THE UNIVERSITY OF QUEENSLAND
AUSTRALIA

PFAS Exposure Study
2018-2019

Queensland Alliance for Environmental Health Sciences (QAEHS)

Summary of the 2nd PFAS Exposure Study of ARFFS Staff

The 2019 Exposure study was conducted as a follow-up to a similar study conducted in 2014. 799 current and former ARFFS staff participated in this study. There were four key aims of this study.

Aim 1: To measure the participants' PFAS blood concentration levels and understand how these levels were linked to 'work history'.

Aim 2: To determine how PFAS blood levels change over time and compare these levels and changes to those in the general population.

Aim 3: To determine whether the PFAS blood levels were associated with any changes in other biochemical measures of health such as cholesterol, liver and kidney tests.

Aim 4: To provide advice to Airservices on how best to assess and minimise exposure to PFASs.

What the study involved:

Each participant was asked to fill out a questionnaire about their personal work history and their health and lifestyle. Blood samples were taken. The level of a number of PFAS chemicals and biochemical markers of health (biomarkers) were measured in the blood. The results in this report focus on four PFAS chemicals: PFOA, PFHxS, PFHpS and PFOS.

Aim 1: To measure the participants' PFAS blood concentration levels and understand how these levels were linked to 'work history'.

Some PFAS chemicals build up (accumulate) in the body. In this study, we found that the average levels of PFOA in participants' blood were very similar to levels observed in the general Australian population. The average levels of PFHxS, PFHpS and PFOS were higher than the levels observed in the general Australian population. We found that the higher levels were observed in those participants who had commenced work with Airservices before the introduction of Ansulite i.e. those with higher levels had been working when 3M AFFF was still in use (prior to 2005). The average levels of PFHxS, PFHpS and PFOS in the participants who started service after the introduction of Ansulite (after 2005) were similar to the levels found in the general Australian population. These results show that switching from 3M LightWater Foam to Ansulite and later to Solberg RF6 was an effective exposure control.

These results also demonstrate that there is now little ongoing occupational exposure to PFAS at these sites.

Our study also showed that the average levels of PFAS found in Emergency Vehicle Technicians (EVTs) were higher than those found in firefighters when comparing employees that have been working with 3M AFFF (prior to 2005), possibly indicating a different type of exposure for EVTs. The number of EVTs employed after 2005 was too low to make a meaningful comparison and therefore it is uncertain if EVTs had an increased exposure after the replacement of 3M AFFF.

Aim 2: To determine how PFAS blood levels change over time and compare these levels and changes to those in the general population.

PFAS levels decrease over time. The average PFAS levels (PFOA, PFHxS, PFHpS and PFOS) found in the participants were 55-65% lower than the PFAS levels measured in the 2014 study. It should be noted that although there was overlap in the two participant groups, there were some different individuals included in each of these groups.

In the subgroup of participants who participated in both studies, the PFAS levels decreased on average: with a decrease of 58% for PFOA, 42% for PFHxS, 45% for PFHpS and 49% for PFOS. By comparing the levels in 2014 to those in 2019 in participants with elevated levels, we were able to calculate the time taken to eliminate half of these PFAS chemicals from the blood. The half-lives were estimated to be 8.2 years for PFHxS, 7.8 years for PFHpS and 6.6 years for PFOS. These estimations compare well to the half-lives estimated in other published studies of occupationally exposed groups. In the Airservices participants, the average rate of decrease was higher than the decrease in the general population described in studies from Australia and Sweden. This indicates that PFAS were cleared faster in the Airservices participants. It is likely that this occurred because their main source of exposure (i.e. the replacement of 3M LightWater foam) was eliminated. A more significant reduction in PFAS levels was observed for those participants who were regular blood donors. This finding has also been observed in studies looking at PFAS levels in the general population and in other occupational cohorts.

Aim 3: To determine whether the PFAS blood levels were associated with any changes in other biochemical measures of health such as cholesterol, liver and kidney tests.

We assessed whether the PFAS levels were associated with any significant changes in other biochemical measures of health (biomarkers): Serum lipids, thyroid function markers, kidney function markers, liver function markers. We also assessed whether the PFAS levels were associated with other self-reported health conditions.

To identify these relationships, we looked at the levels measured across all of the participants' results, not at individual participants. All analyses considered other factors such as gender, age, body mass index (BMI) and lifestyle factors (such as diet, smoking and physical activity) that can have an influence on PFAS levels and biomarkers. This information was provided by participants through the questionnaire. When interpreting these results, it is important to

understand that the findings do not apply to specific individuals. Also, the finding of an association does not prove that the PFAS chemicals caused the change in the biomarker. The findings describe an association, rather than causation. There was no significant relationship between the PFAS chemical levels and many of the biomarkers that were measured.

The relationships that were found are listed here:

Higher levels of total cholesterol levels were associated with higher levels of PFOS. Higher levels of low density lipoprotein (LDL), a serum lipid that is sometimes called the "bad" cholesterol, were associated with higher levels of all four different PFASs chemicals (PFOA, PFHxS, PFHpS and PFOS). Nonetheless, the associations between PFAS levels and total cholesterol or LDL levels did not increase the risk of having a cholesterol/LDL level outside of the normal range.

Higher levels of PFOA were associated with higher levels of the thyroid biomarker, TSH. A high TSH can indicate reduced thyroid function. However, higher PFOA levels did not increase the likelihood of having TSH levels outside of the normal reference range. In other words, higher levels of PFOA did not increase the risk of having abnormally low thyroid function.

Higher levels of PFOA were associated with higher levels of the renal (kidney) biomarker, urate. A high urate level can indicate reduced renal function. However, higher levels of PFOA did not increase the likelihood of having urate levels outside the normal reference range. Therefore, in this study, the increased levels of PFOA did not increase the risk of having poor renal function. Additionally, increasing PFOA levels didn't increase the likelihood of having poor kidney (glomerular) filtration rate (eGFR). The eGFR is another measure of renal function.

Higher levels of PFOA were found to be associated with lower levels of ALT, but it did not increase the likelihood of being outside of the normal reference range. A high level of ALT may indicate reduced liver function, but a lower ALT level is not considered to the clinically significant.

Overall, the levels of PFOA found in study participants were within the range that has been recorded for the general population of Australia.

Table showing the associations between PFAS levels and biomarkers. (Arrows indicate an association with increased or decreased biomarker levels. Dashes indicate no change in biomarker levels.)

Assessed Outcomes				
	PFOA	***PFHxS***	***PFHpS***	***PFOS***
Serum lipids				
Cholesterol	-	-	-	↑*
HDL	-	-	-	-
LDL	↑*	↑*	↑*	↑*
Thyroid function markers				
TSH	↑*	-	-	-
T3	-	-	-	-
T4	-	-	-	-
Kidney function markers				
Urate	↑*	-	-	-
eGFR	*	-	-	-
Liver function markers				
ALT	↓*	-	-	-

↑; (Orange); Positive association: Increasing PFAS levels associate with increasing biomarker levels

↓; (Blue); Negative association: Increasing PFAS levels associate with decreasing biomarker levels

-; (Green); Assessed but no association found,

**; Increasing PFAS levels do not increase the risk of having biomarker levels outside of the normal reference range.*

A questionnaire was used to record a number of self-reported health outcomes experienced by participants. There are limitations related to collecting self-reported health data. For example, the diagnoses or health issues may not be accurately reported or they may not be medically confirmed. These different understandings of personal self-reporting of health issues can impact on the ability of a study to identify relationships with other findings such as PFAS levels in the blood.

There were twelve self-reported health conditions reported in this study: asthma, heart disease, cancer (any form), skin cancer, prostate cancer, diabetes (type 2), high blood pressure, kidney problems, liver problems, reproductive/fertility problems, serious arthritis and thyroid problems.

Associations were found for two of these health conditions. Firstly, there were less self-reports of serious arthritis associated with increasing levels of PFOA. Secondly, there were more cases of self-reported skin cancer associated with increasing levels of PFOA.

The significance of these findings is unknown. It is very possible that these relationships are chance findings and the relationship with PFAS concentrations needs to be interpreted with caution.

Aim 4: To provide advice to Airservices on how best to assess and minimise exposure to PFASs.

For participants who participated in both studies, this study documented a decrease in the average PFAS levels. This study also showed that recent employees had PFAS levels that were consistent with the levels seen in the general public. These findings indicate that the workplace health and safety practises that have been implemented by Airservices are working to reduce exposure to PFAS chemicals. The study has also shown that there is minimal ongoing occupational PFAS exposure for Airservices staff. In particular, the substitution of AFFF has been effective at reducing or eliminating elevated exposures.