.

Figure 13. Percent Distribution of PFUnDA Testing Results Among Participating DoD Firefighters (n=8,428), FY 2024 (October 1, 2023–September 30, 2024)



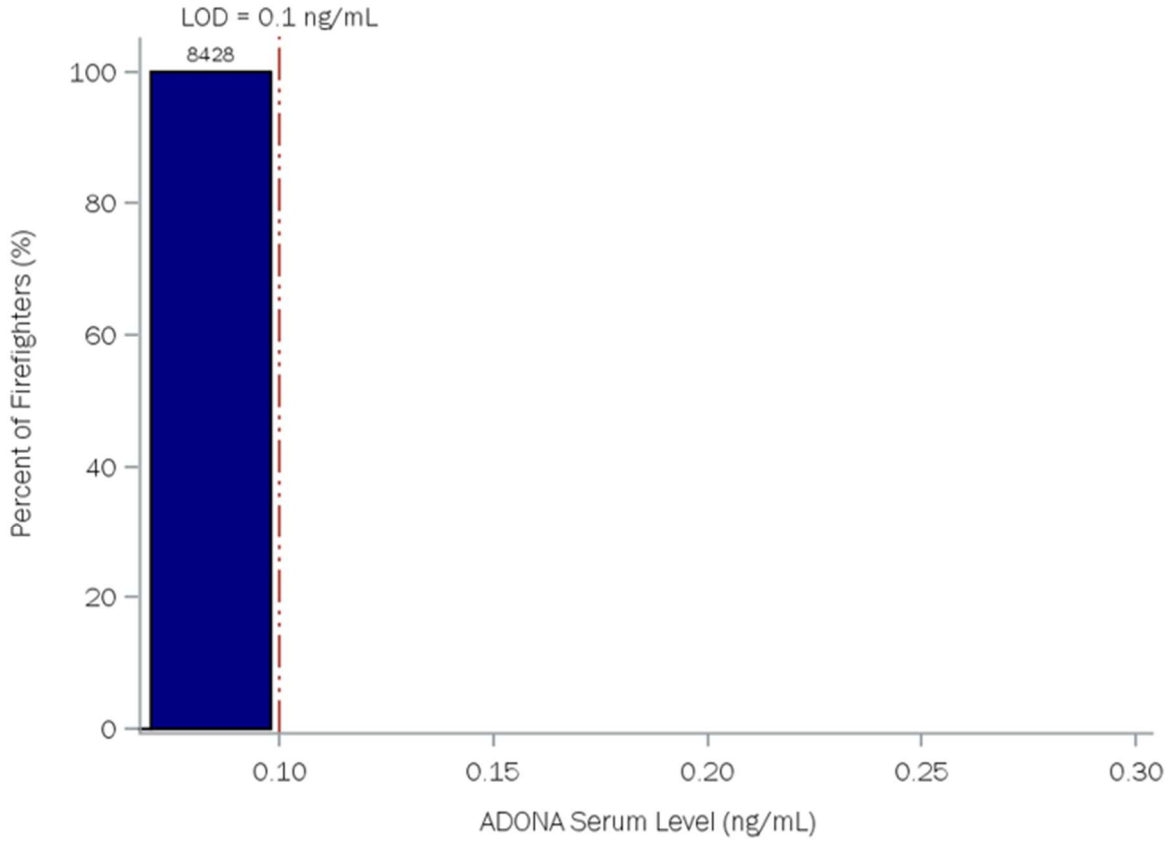
Data Source: LabCorp.
Abbreviations: PFUnDA, perfluoroundecanoic acid; DoD, Department of Defense; FY, fiscal year; PFAS, per- and polyfluoroalkyl substances.
Figure includes service members (SMs) and civilian firefighters.
The distribution of firefighters with blood PFUnDA serum is displayed in histogram bars (concentration bins) reflecting measured concentrations that are equal to or less than 2 ng/mL. The truncation of the x-axis and width of concentration bins were arbitrarily assigned to provide visual resolution to the distribution. There were 2 values above 2 ng/mL.
The number of records below the limit of detection (LOD)=6,526 (77.43%). The LOD is 0.1 ng/mL.
Prepared by the EpiData Center, Defense Centers for Public Health - Portsmouth on April 15, 2025.

Figure 14. Percent Distribution of PFDoDA Testing Results Among Participating DoD Firefighters (n=8,428), FY 2024 (October 1, 2023–September 30, 2024)



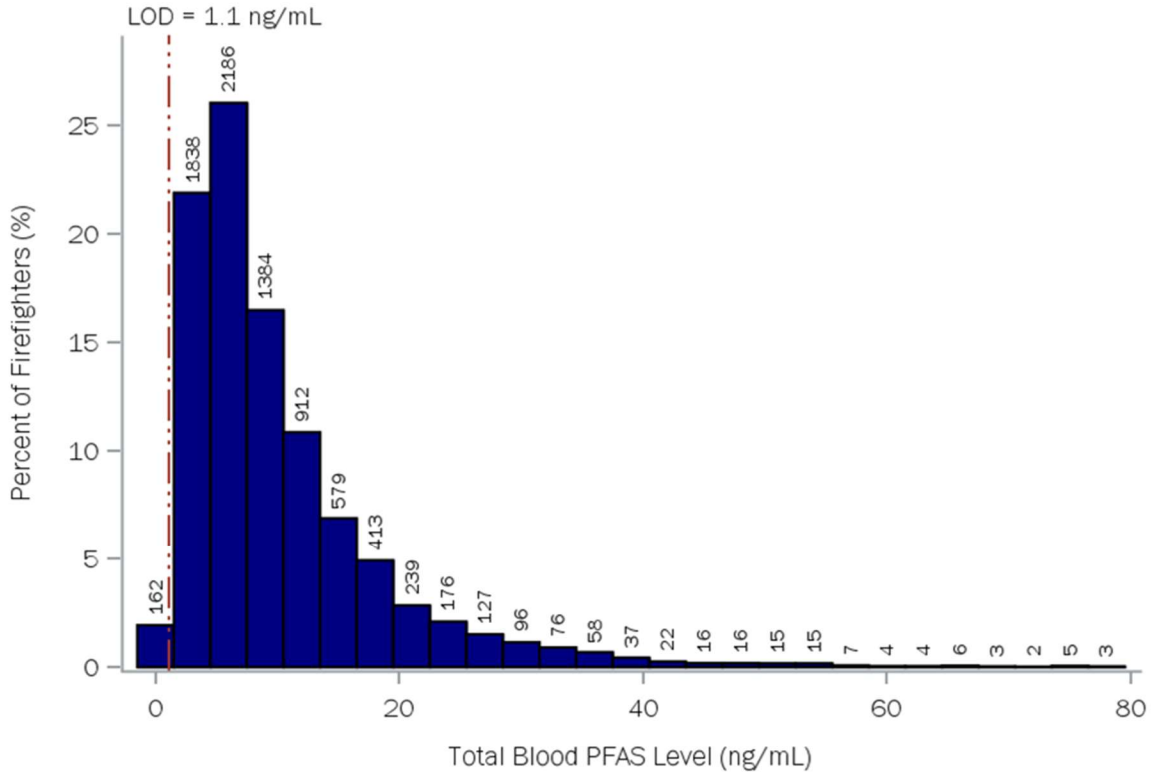
Data Source: LabCorp.
Abbreviations: PFDoDA, perfluorododecanoic acid; DoD, Department of Defense; FY, fiscal year; PFAS, per- and polyfluoroalkyl substances.
Figure includes service members (SMs) and civilian firefighters.
The distribution of firefighters with blood PFDoDA serum is displayed in histogram bars (concentration bins) reflecting measured concentrations that are equal to or less than 4 ng/mL. The truncation of the x-axis and width of concentration bins were arbitrarily assigned to provide visual resolution to the distribution.
The number of records below the limit of detection (LOD)=8,352 (99.10%). The LOD is 0.1 ng/mL.
Prepared by the EpiData Center, Defense Centers for Public Health - Portsmouth on April 15, 2025.

Figure 15. Percent Distribution of ADONA Testing Results Among Participating DoD Firefighters (n=8,428), FY 2024 (October 1, 2023–September 30, 2024)



Data Source: LabCorp.
Abbreviations: ADONA, 4,8-dioxa-3H-perfluorononanoic acid; DoD, Department of Defense; FY, fiscal year; PFAS, per- and polyfluoroalkyl substances.
Figure includes service members (SMs) and civilian firefighters.
The distribution of firefighters with blood PFDoDA serum is displayed in histogram bars (concentration bins) reflecting measured concentrations that are equal to or less than 0.30 ng/mL. The truncation of the x-axis and width of concentration bins were arbitrarily assigned to provide visual resolution to the distribution.
The number of records below the limit of detection (LOD)=8,428 (100%). The LOD is 0.1 ng/mL.
Prepared by the EpiData Center, Defense Centers for Public Health - Portsmouth on April 15, 2025.

Figure 16. Percent Distribution of Total Blood PFAS Testing Results Among Participating DoD Firefighters (n=8,428), FY 2024 (October 1, 2023–September 30, 2024)



Data Source: LabCorp.
Abbreviations: DoD, Department of Defense; CDC, Centers for Disease Control and Prevention; FY, fiscal year; PFAS, per- and polyfluoroalkyl substances.
Total Blood PFAS measures the sum of all individual analytes with calculated geometric means, excluding Total PFOS and Total PFOA.
Figure includes service members (SMs) and civilian firefighters.
The distribution of firefighters with Total Blood PFAS is displayed in histogram bars (concentration bins) reflecting measured concentrations that are equal to or less than 80 ng/mL. The truncation of the x-axis and width of concentration bins were arbitrarily assigned to provide visual resolution to the distribution. There were 27 values above 80 ng/mL.
The number of records below the limit of detection (LOD)=121 (1.44%). The LOD is 1.1 ng/mL and was calculated as the number of analytes (11) multiplied by the LOD of individual analytes (0.1).
Prepared by the EpiData Center, Defense Centers for Public Health - Portsmouth on April 15, 2025.

Age and Sex Analyses

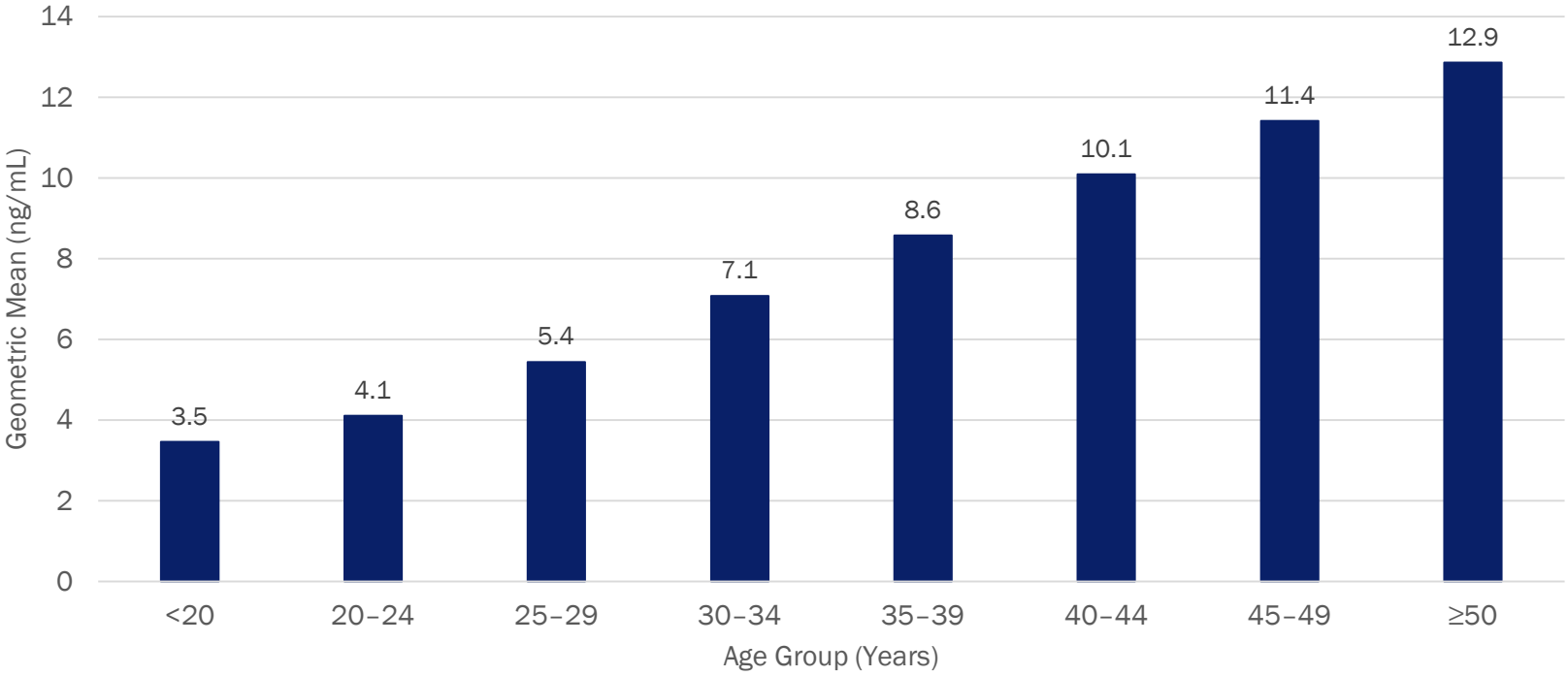
Results by Age Group

Table 3. Participating DoD Firefighters Tested for PFAS by Age Group, FY 2024 (October 1, 2023–September 30, 2024)

Age Group (Years)	Total Participants Tested	Percent (%)
<20	144	1.8
20–24	1,150	14.1
25–29	1,148	14.1
30–34	1,186	14.6
35–39	1,332	16.3
40–44	1,272	15.6
45–49	1,060	13.0
≥50	858	10.5
Total	**8,150**	**100.0**

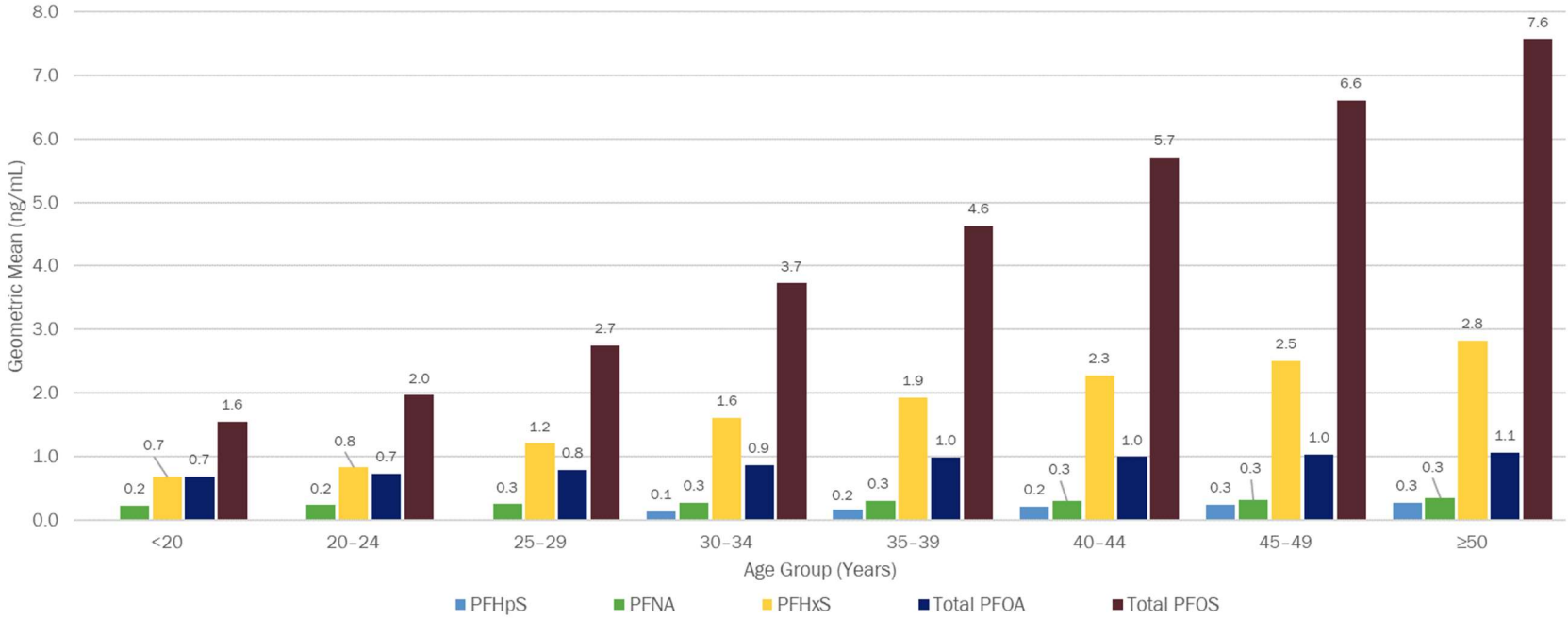
Data Sources: LabCorp, Defense Enrollment Eligibility Reporting System (DEERS), and the Defense Manpower Data Center (DMDC).
Abbreviations: DoD, Department of Defense; PFAS, per- and polyfluoroalkyl substances; FY, fiscal year.
Includes service members (SMs) and civilian firefighters.
Prepared by the EpiData Center, Defense Centers for Public Health - Portsmouth on April 10, 2025.

Figure 17. Geometric Mean of Total Blood PFAS Testing Results among DoD Firefighters by Age Group (n=8,428), FY 2024 (October 1, 2023–September 30, 2024)



Data Sources: LabCorp, Defense Enrollment Eligibility Reporting System (DEERS), and the Defense Manpower Data Center (DMDC).
Abbreviations: PFAS, per- and polyfluoroalkyl substances; DoD, Department of Defense; FY, fiscal year.
Total Blood PFAS measures the sum of all individual analytes with calculated geometric means, excluding Total PFOS and Total PFOA.
Data prepared by the EpiData Center, Defense Centers for Public Health - Portsmouth on April 15, 2025.

Figure 18. Geometric Means of PFAS Analyte Testing Results among DoD Firefighters by Age Group (n=8,428), FY 2024 (October 1, 2023–September 30, 2024)



Data Sources: LabCorp, Defense Enrollment Eligibility Reporting System (DEERS), and the Defense Manpower Data Center (DMDC).
Abbreviations: PFAS, per- and polyfluoroalkyl substances; DoD, Department of Defense; FY, fiscal year; PFHxS, perfluorohexane sulfonic acid; PFHpS, perfluoroheptane sulfonic acid; PFOS, perfluorooctane sulfonic acid; PFOA, perfluorooctanoic acid; PFNA, perfluorononanoic acid.
PFAS analytes with calculated geometric means are shown, excluding Linear PFOS, Linear PFOA and Branched PFOA.
The ratio of geometric means of linear PFOS to branched PFOS was similar across age groups; this ratio was not calculated for branched PFOA and linear PFOA because the proportion of results below limits of detection for Linear PFOS were too high to calculate a geometric mean.
PFHpS not calculated for certain age groups because proportions of results below limits of detection were too high to provide a valid result.
Data prepared by the EpiData Center, Defense Centers for Public Health - Portsmouth on April 15, 2025.

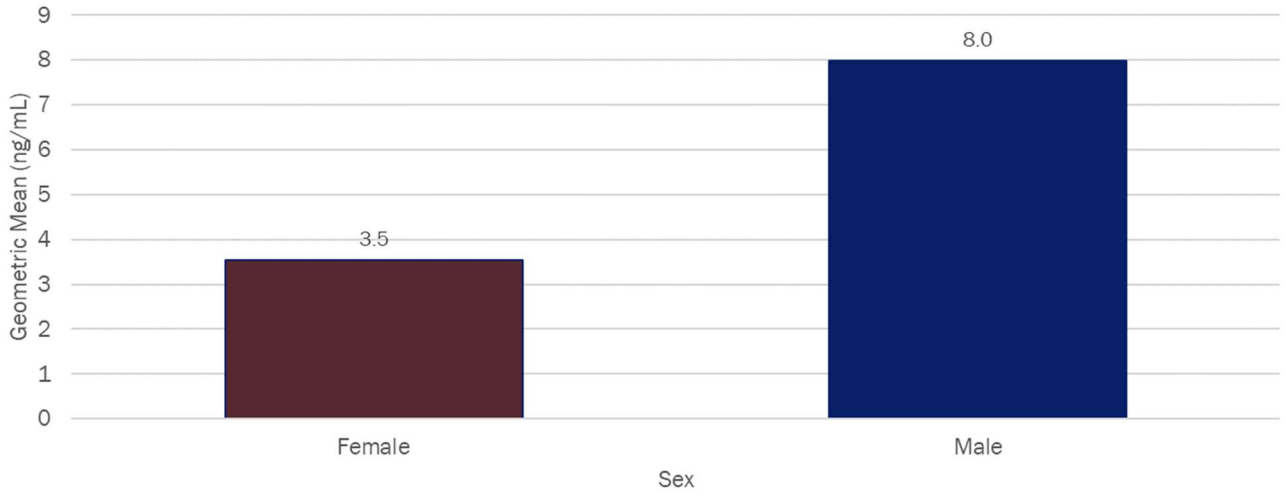
Results by Sex

Table 4. Participating DoD Firefighters Tested for PFAS by Sex, FY 2024 (October 1, 2023–September 30, 2024)

Sex	Total Participants Tested	Percent (%)
Female	357	4.4
Male	7,790	95.6
Total*	**8,147**	**100.0**

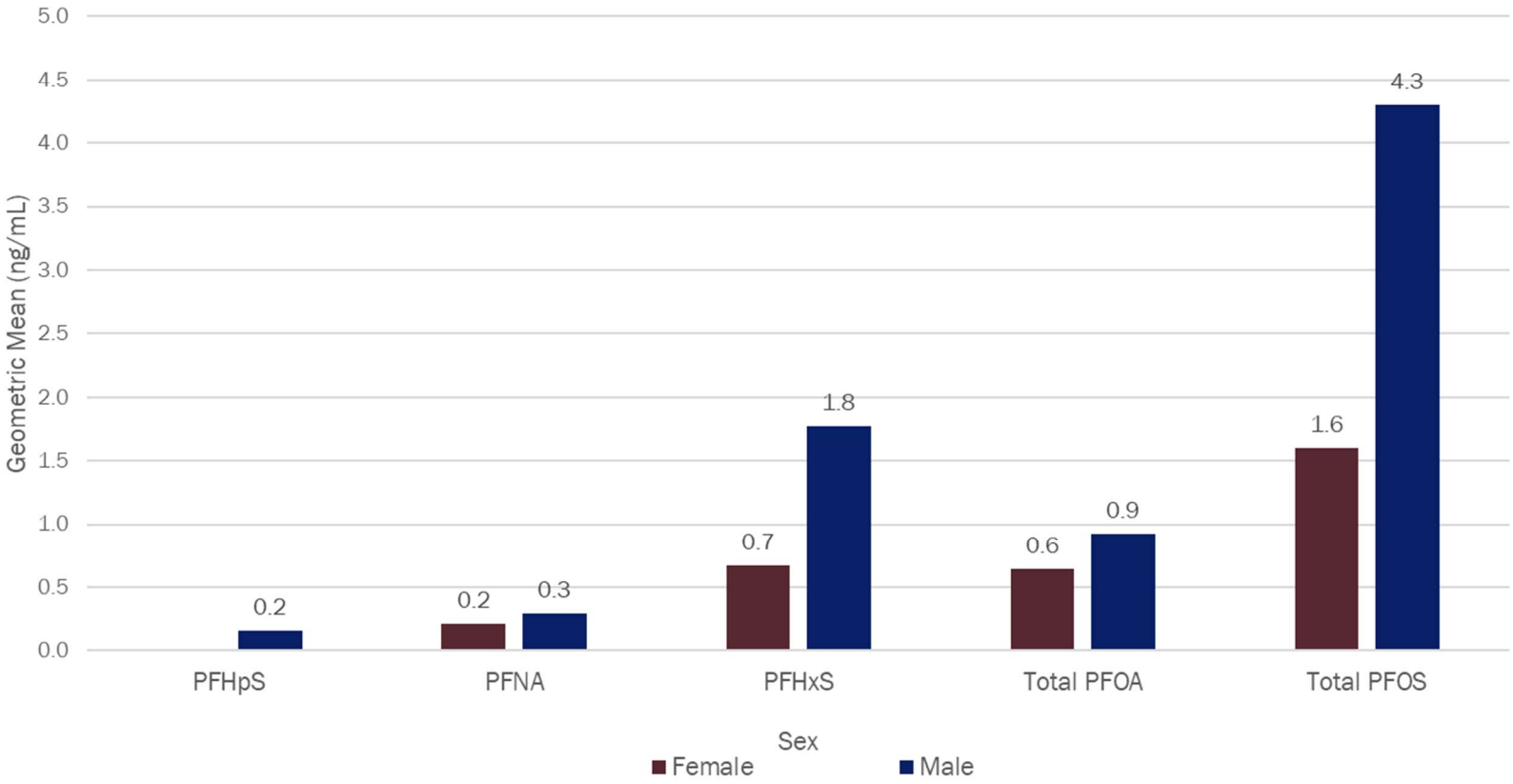
Data Sources: LabCorp, Defense Enrollment Eligibility Reporting System (DEERS), and the Defense Manpower Data Center (DMDC).
*Data does not include observations with missing sex (n=3).
Abbreviations: DoD, Department of Defense; PFAS, per- and polyfluoroalkyl substances; FY, fiscal year.
Prepared by the EpiData Center, Defense Centers for Public Health - Portsmouth on April 10, 2025.

Figure 19. Geometric Mean of Total Blood PFAS Testing Results among DoD Firefighters by Sex (n=8,425), FY 2024 (October 1, 2023–September 30, 2024)



Data Sources: LabCorp, Defense Enrollment Eligibility Reporting System (DEERS), and the Defense Manpower Data Center (DMDC).
Abbreviations: PFAS, per- and polyfluoroalkyl substances; DoD, Department of Defense; FY, fiscal year.
Total Blood PFAS measures the sum of all individual analytes with corresponding geometric means excluding Total PFOA and Total PFOS.
Data prepared by the EpiData Center, Defense Centers for Public Health - Portsmouth on April 15, 2025.

Figure 20. Geometric Mean of PFAS Analyte Testing Results among DoD Firefighters by Sex (n=8,425), FY 2024 (October 1, 2023–September 30, 2024)



Data Sources: LabCorp, Defense Enrollment Eligibility Reporting System (DEERS), and the Defense Manpower Data Center (DMDC).
Abbreviations: PFAS, per- and polyfluoroalkyl substances; DoD, Department of Defense; FY, fiscal year; PFHxS, perfluorohexane sulfonic acid; PFHpS, perfluoroheptane sulfonic acid; PFOS, perfluorooctane sulfonic acid; PFOA, perfluorooctanoic acid; PFNA, perfluorononanoic acid.
PFAS analytes with calculated geometric means are shown, excluding Linear PFOS, Linear PFOA and Branched PFOA.
The ratio of geometric means of linear PFOS to branched PFOS was higher for females (3.9) than males (3.4); this ratio was not calculated for branched PFOA to linear PFOA because the proportion of results below limits of detection for linear PFOS were too high to calculate a geometric mean.
PFHpS not calculated for females because proportions of results below limits of detection were too high to provide a valid result.
Data prepared by the EpiData Center, Defense Centers for Public Health - Portsmouth on April 15, 2025.

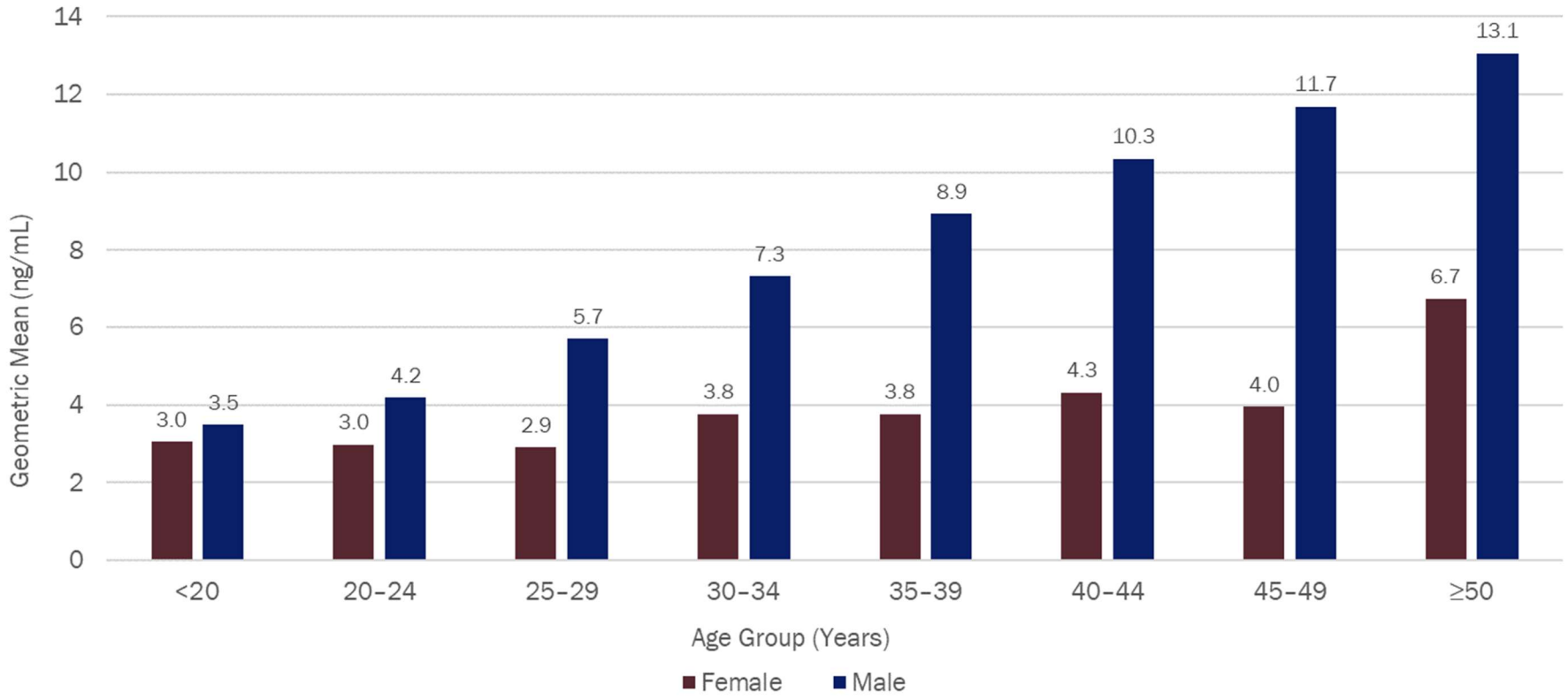
Results by Age Group, Stratified by Sex

Table 5. Participating DoD Firefighters Tested for PFAS by Sex and Age Group, FY 2024 (October 1, 2023–September 30, 2024)

Age Group (Years)	Female Participants Tested (%)	Male Participants Tested (%)
<20	8 (2.2%)	136 (1.7%)
20–24	68 (19.0%)	1,082 (13.9%)
25–29	82 (23.0%)	1,066 (13.7%)
30–34	61 (17.1%)	1,123 (14.4%)
35–39	61 (17.1%)	1,270 (16.3%)
40–44	36 (10.1%)	1,236 (15.9%)
45–49	23 (6.4%)	1,037 (13.3%)
≥50	18 (5.0%	840 (10.8%)
Total*	**357 (100%)**	**7,790 (100%)**

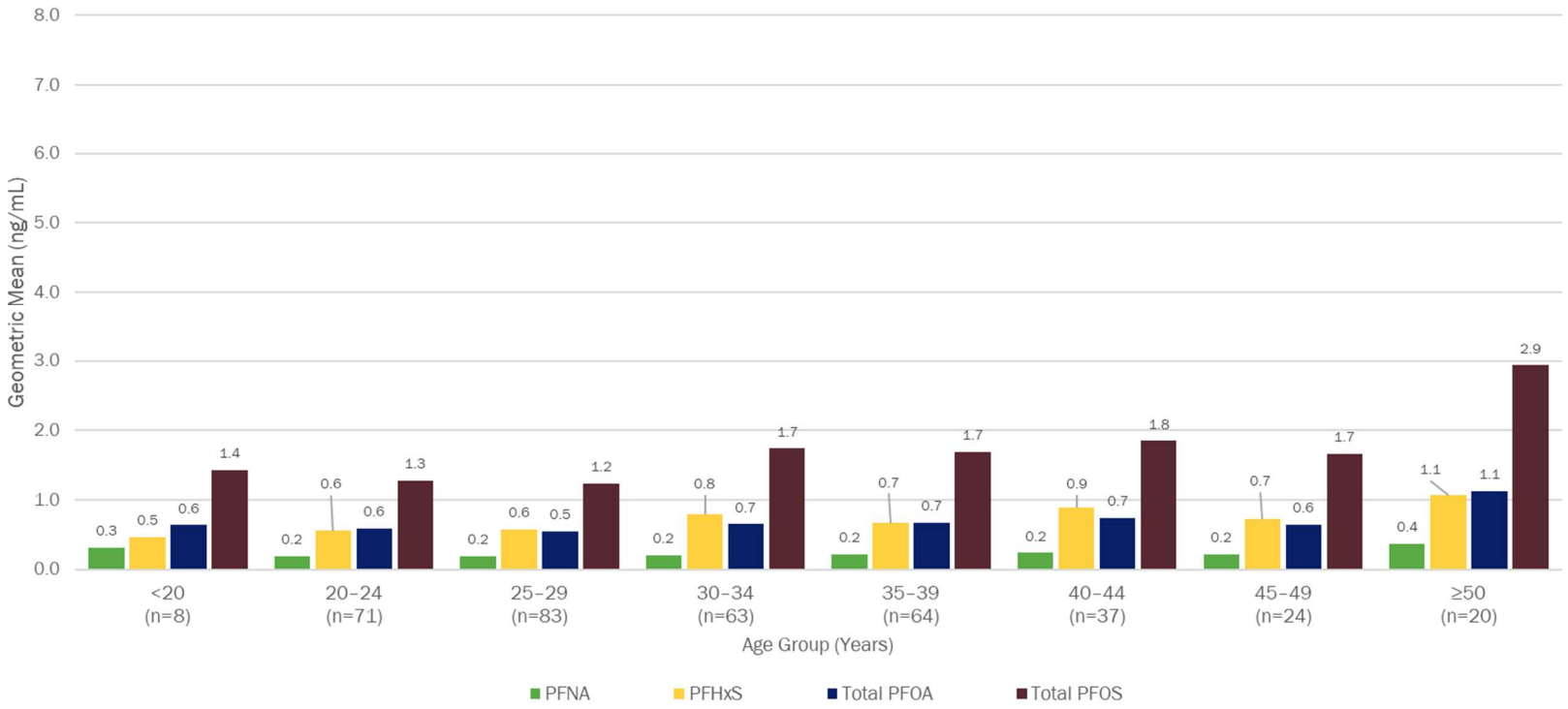
Data Sources: LabCorp, Defense Enrollment Eligibility Reporting System (DEERS), and the Defense Manpower Data Center (DMDC).
*Data does not include observations with missing sex (n=3).
Abbreviations: DoD, Department of Defense; PFAS, per- and polyfluoroalkyl substances; FY, fiscal year.
Includes service members (SMs) and civilian firefighters.
Prepared by the EpiData Center, Defense Centers for Public Health - Portsmouth on April 10, 2025.

Figure 21. Geometric Mean of Total Blood PFAS Testing Results among DoD Firefighters by Sex and Age Group (n=8,425), FY 2024 (October 1, 2023–September 30, 2024)



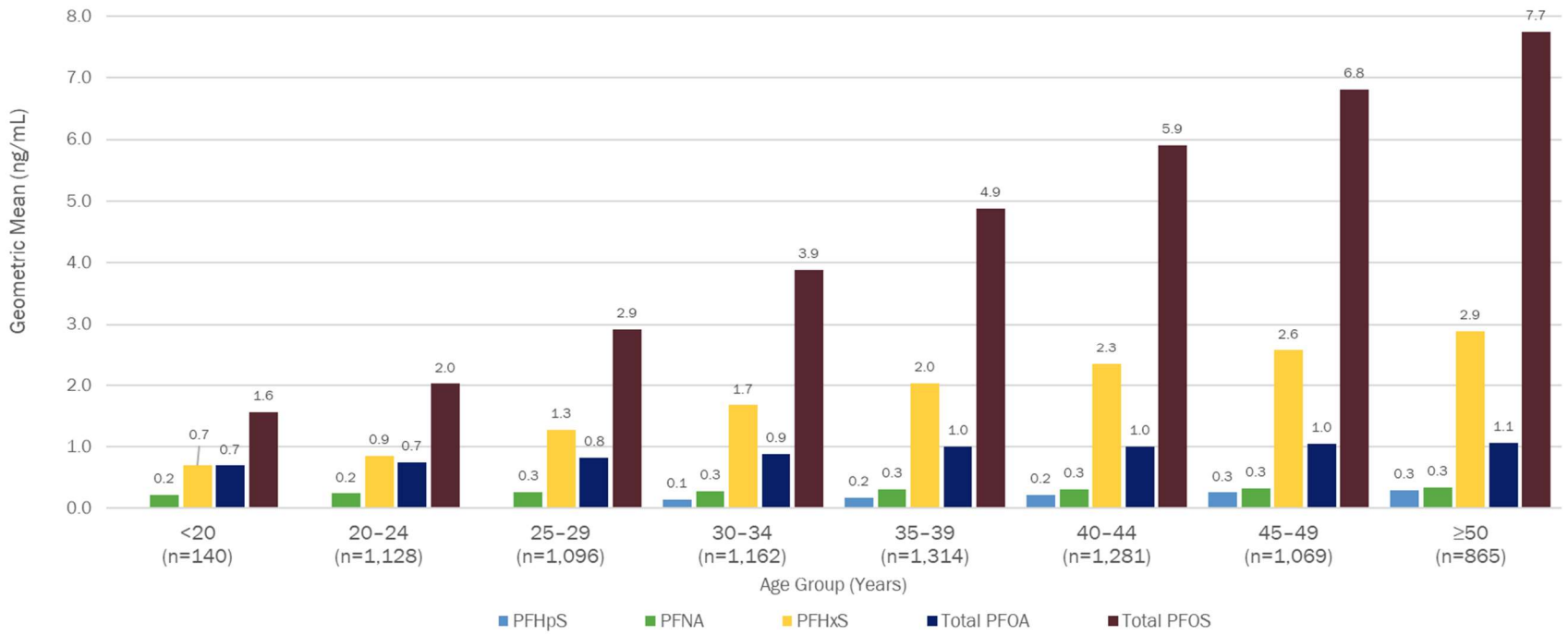
Data Sources: LabCorp, Defense Enrollment Eligibility Reporting System (DEERS), and the Defense Manpower Data Center (DMDC).
Abbreviations: PFAS, per- and polyfluoroalkyl substances; DoD, Department of Defense; FY, fiscal year.
Total Blood PFAS measures the sum of all individual analytes with corresponding geometric means excluding Total PFOA and Total PFOS.
Data prepared by the EpiData Center, Defense Centers for Public Health - Portsmouth on April 15, 2025.

Figure 22. Geometric Mean of PFAS Analyte Testing Results among Participating Female DoD Firefighters by Age Group (n=370), FY 2024 (October 1, 2023–September 30, 2024)



Data Sources: LabCorp, Defense Enrollment Eligibility Reporting System (DEERS), and the Defense Manpower Data Center (DMDC).
Abbreviations: PFAS, per- and polyfluoroalkyl substances; DoD, Department of Defense; FY, fiscal year; PFHxS, perfluorohexane sulfonic acid; PFHpS, perfluoroheptane sulfonic acid; PFOS, perfluorooctane sulfonic acid; PFOA, perfluorooctanoic acid; PFNA, perfluorononanoic acid.
PFAS analytes with calculated geometric means are shown, excluding Linear PFOS, Linear PFOA and Branched PFOA.
The ratio of geometric means of linear PFOS to branched PFOS varied across age groups; this ratio was not calculated for branched PFOA to linear PFOA because the proportion of results below limits of detection for linear PFOS were too high to calculate a geometric mean.
PFHpS not calculated for females because proportions of results below limits of detection were too high to provide a valid result.
Data prepared by the EpiData Center, Defense Centers for Public Health - Portsmouth on April 15, 2025.

Figure 23. Geometric Mean of PFAS Analyte Testing Results among Participating Male DoD Firefighters by Age Group (n=8,055), FY 2024 (October 1, 2023–September 30,



Data Sources: LabCorp, Defense Enrollment Eligibility Reporting System (DEERS), and the Defense Manpower Data Center (DMDC).
Abbreviations: PFAS, per- and polyfluoroalkyl substances; DoD, Department of Defense; FY, fiscal year; PFHxS, perfluorohexane sulfonic acid; PFHpS, perfluoroheptane sulfonic acid; PFOS, perfluorooctane sulfonic acid; PFOA, perfluorooctanoic acid; PFNA, perfluorononanoic acid.
PFAS analytes with calculated geometric means are shown, excluding Linear PFOS, Linear PFOA and Branched PFOA.
The ratio of geometric means of linear PFOS to branched PFOS was similar across age groups; this ratio was not calculated for branched PFOA to linear PFOA because the proportion of results below limits of detection for linear PFOS were too high to calculate a geometric mean. PFHpS not calculated for certain age groups because proportions of results below limits of detection were too high to provide a valid result.
Prepared by the EpiData Center, Defense Centers for Public Health - Portsmouth on April 15, 2025.

Trend Analyses from FYs 2021 to 2024

Table 6. Univariate Statistics for PFAS Blood Testing Among Participating DoD Firefighters with Records in FYs 2021–2024 (October 1, 2020–September 30, 2024)

	FY 2021		FY 2022		FY 2023		FY 2024	
Analyte	Total Valid Tests	Geometric Mean (ng/mL)[a]	Total Valid Tests	Geometric Mean (ng/mL)[a]	Total Valid Tests	Geometric Mean (ng/mL)[a]	Total Valid Tests	Geometric Mean (ng/mL)[a]
PFHxS	1,390	3.10 (2.97–3.23)	1,409	2.67 (2.56–2.80)	1,408	2.36 (2.25–2.48)	1,426	2.23 (2.13–2.34)
PFNA	1,437	0.44 (0.42–0.45)	1,413	0.38 (0.37–0.39)	1,407	0.34 (0.33–0.36)	1,426	0.32 (0.31–0.33)
Linear PFOA	1,446	1.20 (1.15–1.25)	1,423	1.07 (1.02–1.13)	1,408	0.99 (0.95–1.04)	1,426	0.97 (0.94–1.01)
Total Blood PFAS[b]	**1,446**	**4.82 (4.64–5.00)**	**1,425**	**4.42 (4.26–4.59)**	**1,408**	**4.01 (3.86–4.17)**	**1,426**	**3.76 (3.62–3.91)**

Data Source: LabCorp.

[a]95% Confidence Limits were calculated for the geometric mean.

[b]Total Blood PFAS was calculated as the sum of PFHxS, PFNA and linear isomer of PFOA values. These analytes were were tested in both the proprietary (October 1, 2020–April 30, 2023) and CDC (May 1, 2023–analytical methodologies and split samples did not yield statistically different results when assessed using either of these analytical methodologies. Although the linear isomer of PFOS is common to both methodologies, it was not included because the proprietary and CDC analytical methods detected statistically dissimilar concentrations in split blood samples.[9]

*Not calculated: Linear PFOS, and PFAS analytes where proportions of results below limits of detection were too high to provide a valid result.

Abbreviations: PFAS, per- and polyfluoroalkyl substances; DoD, Department of Defense; FY, fiscal year; PFHxS, perfluorohexane sulfonic acid; PFNA, perfluorononanoic acid; PFOA, perfluorooctanoic acid; CDC, Centers for Disease Control and Prevention; NHANES, National Health and Nutrition Examination Survey.

Includes service members (SMs) and civilian firefighters.

Values are not directly comparable to CDC-NHANES PFAS reporting.

Table 7. Univariate Statistics for PFAS Blood Testing Among Participating DoD Firefighters with Records in FYs 2023 and 2024 (October 1, 2022–September 30, 2024)

	FY 2023		FY 2024	
Analyte	Total Valid Tests	Geometric Mean (ng/mL)[a]	Total Valid Tests	Geometric Mean (ng/mL)[a]
PFHxS	1,846	1.75 (1.67–1.82)	1,941	1.76 (1.69–1.83)
PFHpS[b]	1,847	0.17 (0.17–0.18)	1,941	0.16 (0.16–0.17)
Total PFOS	1,846	4.57 (4.37–4.77)	1,941	4.43 (4.25–4.62)
Linear PFOS	1,846	3.44 (3.29–3.59)	1,941	3.44 (3.30–3.59)
Branched PFOS[b]	1,847	1.16 (1.12–1.21)	1,941	1.02 (0.99–1.07)
Total PFOA	1,847	0.94 (0.92–0.97)	1,938	0.91 (0.89–0.94)
Linear PFOA[b]	1,847	0.94 (0.92–0.97)	1,940	0.91 (0.89–0.94)
PFNA[b]	1,847	0.30 (0.30–0.31)	1,941	0.29 (0.28–0.30)
Total Blood PFAS[b,c]	**1,847**	**3.21 (3.11–3.32)**	**1,941**	**3.17 (3.07–3.27)**

Data Source: LabCorp.

[a]95% Confidence Limits were calculated for the geometric mean.

[b]Results of the Wilcoxon signed-rank test for these individual PFAS analytes and Total Blood PFAS demonstrate a statistically significant decrease in blood levels ($p<.001$) from FY 2023 to FY 2024.

[c]Total Blood PFAS was calculated as the sum of all individual analytes with calculated geometric means, excluding Total PFOS and Total PFOA.

*Not calculated: PFAS analytes where proportions of results below limits of detection were too high to provide a valid result.

Abbreviations: PFAS, per- and polyfluoroalkyl substances; DoD, Department of Defense; FY, fiscal year; PFHxS, perfluorohexane sulfonic acid; PFHpS, perfluoroheptane sulfonic acid; PFOS, perfluorooctane sulfonic acid; PFOA, perfluorooctanoic acid; PFNA, perfluorononanoic acid.

Includes service members (SMs) and civilian firefighters.

Prepared by the EpiData Center, Defense Centers for Public Health - Portsmouth on April 9, 2025.

Discussion

Adoption of CDC Analytical Methodology

In May of 2023, the DoD began using the CDC analytical methodology and an expanded PFAS target analyte list. The purpose of these changes in the blood PFAS testing protocol was to provide a more robust assessment of DoD firefighters' PFAS exposure levels and to allow direct comparisons of firefighter blood PFAS levels with those reported by the CDC in NHANES for the general population.[8] The results of the NMS Labs proprietary analytical analyses in FYs 2021–2023 are generally comparable to those of the CDC using their analytical methodology with the exception of linear PFOS and the PFAS analytes for which a geometric mean could not be determined (i.e., PFBS and PFHpA).

In a validation study, the NMS Labs compared the results of blood PFAS analyses, obtained using their proprietary analytical methodology, with the CDC analytical methodology using split blood samples from 212 DoD firefighters.[12] NMS Labs proprietary analytical methodology was used prior to May 1, 2023 to assess blood levels of six PFAS analytes (i.e., PFHxS, PFNA, PFBS, PFHpA, and the linear isomers of PFOA and PFOS). NMS Labs demonstrated results that are statistically indistinguishable from those obtained using the CDC analytical methodology. There was good agreement between the two analytical methods for three of the four analytes for which a geometric mean could be calculated (i.e., PFHxS, PFNA, and the linear isomer of PFOA). These three PFAS analytes were used in trend analyses over FYs 2021–2023.[12]

Neither analytical method detected sufficient blood PFBS or PFHpA levels required to calculate a geometric mean. As a result, neither of these analytes were further evaluated. For linear PFOS, the results obtained from 215 split sample analyses did not agree. While the proprietary analytical methodology identified a geometric mean of 3.68 ± 2.45 ng/mL, the CDC analytical methodology identified a geometric mean of 5.99 ± 4.64 ng/mL. This reflects an NMS Labs proprietary analytical bias of 2.31 ng/mL (62.8%) over the CDC analytical methodology. NMS Labs suggests that this bias is due to coelution of 1-methyl-perfluoroheptane sulfonic acid (1M-PFHpS) with the target linear PFOS analyte in the CDC analytical methodology. The CDC indicated that coelution does occur and impacts their linear PFOS analytical result but noted that the Total PFOS levels reported in firefighter blood should still be accurate. [12] While a confounded analytical result, the CDC analytical results remain comparable between DoD firefighters and the general population. Because of the difference in linear PFOS analytical results between the two analytical methodologies, the analytical results cannot be compared or used in trend analyses.

Comparison of DoD Firefighters with the General Population

Table 2 compares DoD firefighter blood PFAS levels in FY 2024 to the latest results reported by the CDC in NHANES. Consistent with blood PFAS test results from the latter half of FY 2023, fewer than 40% of the samples had detectable levels of the following analytes above the applicable LOD of 0.10 ng/mL: MeFOSAA, PFHxA, branched PFOA, PFDA, PFUnDA, PFDoDA or ADONA. No geometric mean was calculated for these target PFAS analytes.

Generally, the geometric means of blood PFAS levels measured in DoD firefighters in FY 2024 were lower than those reported by the CDC in 2017–2018 in persons ≥20 years of age in the general population. However, the geometric mean concentration of PFHxS and the linear isomer of PFOS in firefighter blood assessed in FY 2024 were slightly higher than those reported by the CDC among the general population cohort. Specifically, blood PFHxS levels in DoD firefighters (geometric mean = 1.70 ng/mL [95% CI: 1.66–1.73 ng/mL]) appear to be elevated with respect to the general

population (geometric mean = 1.11 ng/mL [95% CI: 1.03–1.21]). This comparison is potentially confounded by the 7-year difference in specimen collection dates and significant demographic differences between these two populations (i.e., the healthy military population). The CDC has reported a general decline in PFAS analytical results with each sample year. Should this trend continue, the level of PFHxS in the blood samples collected from the general population in FY 2024 may be lower than those measured in DoD firefighters from FY 2024. Because of these disparities, a comparison cannot conclude whether blood PFHxS levels in DoD firefighters are different from those in the general population.

DoD firefighter blood PFAS levels may not be significantly different from those in the general population. This may be because over the past few years, the use of AFFF containing PFAS by DoD firefighters has decreased and DoD policies have been implemented to reduce other potential PFAS exposures.[10] Regardless, firefighters may have significant occupational exposure to PFAS that is unrelated to the use AFFF. Levasseur et al. noted that firefighters, who do not use AFFF in fighting fires, also appear to have a higher external exposure to PFHxS and other PFAS than peers who did not fight fires.[14]

The geometric mean of linear PFOS isomers in DoD firefighters (geometric mean = 3.21 ng/mL [95% CI: 3.15–3.28 ng/mL]) was slightly higher than that reported by the CDC in the general population (geometric mean = 3.11 ng/mL [95% CI: 2.86–3.38 ng/mL]), but this difference was not statistically significant.

Variation of PFAS Blood Levels by Age, Sex, and Fiscal Year

Generally, the geometric means of blood PFAS levels in DoD firefighters demonstrated a downward trend from FY 2023 to FY 2024 (Table 7). A statistically insignificant increase was reported in firefighter blood PFHxS levels (1.75 ng/mL [95% CI: 1.67–1.82 ng/mL] to 1.76 ng/mL [95% CI: 1.69–1.83 ng/mL]). The geometric mean of linear PFOS blood levels showed no significant change from FY 2023 to FY 2024 (3.44 ng/mL [95% CI: 3.29–3.59 ng/mL] to 3.44 ng/mL [95% CI: 3.30–3.59 ng/mL]). The relatively stable measures of blood PFHxS and linear PFOS levels in DoD firefighters may reflect the acquisition of a steady state equilibrium where the intake of these PFAS compounds is equivalent to their elimination. For the remaining PFAS analytes, the decline in blood levels from FY 2023 to FY 2024 likely reflects a reduction in exposure resulting from DoD, federal, and state policies that reduce exposure to PFAS at home and in the workplace.

Consistent with the results of recent research publications, older DoD firefighters tend to have higher blood PFAS levels than younger firefighters (Figures 17, 18, 21, 22, 23).[8,13,15,16] This is due to the prolonged half-lives of some target PFAS analytes in the human body. Historically, the intake of PFAS over many years has exceeded the rate of PFAS elimination from the body. This results in the accumulation of PFAS levels over time. Recent policies designed to limit, mitigate, and reduce PFAS exposures have reduced the intake of these compounds to levels that are equivalent to their elimination from the body for some PFAS. This reduces the overall body burden for a particular age group and can result in a cessation of accumulation in older firefighters. This appears to have occurred for all the PFAS for which there is sufficient information to calculate a geometric mean. Each of these PFAS appear to have reached a maximum blood PFAS level over time that reflects that PFAS's half-life in the human body (i.e., the clearance or elimination rate).

Consistent with prior published research, the geometric mean of Total Blood PFAS, illustrated in Figure 17 (sum of PFHxS, PFHpS, linear and branched PFOS, linear PFOA and PFNA), demonstrated a linear increase in Total Blood PFAS levels with DoD firefighter age. Specifically, the highest geometric

mean occurred among those firefighters ≥50 years of age (12.9 ng/mL). As expected, the lowest Total Blood PFAS levels were observed among firefighters <20 years of age (3.5 ng/mL). The conclusions regarding this age group of firefighters should be viewed cautiously as this age group contains the smallest number of firefighters and is likely confounded by pre-service PFAS exposures. Both linear PFOS and PFHxS had the highest geometric means in each age group. Tables B1 and B2 demonstrate a clear age dependence of accumulation for all PFAS analytes, which reflects both occupational and nonoccupational PFAS exposures. These findings corroborate recent research.[8,13,15-17]

Figure 18 shows age-dependent accumulation of individual PFAS analytes. Total PFOA, PFHpS, and PFNA appear to have reached a maximum concentration at a particular firefighter age group with no subsequent increase with increasing age. Total PFOA appears to have reached a maximum blood level from 35 to 39 years of age and does not show increased levels at older ages. Similarly, PFNA and PFHpS appear to have reached maximum concentrations in the age ranges of 25 to 29 and 45 to 49 years of age, respectively, without further increases in body burden with increasing age. Reaching a maximum blood PFAS level at a particular firefighter age without further increasing concentrations with increasing age suggests that the accumulation of PFAS has reached an equilibrium in firefighters, where intake is roughly equivalent to elimination. The figure does not indicate that such an equilibrium has been reached for either Total PFOS or PFHxS.

The accumulation of target PFAS analytes in DoD firefighters shows a clear sexual dimorphism. Individual PFAS analytes appear to differentially accumulate in male and female firefighters, with individual and Total PFAS levels accumulating to a much greater degree in male than in female firefighters (Figures 22 and 23). These findings are consistent with the most recent CDC NHANES data.[11] It is important to note that female firefighters comprise only slightly more than 4% of all DoD firefighters participating in blood PFAS testing. Information relating to female firefighters' health status is not available. Health status information such as pregnancy, childbirth, lactation, and menstruation can significantly impact PFAS elimination in women, resulting in lower blood PFAS levels.[3,7,15]

Interestingly, when blood PFAS testing results were stratified by sex and age group, male DoD firefighters appear to accumulate two to three times more PFHxS and the linear isomer of PFOS than female firefighters. Male firefighters also appear to accumulate higher levels of the linear isomer of PFOA than female firefighters in all potential child-bearing age groups. At 50 years of age, the geometric means of Total PFOA levels are relatively similar for female and male firefighters (1.12 ± SD and 1.06 ± SD ng/mL, respectively). While there appears to be much less accumulation of PFNA than the other target PFAS analytes, male firefighters tended to accumulate slightly more PFNA than female firefighters.

Sources of PFAS for DoD Firefighters

A very small fraction of DoD firefighters currently use AFFF to fight fires. Over the last few years, there have been an average of fewer than 10 events occurring annually across the globe where DoD firefighters have used PFAS-containing AFFF in firefighting. Data that identify these specific firefighters were unavailable for this report.

DoD firefighters within the same unit and who fight fires during the same shift are assumed to have similar exposures to environmental contaminates like PFAS. These firefighters typically respond to fires as part of a group or unit. Because of this, each firefighter within a group/unit is expected to have similar blood PFAS levels, with higher group/unit blood PFAS levels potentially attributable to

use of PFAS-containing AFFF during firefighting activities. Individual firefighter results with significantly higher blood PFAS levels than any of their group/unit peers are unlikely to have resulted from occupational PFAS exposures. These higher individual firefighter blood PFAS levels may be due to nonoccupational sources of exposure such as treating lawn furniture with commercially available products containing PFAS. The ability to group firefighters by group and unit, AFFF use, and the number of fire responses may provide useful information concerning occupational PFAS exposures.

Conclusions

This annual surveillance report analyzes individual blood PFAS levels and population trends in blood PFAS levels in DoD firefighter serum. Currently, available DoD firefighter blood PFAS analytical results do not allow the determination of the magnitude, timing of exposure (frequency and duration), or likely source of PFAS exposures. In fact, the reported blood PFAS levels describe the total of individual blood PFAS target analyte levels and total aggregated PFAS levels in DoD firefighters, regardless of their source and magnitude of exposure. A limited analysis of DoD firefighter blood PFAS testing results in FYs 2021–2024 shows a statistically significant downward trend in total and individual PFAS serum levels.

Limitations

The available records do not contain any information about the individual's risk for exposure to PFAS (e.g., job duties, length of employment, or contact with AFFF) or their risk for developing adverse health outcomes. Data cleaning was conducted to retain records for DoD firefighters only. However, while this report references "firefighters," this analysis could not confirm the current duties of the individuals tested. As a result, this report may include blood PFAS analyses from individuals in other occupations or beneficiaries who were tested for blood PFAS, based on potential exposure concerns.

This report compared PFAS blood results between DoD firefighters tested in FY 2024 and CDC NHANES data from 2015–2018. Due to this time difference, results should be interpreted with caution.

The EDC receives PFAS testing records directly from LabCorp. EDC used categorization and validation of firefighter blood PFAS data to reduce potential misclassification errors. The data presented in this report, and the conclusions derived from the EDC's analysis, are based on FY 2021 through FY 2024 data. While a statistical trend analysis of the latter half of FY 2023 and FY 2024 DoD firefighter blood PFAS testing results were suggestive, more data points are needed to draw more reliable and meaningful conclusions.

Contact Us

Since 2006, the EDC has provided timely, actionable data surveillance and analysis for the Department of the Navy and Department of Defense in support of military health and readiness. The EDC's epidemiological and technical expertise informs a comprehensive, evidence-based suite of public health products regarding reportable and emerging infections, healthcare-associated infections, delivery of care challenges, patient safety, behavioral and operational health, exposure and injury analysis, and application development and data systems support.

For questions about this report, or to inquire about project support, please contact the EDC at usn.hampton-roads.navmcpubhlthcenpors.list.nmcphc-epi-plls@health.mil.

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Appendix A: Glossary

95th percentile – A statistical measurement indicating that 95% of the values in a dataset will fall below it.

ADONA – A polyfluoroalkyl substance with the chemical formula 4,8-dioxa-3H-perfluorononanoic acid. Used in the production of fluoropolymers.

Branched PFOS – Type of PFOS molecule where the fluorocarbon chain has a branched structure, rather than a straight chain.

Confidence interval – An estimated range of values from a sample data that contains the true population parameter for a variable of interest.

Firefighter – A first responder trained in controlling and extinguishing fires.

Geometric mean – The mean value which signifies the central tendency of the set of numbers by finding the product of their values.

Limit of detection – The lowest concentration of an analyte that can be reliably detected with a given analytical method, against a blank or background noise.

Linear mixed effects model – A statistical model that combines fixed effects, which are consistent across all observations, and random variables, which vary between different groups, and is often used for analysis of data that contains repeated measures of the same population.

Linear PFOS – Type of PFOS molecule where the fluorocarbon chain is straight and unbranched.

MeFOSAA – 2-(N-Methyl-perfluorooctane sulfonamido) acetic acid

ng/mL – Nanograms per milliliter

Non-normal distribution – Any probability distribution that does not conform to the bell-shaped, symmetrical pattern of a normal distribution.

PFAS – Per and Polyfluoroalkyl substances

PFBS – Perfluorobutane sulfonic acid

PFDA - Perfluorodecanoic acid

PFDoDA – Perfluorododecanoic acid

PFHpA – Perfluoroheptanoic acid

PFHpS – Perfluoroheptane sulfonic acid

PFHxA – Perfluorohexanoic acid

PFHxS – Perfluorohexane sulfonic acid

PFNA – Perfluorononanoic acid

PFOA – Perfluorooctanoic acid

PFOS – Perfluorooctane sulfonic acid

PFUnDA – Perfluoroundecanoic acid

Total Blood PFAS– the sum of PFAS analytes for which a geometric mean could be calculated (PFHxS, PFHpS, linear PFOS, branched PFOS, linear PFOA and PFNA), excluding Total PFOA and Total PFOS. Total Blood PFAS level was used to estimate a DoD firefighter's total exposure to PFAS from all occupational and environmental sources but cannot be used to determine the potential risk to human health.

Wilcoxon signed-rank test – A non-parametric test to analyze repeated measures on the same group of subject to determine if their population mean ranks differ.

Appendix B: Univariate Statistics of PFAS Analytes by Age, FY 2024

Table B1. PFAS Laboratory Testing Results Among Participating DoD Firefighters by Age Group, FY 2024 (October 1, 2023–September 30, 2024)

Analyte	PFHxS			PFHpS		
Age Group (Years)	Total Valid Tests	Geometric Mean (ng/mL)[a]	Maximum Value (ng/mL)	Total Valid Tests	Geometric Mean (ng/mL)[a]	Maximum Value (ng/mL)
<20	148	0.69 (0.63–0.76)	5.20	*	*	*
20–24	1,199	0.84 (0.81–0.87)	42.00	*	*	*
25–29	1,179	1.21 (1.16–1.26)	21.00	*	*	*
30–34	1,227	1.61 (1.53–1.69)	40.00	1,226	0.13 (0.13–0.14)	1.80
35–39	1,379	1.93 (1.84–2.02)	58.00	1,379	0.17 (0.16–0.17)	4.60
40–44	1,318	2.28 (2.18–2.39)	61.00	1,318	0.21 (0.21–0.22)	2.90
45–49	1,093	2.51 (2.37–2.65)	240.00	1,093	0.25 (0.24–0.26)	14.00
≥50	885	2.82 (2.64–3.01)	100.00	885	0.28 (0.27–0.30)	9.00
Analyte	**PFNA**			**Branched PFOS**		
Age Group (Years)	Total Valid Tests	Geometric Mean (ng/mL)[a]	Maximum Value (ng/mL)	Total Valid Tests	Geometric Mean (ng/mL)[a]	Maximum Value (ng/mL)
<20	148	0.23 (0.21–0.25)	2.20	148	0.37 (0.34–0.41)	1.40
20–24	1,199	0.24 (0.23–0.24)	4.00	1,199	0.46 (0.44–0.48)	6.00
25–29	1,179	0.25 (0.25–0.26)	1.40	1,179	0.63 (0.61–0.66)	7.20
30–34	1,227	0.28 (0.27–0.28)	2.40	1,227	0.87 (0.83–0.91)	9.10
35–39	1,379	0.31 (0.30–0.32)	6.30	1,379	1.07 (1.03–1.12)	17.00
40–44	1,318	0.31 (0.30–0.32)	4.10	1,318	1.30 (1.25–1.36)	13.00
45–49	1,093	0.32 (0.31–0.33)	5.10	1,093	1.53 (1.46–1.61)	56.00
≥50	885	0.35 (0.33–0.36)	5.40	885	1.72 (1.63–1.82)	33.00

Data Sources: LabCorp, Defense Enrollment Eligibility Reporting System (DEERS), and the Defense Manpower Data Center (DMDC).

[a]95% Confidence Limits were calculated for the geometric mean.

*Age group not calculated because proportions of results below limits of detection were too high to provide a valid result.

Abbreviations: PFAS, per- and polyfluoroalkyl substances; DoD, Department of Defense; FY, fiscal year; MeFOSAA, 2-(N-methyl-perfluorooctane sulfonamido) acetic acid; PFHxS, perfluorohexane sulfonic acid; PFHpS, perfluoroheptane sulfonic acid; PFOS, perfluorooctane sulfonic acid; PFHxA, perfluorohexanoic acid; PFOA, perfluorooctanoic acid; PFNA, perfluorononanoic acid; PFDA, perfluorodecanoic acid; PFUnDA, perfluoroundecanoic acid; PFDoDA, perfluorododecanoic acid; ADONA, 4,8-dioxa-3H-perfluorononanoic acid; CDC, Centers for Disease Control and Prevention; NHANES, National Health and Nutrition Examination Survey.

Not included: MeFOSAA, PFHxA, Branched PFOA, PFDA, PFUnDA, PFDoDA, and ADONA; proportions of results below LOD were too high to provide a valid result.

Includes service members (SMs) and civilian firefighters.

Values are comparable to CDC-NHANES PFAS reporting.

Prepared by the EpiData Center, Defense Centers for Public Health - Portsmouth on April 14, 2025.

Table B2. PFAS Laboratory Testing Results Among Participating DoD Firefighters by Age Group, FY 2024 (October 1, 2023–September 30, 2024)

Analyte	Linear PFOS			Linear PFOA		
Age Group (Years)	Total Valid Tests	Geometric Mean (ng/mL)[a]	Maximum Value (ng/mL)	Total Valid Tests	Geometric Mean (ng/mL)[a]	Maximum Value (ng/mL)
<20	148	1.21 (1.09–1.35)	8.10	148	0.68 (0.64–0.72)	2.30
20–24	1,199	1.55 (1.49–1.62)	20.00	1,199	0.73 (0.71–0.75)	5.50
25–29	1,179	2.15 (2.06–2.25)	31.00	1,179	0.80 (0.78–0.82)	5.40
30–34	1,227	2.90 (2.76–3.04)	29.00	1,227	0.87 (0.85–0.90)	15.00
35–39	1,379	3.60 (3.43–3.77)	85.00	1,379	0.98 (0.95–1.01)	10.00
40–44	1,318	4.43 (4.23–4.65)	68.00	1,318	1.00 (0.97–1.03)	9.70
45–49	1,093	5.09 (4.82–5.39)	180.00	1,093	1.03 (1.00–1.07)	15.00
	885	5.83 (5.48–6.21)	150.00	884	1.06 (1.02–1.11)	17.00
Analyte	**Total PFOS**			**Total PFOA**		
Age Group (Years)	Total Valid Tests	Geometric Mean (ng/mL)[a]	Maximum Value (ng/mL)	Total Valid Tests	Geometric Mean (ng/mL)[a]	Maximum Value (ng/mL)
<20	148	1.55 (1.40–1.72)	9.20	148	0.69 (0.65–0.73)	2.30
20–24	1,199	1.97 (1.89–2.05)	24.50	1,198	0.73 (0.71–0.75)	5.50
25–29	1,179	2.74 (2.62–2.86)	38.20	1,179	0.80 (0.78–0.82)	5.40
30–34	1,227	3.72 (3.54–3.91)	38.10	1,226	0.87 (0.85–0.90)	15.00
35–39	1,379	4.64 (4.43–4.86)	102.00	1,379	0.98 (0.95–1.01)	10.00
40–44	1,318	5.71 (5.44–6.00)	77.80	1,316	1.00 (0.97–1.03)	9.80
45–49	1,093	6.60 (6.24–6.99)	236.00	1,091	1.03 (1.00–1.07)	15.00
	885	7.57 (7.12–8.06)	182.00	883	1.06 (1.02–1.11)	17.00

Data Sources: LabCorp, Defense Enrollment Eligibility Reporting System (DEERS), and the Defense Manpower Data Center (DMDC).

[a]95% Confidence Limits were calculated for the geometric mean.

Abbreviations: PFAS, per- and polyfluoroalkyl substances; DoD, Department of Defense; FY, fiscal year; MeFOSAA, 2-(N-methyl-perfluorooctane sulfonamido) acetic acid; PFHxS, perfluorohexane sulfonic acid; PFHpS, perfluoroheptane sulfonic acid; PFOS, perfluorooctane sulfonic acid; PFHxA, perfluorohexanoic acid; PFOA, perfluorooctanoic acid; PFNA, perfluorononanoic acid; PFDA, perfluorodecanoic acid; PFUnDA, perfluoroundecanoic acid; PFDoDA, perfluorododecanoic acid; ADONA, 4,8-dioxa-3H-perfluorononanoic acid; CDC, Centers for Disease Control and Prevention; NHANES, National Health and Nutrition Examination Survey.

Not included: MeFOSAA, PFHxA, Branched PFOA, PFDA, PFUnDA, PFDoDA, and ADONA; proportions of results below LOD were too high to provide a valid result.

Includes service members (SMs) and civilian firefighters.

Values are comparable to CDC-NHANES PFAS reporting.

Prepared by the EpiData Center, Defense Centers for Public Health - Portsmouth on April 14, 2025.

Appendix C: Univariate Statistics of PFAS Analytes by Sex, FY 2024

Table C1. PFAS Laboratory Testing Results Among Participating DoD Firefighters by Sex, FY 2024 (October 1, 2023–September 30, 2024)

	Female			Male		
Analyte	Total Valid Tests	Geometric Mean (ng/mL)[a]	Maximum Value (ng/mL)	Total Valid Tests	Geometric Mean (ng/mL)[a]	Maximum Value (ng/mL)
PFHxS	370	0.67 (0.62–0.73)	42.00	8,055	1.77 (1.73–1.81)	240.00
PFHpS	*	*	*	8,054	0.16 (0.16–0.16)	14.00
Total PFOS	370	1.55 (1.39–1.73)	30.50	8,055	4.32 (4.23–4.41)	236.00
Linear PFOS	370	1.29 (1.17–1.44)	28.00	8,055	3.35 (3.28–3.42)	180.00
Branched PFOS	370	0.33 (0.30–0.36)	2.50	8,055	1.00 (0.98–1.02)	56.00
Total PFOA	370	0.64 (0.60–0.68)	9.90	8,047	0.92 (0.91–0.94)	17.00
Linear PFOA	370	0.64 (0.60–0.68)	9.90	8,054	0.92 (0.91–0.94)	17.00
PFNA	370	0.21 (0.20–0.23)	0.95	8,055	0.29 (0.29–0.30)	6.30

Data Sources: LabCorp, Defense Enrollment Eligibility Reporting System (DEERS), and the Defense Manpower Data Center (DMDC).

[a]95% Confidence Limits were calculated for the geometric mean.

*PFHpS not calculated for females because proportions of results below limits of detection (LOD) were too high to provide a valid result.

Abbreviations: PFAS, per- and polyfluoroalkyl substances; DoD, Department of Defense; FY, fiscal year; MeFOSAA, 2-(N-methyl-perfluorooctane sulfonamido) acetic acid; PFHxS, perfluorohexane sulfonic acid; PFHpS, perfluoroheptane sulfonic acid; PFOS, perfluorooctane sulfonic acid; PFHxA, perfluorohexanoic acid; PFOA, perfluorooctanoic acid; PFNA, perfluorononanoic acid; PFDA, perfluorodecanoic acid; PFUnDA, perfluoroundecanoic acid; PFDoDA, perfluorododecanoic acid; ADONA, 4,8-dioxa-3H-perfluorononanoic acid; CDC, Centers for Disease Control and Prevention; NHANES, National Health and Nutrition Examination Survey.

Not included: MeFOSAA, PFHxA, Branched PFOA, PFDA, PFUnDA, PFDoDA, and ADONA; proportions of results below LOD were too high to provide a valid result.

Includes service members (SMs) and civilian firefighters.

Values are comparable to CDC-NHANES PFAS reporting.

Prepared by the EpiData Center, Defense Centers for Public Health - Portsmouth on April 14, 2024.

Appendix D: Univariate Statistics of PFAS Analytes by Age, Stratified by Sex, FY 2024

Table D1. PFAS Laboratory Testing Results Among Participating Female DoD Firefighters by Age Group, FY 2024 (October 1, 2023–September 30, 2024)

Analyte	PFHxS			PFHpS		
Age Group (Years)	Total Valid Tests	Geometric Mean (ng/mL)[a]	Maximum Value (ng/mL)	Total Valid Tests	Geometric Mean (ng/mL)[a]	Maximum Value (ng/mL)
<20	8	0.46 (0.27–0.79)	1.60	*	*	*
20–24	71	0.55 (0.47–0.66)	7.10	*	*	*
25–29	83	0.57 (0.49–0.67)	7.00	*	*	*
30–34	63	0.79 (0.64–0.97)	30.00	*	*	*
35–39	64	0.67 (0.57–0.79)	2.20	*	*	*
40–44	37	0.89 (0.69–1.15)	5.70	*	*	*
45–49	24	0.73 (0.43–1.22)	42.00	*	*	*
≥50	20	1.06 (0.67–1.68)	22.00	*	*	*
Analyte	**PFNA**			**Branched PFOS**		
Age Group (Years)	Total Valid Tests	Geometric Mean (ng/mL)[a]	Maximum Value (ng/mL)	Total Valid Tests	Geometric Mean (ng/mL)[a]	Maximum Value (ng/mL)
<20	8	0.32 (0.18–0.57)	0.85	8	0.24 (0.12–0.49)	0.66
20–24	71	0.19 (0.17–0.21)	0.65	71	0.28 (0.23–0.33)	1.60
25–29	83	0.20 (0.17–0.22)	0.73	83	0.25 (0.21–0.31)	2.40
30–34	63	0.20 (0.17–0.22)	0.66	63	0.36 (0.29–0.45)	2.50
35–39	64	0.22 (0.19–0.26)	0.95	64	0.36 (0.29–0.45)	2.50
40–44	37	0.24 (0.20–0.28)	0.63	37	0.42 (0.31–0.57)	1.70
45–49	24	0.22 (0.17–0.29)	0.75	24	0.39 (0.26–0.59)	1.50
≥50	20	0.37 (0.30–0.46)	0.63	20	0.63 (0.41–0.97)	1.90

Data Sources: LabCorp, Defense Enrollment Eligibility Reporting System (DEERS), and the Defense Manpower Data Center (DMDC).

[a]95% Confidence Limits were calculated for the geometric mean.

*PFHpS not calculated for females because proportions of results below limits of detection (LOD) were too high to provide a valid result.

Abbreviations: PFAS, per- and polyfluoroalkyl substances; DoD, Department of Defense; FY, fiscal year; MeFOSAA, 2-(N-methyl-perfluorooctane sulfonamido) acetic acid; PFHxS, perfluorohexane sulfonic acid; PFHpS, perfluoroheptane sulfonic acid; PFOS, perfluorooctane sulfonic acid; PFHxA, perfluorohexanoic acid; PFOA, perfluorooctanoic acid; PFNA, perfluorononanoic acid; PFDA, perfluorodecanoic acid; PFUnDA, perfluoroundecanoic acid; PFDoDA, perfluorododecanoic acid; ADONA, 4,8-dioxa-3H-perfluorononanoic acid; CDC, Centers for Disease Control and Prevention; NHANES, National Health and Nutrition Examination Survey.

Includes service members (SMs) and civilian firefighters.

Not included: MeFOSAA, PFHxA, Branched PFOA, PFDA, PFUnDA, PFDoDA, and ADONA; proportions of results below LOD were too high to provide a valid result.

Values are comparable to CDC-NHANES PFAS reporting.

Prepared by the EpiData Center, Defense Centers for Public Health - Portsmouth on April 15, 2024.

Table D2. PFAS Laboratory Testing Results Among Participating Female DoD Firefighters by Age Group, FY 2024 (October 1, 2023–September 30, 2024)

Analyte	Linear PFOS			Linear PFOA		
Age Group (Years)	Total Valid Tests	Geometric Mean (ng/mL)[a]	Maximum Value (ng/mL)	Total Valid Tests	Geometric Mean (ng/mL)[a]	Maximum Value (ng/mL)
<20	8	1.19 (0.84–1.69)	2.10	8	0.64 (0.42–0.97)	1.80
20–24	71	1.07 (0.86–1.33)	7.10	71	0.59 (0.53–0.65)	4.90
25–29	83	1.05 (0.84–1.30)	10.00	83	0.55 (0.48–0.62)	4.10
30–34	63	1.43 (1.16–1.76)	10.00	63	0.65 (0.55–0.77)	9.90
35–39	64	1.40 (1.07–1.84)	28.00	64	0.67 (0.58–0.78)	2.30
40–44	37	1.52 (1.04–2.20)	8.90	37	0.74 (0.63–0.86)	1.60
45–49	24	1.39 (0.80–2.42)	6.90	24	0.64 (0.47–0.88)	1.70
≥50	20	2.40 (1.44–4.01)	8.90	20	1.12 (0.90–1.40)	2.00
Analyte	**Total PFOS**			**Total PFOA**		
Age Group (Years)	Total Valid Tests	Geometric Mean (ng/mL)[a]	Maximum Value (ng/mL)	Total Valid Tests	Geometric Mean (ng/mL)[a]	Maximum Value (ng/mL)
<20	8	1.43 (0.98–2.09)	2.70	8	0.64 (0.42–0.97)	1.80
20–24	71	1.28 (1.01–1.61)	8.70	71	0.59 (0.53–0.65)	4.90
25–29	83	1.23 (0.98–1.55)	12.40	83	0.55 (0.48–0.62)	4.10
30–34	63	1.74 (1.39–2.16)	12.50	63	0.65 (0.55–0.77)	9.90
35–39	64	1.69 (1.28–2.24)	30.50	64	0.67 (0.58–0.78)	2.30
40–44	37	1.85 (1.25–2.73)	10.60	37	0.74 (0.63–0.86)	1.60
45–49	24	1.66 (0.93–2.97)	8.10	24	0.64 (0.47–0.88)	1.70
≥50	20	2.93 (1.72–5.01)	10.60	20	1.12 (0.90–1.40)	2.00

Data Sources: LabCorp, Defense Enrollment Eligibility Reporting System (DEERS), and the Defense Manpower Data Center (DMDC).

[a]95% Confidence Limits were calculated for the geometric mean.

Abbreviations: PFAS, per- and polyfluoroalkyl substances; DoD, Department of Defense; FY, fiscal year; MeFOSAA, 2-(N-methyl-perfluorooctane sulfonamido) acetic acid; PFHxS, perfluorohexane sulfonic acid; PFHpS, perfluoroheptane sulfonic acid; PFOS, perfluorooctane sulfonic acid; PFHxA, perfluorohexanoic acid; PFOA, perfluorooctanoic acid; PFNA, perfluorononanoic acid; PFDA, perfluorodecanoic acid; PFUnDA, perfluoroundecanoic acid; PFDoDA, perfluorododecanoic acid; ADONA, 4,8-dioxa-3H-perfluorononanoic acid; CDC, Centers for Disease Control and Prevention; NHANES, National Health and Nutrition Examination Survey.

Includes service members (SMs) and civilian firefighters.

Not included: MeFOSAA, PFHxA, Branched PFOA, PFDA, PFUnDA, PFDoDA, and ADONA; proportions of results below LOD were too high to provide a valid result.

Values are comparable to CDC-NHANES PFAS reporting.

Prepared by the EpiData Center, Defense Centers for Public Health - Portsmouth on April 15, 2024.

Table D3. PFAS Laboratory Testing Results Among Participating Male DoD Firefighters by Age Group, FY 2024 (October 1, 2023–September 30, 2024)

Analyte	PFHxS			PFHpS		
Age Group (Years)	Total Valid Tests	Geometric Mean (ng/mL)[a]	Maximum Value (ng/mL)	Total Valid Tests	Geometric Mean (ng/mL)[a]	Maximum Value (ng/mL)
<20	140	0.71 (0.64–0.78)	5.20	*	*	*
20–24	1,128	0.86 (0.83–0.89)	42.00	*	*	*
25–29	1,096	1.28 (1.23–1.33)	21.00	*	*	*
30–34	1,162	1.68 (1.59–1.76)	40.00	1,161	0.14 (0.13–0.14)	1.80
35–39	1,314	2.03 (1.94–2.13)	58.00	1,314	0.17 (0.17–0.18)	4.60
40–44	1,281	2.34 (2.24–2.45)	61.00	1,281	0.22 (0.21–0.23)	2.90
45–49	1,069	2.58 (2.44–2.72)	240.00	1,069	0.26 (0.25–0.27)	14.00
≥50	865	2.89 (2.71–3.08)	100.00	865	0.29 (0.27–0.30)	9.00
Analyte	**PFNA**			**Branched PFOS**		
Age Group (Years)	Total Valid Tests	Geometric Mean (ng/mL)[a]	Maximum Value (ng/mL)	Total Valid Tests	Geometric Mean (ng/mL)[a]	Maximum Value (ng/mL)
<20	140	0.22 (0.20–0.24)	2.20	140	0.38 (0.35–0.42)	1.40
20–24	1,128	0.24 (0.24–0.25)	4.00	1,128	0.47 (0.46–0.49)	6.00
25–29	1,096	0.26 (0.25–0.27)	1.40	1,096	0.68 (0.65–0.70)	7.20
30–34	1,162	0.28 (0.27–0.29)	2.40	1,162	0.91 (0.87–0.95)	9.10
35–39	1,314	0.31 (0.30–0.32)	6.30	1,314	1.13 (1.09–1.18)	17.00
40–44	1,281	0.31 (0.30–0.32)	4.10	1,281	1.35 (1.29–1.41)	13.00
45–49	1,069	0.32 (0.31–0.34)	5.10	1,069	1.58 (1.50–1.66)	56.00
≥50	865	0.35 (0.33–0.36)	5.40	865	1.76 (1.67–1.87)	33.00

Data Sources: LabCorp, Defense Enrollment Eligibility Reporting System (DEERS), and the Defense Manpower Data Center (DMDC).

[a]95% Confidence Limits were calculated for the geometric mean.

*PFHpS not calculated for certain age groups because proportions of results below limits of detection (LOD) were too high to provide a valid result.

Abbreviations: PFAS, per- and polyfluoroalkyl substances; DoD, Department of Defense; FY, fiscal year; MeFOSAA, 2-(N-methyl-perfluorooctane sulfonamido) acetic acid; PFHxS, perfluorohexane sulfonic acid; PFHpS, perfluoroheptane sulfonic acid; PFOS, perfluorooctane sulfonic acid; PFHxA, perfluorohexanoic acid; PFOA, perfluorooctanoic acid; PFNA, perfluorononanoic acid; PFDA, perfluorodecanoic acid; PFUnDA, perfluoroundecanoic acid; PFDoDA, perfluorododecanoic acid; ADONA, 4,8-dioxa-3H-perfluorononanoic acid; CDC, Centers for Disease Control and Prevention; NHANES, National Health and Nutrition Examination Survey.

Includes service members (SMs) and civilian firefighters.

Not included: MeFOSAA, PFHxA, Branched PFOA, PFDA, PFUnDA, PFDoDA, and ADONA; proportions of results below LOD were too high to provide a valid result.

Values are comparable to CDC-NHANES PFAS reporting.

Prepared by the EpiData Center, Defense Centers for Public Health - Portsmouth on April 15, 2024.

Table D4. PFAS Laboratory Testing Results Among Participating Male DoD Firefighters by Age Group, FY 2024 (October 1, 2023–September 30, 2024)

Analyte	Linear PFOS			Linear PFOA		
Age Group (Years)	Total Valid Tests	Geometric Mean (ng/mL)[a]	Maximum Value (ng/mL)	Total Valid Tests	Geometric Mean (ng/mL)[a]	Maximum Value (ng/mL)
<20	140	1.21 (1.09–1.36)	8.10	140	0.68 (0.64–0.72)	2.30
20–24	1,128	1.59 (1.53–1.66)	20.00	1,128	0.74 (0.72–0.77)	5.50
25–29	1,096	2.27 (2.18–2.37)	31.00	1,096	0.82 (0.80–0.84)	5.40
30–34	1,162	3.01 (2.87–3.16)	29.00	1,162	0.89 (0.86–0.92)	15.00
35–39	1,314	3.77 (3.60–3.94)	85.00	1,314	1.00 (0.97–1.03)	10.00
40–44	1,281	4.57 (4.36–4.79)	68.00	1,281	1.01 (0.97–1.04)	9.70
45–49	1,069	5.24 (4.96–5.54)	180.00	1,069	1.04 (1.01–1.08)	15.00
≥50	865	5.95 (5.60–6.33)	150.00	864	1.06 (1.01–1.11)	17.00
Analyte	**Total PFOS**			**Total PFOA**		
Age Group (Years)	Total Valid Tests	Geometric Mean (ng/mL)[a]	Maximum Value (ng/mL)	Total Valid Tests	Geometric Mean (ng/mL)[a]	Maximum Value (ng/mL)
<20	140	1.56 (1.40–1.74)	9.20	140	0.69 (0.65–0.74)	2.30
20–24	1,128	2.02 (1.94–2.10)	24.50	1,127	0.74 (0.72–0.77)	5.50
25–29	1,096	2.91 (2.79–3.04)	38.20	1,096	0.82 (0.80–0.84)	5.40
30–34	1,162	3.88 (3.69–4.08)	38.10	1,161	0.89 (0.86–0.92)	15.00
35–39	1,314	4.87 (4.66–5.10)	102.00	1,314	1.00 (0.97–1.03)	10.00
40–44	1,281	5.90 (5.63–6.19)	77.80	1,279	1.01 (0.97–1.04)	9.80
45–49	1,069	6.81 (6.45–7.20)	236.00	1,067	1.04 (1.01–1.08)	15.00
≥50	865	7.74 (7.28–8.23)	182.00	863	1.06 (1.01–1.11)	17.00

Data Sources: LabCorp, Defense Enrollment Eligibility Reporting System (DEERS), and the Defense Manpower Data Center (DMDC).

[a]95% Confidence Limits were calculated for the geometric mean.

Abbreviations: PFAS, per- and polyfluoroalkyl substances; DoD, Department of Defense; FY, fiscal year; MeFOSAA, 2-(N-methyl-perfluorooctane sulfonamido) acetic acid; PFHxS, perfluorohexane sulfonic acid; PFHpS, perfluoroheptane sulfonic acid; PFOS, perfluorooctane sulfonic acid; PFHxA, perfluorohexanoic acid; PFOA, perfluorooctanoic acid; PFNA, perfluorononanoic acid; PFDA, perfluorodecanoic acid; PFUnDA, perfluoroundecanoic acid; PFDoDA, perfluorododecanoic acid; ADONA, 4,8-dioxa-3H-perfluorononanoic acid; CDC, Centers for Disease Control and Prevention; NHANES, National Health and Nutrition Examination Survey.

Includes service members (SMs) and civilian firefighters.

Not included: MeFOSAA, PFHxA, Branched PFOA, PFDA, PFUnDA, PFDoDA, and ADONA; proportions of results below LOD were too high to provide a valid result.

Values are comparable to CDC-NHANES PFAS reporting.

Prepared by the EpiData Center, Defense Centers for Public Health - Portsmouth on April 15, 2024.