

Exposure to perfluoroalkyl substances and thyroid function in firefighters

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Introduction

Per- and polyfluorinated alkyl substances (PFAS) have been used for decades in manufacturing processes, consumer products (e.g., nonstick cookware, water-repellent clothing, stain resistant fabrics and carpets), and firefighting foams.

Epidemiological evidence suggests that exposure to certain PFAS may be associated with numerous adverse health outcomes including thyroid disruption. Additionally, animal studies report associations between exposure to some PFAS and endocrine system abnormalities, and, in particular disruptions in thyroid function. The data on the effects of PFAS on thyroid function in humans are less consistent. Several cross-sectional studies explored the associations between different PFAS and thyroid hormones (THs), but overall, findings on alterations of THs are not conclusive.

The C8 Health Project assessed thyroid function in a cross-sectional analysis of 52,296 adults with a year or more of exposure to perfluorooctanoate (PFOA) from drinking water. In this study both PFOA and perfluorooctane sulfonate (PFOS) were associated with significant elevations in serum thyroxine and a significant reduction in T3 uptake in both men in women (2011).

An occupational study among 506 employees showed a negative association for free T4, positive association for T3 and no associations for TSH or T4 and PFOA.

In older adults serum PFOS was positively associated with fT4 and T4. A positive association was suggested between serum PFOS and TSH, and PFOA and T4, although not of statistical significance.

Overall, there is inconsistent evidence of associations between any particular PFAS and thyroid hormones.

The purposes of this study were as follows:

- (1) to investigate the exposure levels of PFAS in serum samples obtained from the group of professional firefighters (as we supposed that firefighters have heightened exposure to PFAS through their protective gear and fire suppression foams and the burning materials they encounter that release particles, which can be inhaled or settled on gear and skin), freshly recruited firefighters and control group
- (2) by assessing associations between thyroid function and serum PFAS to illustrate whether PFAS impair thyroid hormone homeostasis in differently exposed groups, and
- (3) to clarify whether the associations between PFAS and thyroid hormones are modulated by iodine deficiency.

To our knowledge, this is the first study to investigate associations among an extended list of PFAS, thyroid hormones and iodine concentration in group of differently PFAS exposed males.

Study population

The participants were divided into three groups

- i) professional firefighters who had been actively participating in the response to incidents (prof, n = 52);
- ii) the new recruits (new, n = 59), and
- iii) a control group comprising of non-firefighters (ctrl, n = 55).

Study inclusion criteria included being male over 18 years old.

Statistical Analyses

We performed separate statistical analyses for new recruits (at the beginning and at the end of the training), firefighters in active duty and control group. We first examined the association between PFAS and TH levels using linear regression models.

We used a generalized estimating equation (GEE) model with a linear link function and unstructured correlation structure (Hubbard et al. 2010) to assess whether thyroid hormones are influenced by PFAS serum concentration, age, BMI, frequency in using firefighting foam, length of the career.

Statistical analysis was performed using R version 4.1.0 (R Foundation for Statistical Computing, Vienna, Austria), a significance level of 0.05 was used for all tests.

Results

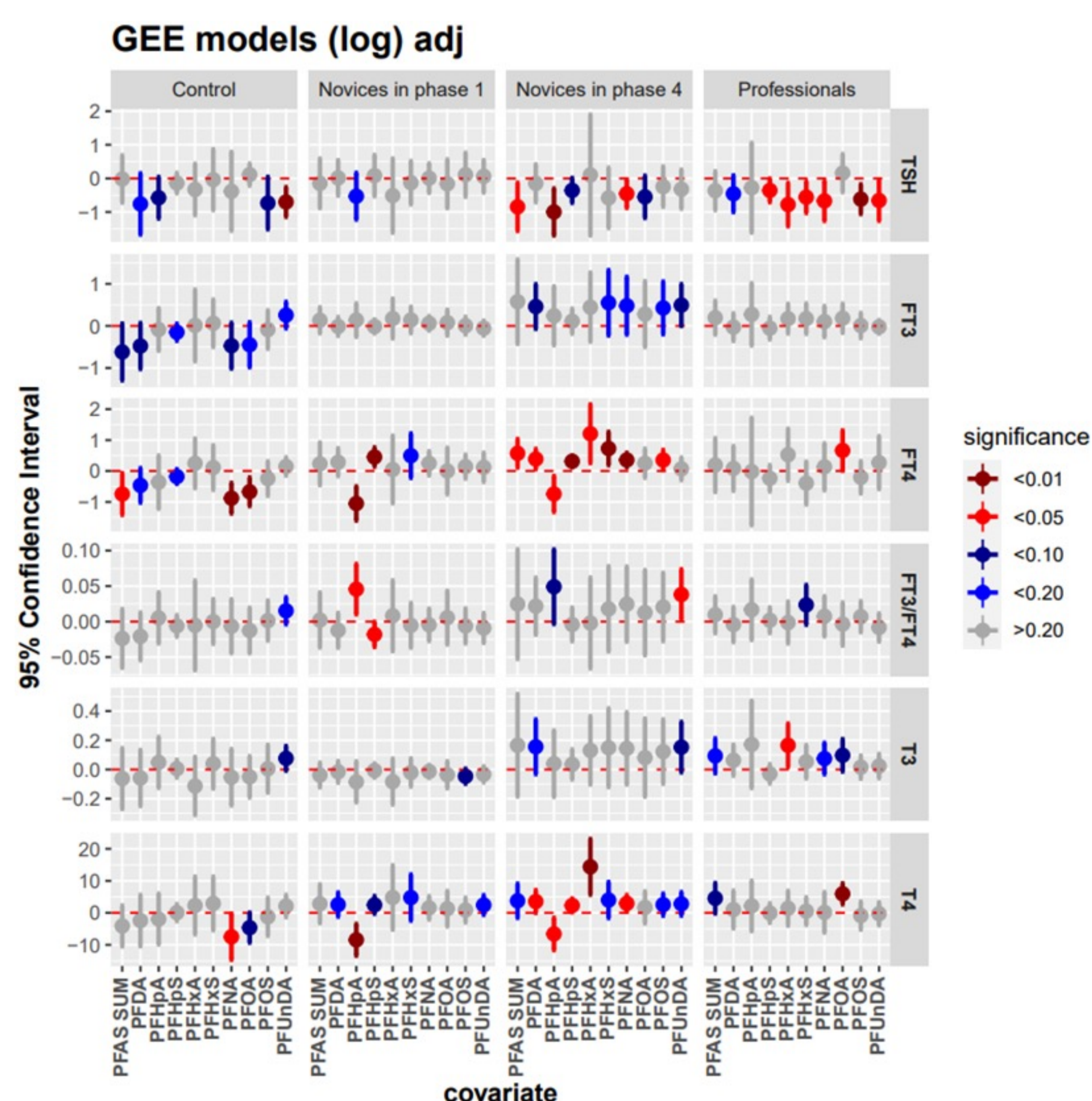


Figure 2. Results of GEE regression analysis: Analysis was performed using log transformed data. The model was adjusted for age, BMI, length of the professional career, use of AFFF and iodine status. Beta coefficients were calculated to represent the change in THs for each unit increase of PFAS variable. Vertical bars reflect the 95% confidence interval (CI); p-value <math>< 0.01</math> is colored dark red, <math>< 0.05</math> is colored red, <math>< 0.10</math> is dark blue, <math>< 0.20</math> is blue and light grey is > 0.20.

Results

In this study, we investigated associations between serum levels of PFAS and thyroid hormones in three differently PFAS exposed groups. We did not observe any consistent pattern of an increased risk of thyroid disruption caused by increased level of serum PFAS. The results from our study must be interpreted with caution due to the limited sample size. Our findings warrant further research on the role of PFAS exposure in development of thyroid hormone imbalances.