PFAS, Phenols, and Parabens: Links to Hormone-Mediated Cancers

Max Aung, PhD, MPH

Keck School of Medicine of USC
Department of Population and Public Health Sciences

Aung Research Team

Translational Environmental Health Sciences

maxaung@usc.edu

@max_aung

Hormone mediated cancers are emerging front runners in new cancer cases

Estimated New Cases

Males				Females		
Prostate	174,650	20%		Breast	268,600	30%
Lung & bronchus	116,440	13%		Lung & bronchus	111,710	13%
Colon & rectum	78,500	9%		Colon & rectum	67,100	8%
Urinary bladder	61,700	7%		Uterine corpus	61,880	7%
Melanoma of the skin	57,220	7%		Melanoma of the skin	39,260	4%
Kidney & renal pelvis	44,120	5%		Thyroid	37,810	4%
Non-Hodgkin lymphoma	41,090	5%		Non-Hodgkin lymphoma	33,110	4%
Oral cavity & pharynx	38,140	4%		Kidney & renal pelvis	29,700	3%
Leukemia	35,920	4%		Pancreas	26,830	3%
Pancreas	29,940	3%		Leukemia	25,860	3%
All Sites	**870,970**	**100%**		**All Sites**	**891,480**	**100%**

Siegel et al. (2019)

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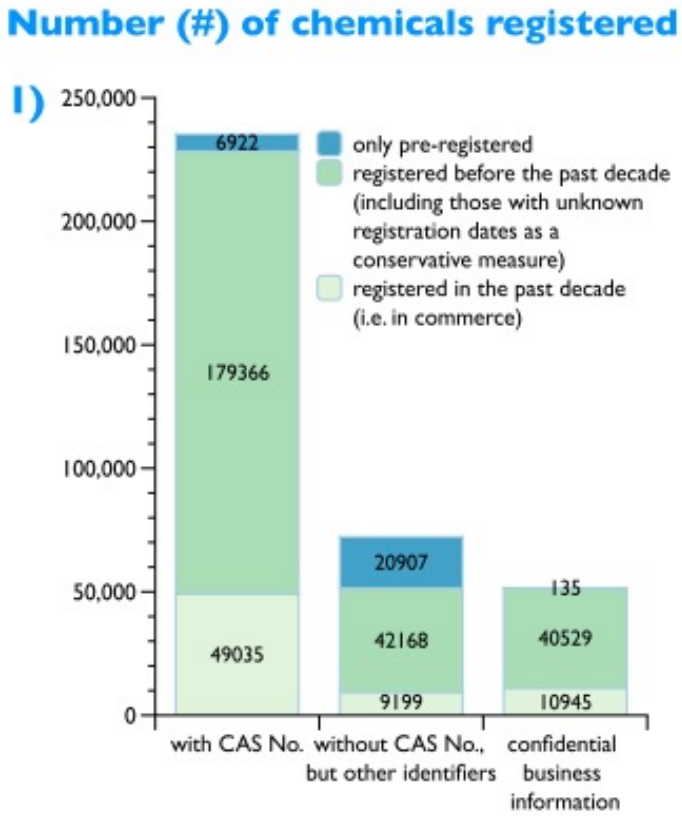
Risk Factors

Demographics | Smoking | Diet/Physical activity | Environmental pollution

Potentially modifiable through interventions

Siegel et al. (2019)

Globally, over 235k chemicals are registered and over 120k chemicals and mixtures without any registration

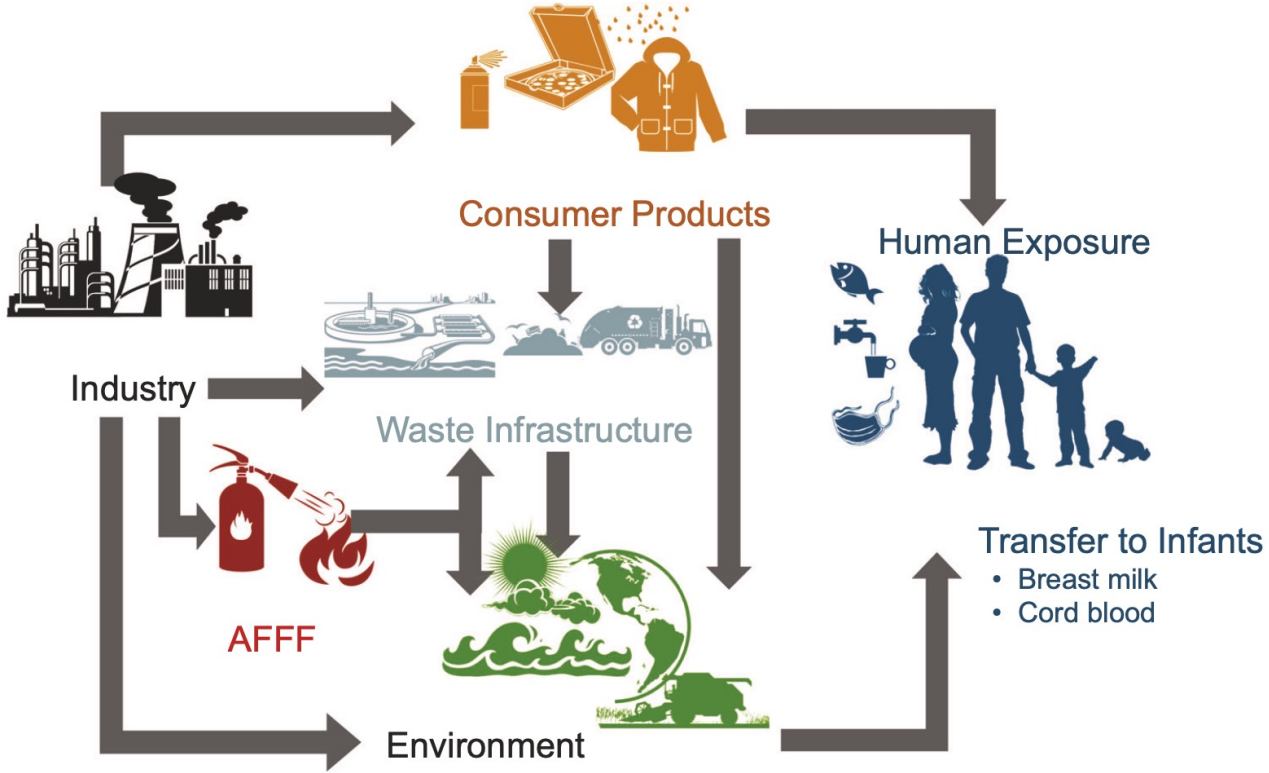


Wang et al. (2020)

Widespread exposure to consumer products such as phenols, parabens and per- and poly-fluoroalkyl substances (PFAS)

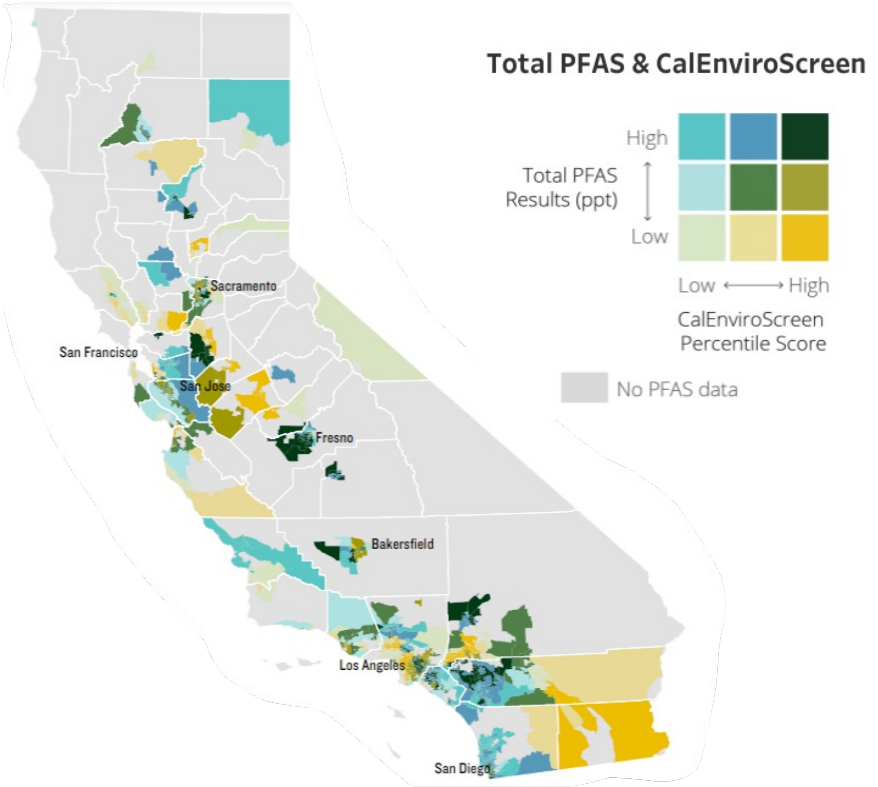
Wang A, Abrahamsson DP, Jiang T, Wang M, Morello-Frosch R, Park J-S, Sirota M, Woodruff TJ. Suspect Screening, Prioritization, and Confirmation of Environmental Chemicals in Maternal-Newborn Pairs from San Francisco. *Environ Sci Technol*. 2021.

PFAS exposures occur through multiple sources

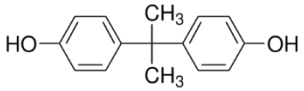


(Sunderland et al. 2018)

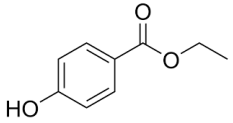
PFAS contamination is also an environmental justice issue



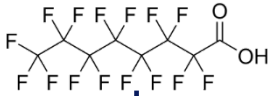
Phenols

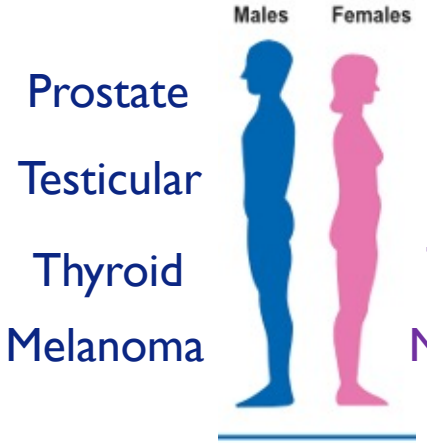


Parabens



PFAS





What environmental chemical exposures are associated with hormone-mediated cancers?

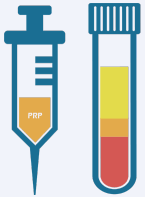
Program on Reproductive Health and the Environment

UCSF EaRTH Center
Environmental Research and Translation for Health

UCSF Helen Diller Family Comprehensive Cancer Center

The National Health and Nutrition Examination Survey (NHANES) data from 2005 to 2018

Physical examinations



Serum PFAS and hormones

Medical conditions and demographic information

Urinary phenols and parabens

The National Health and Nutrition Examination Survey (NHANES) data from 2005 to 2018

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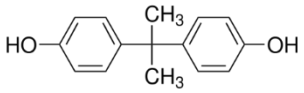
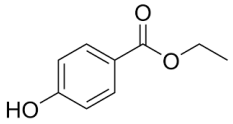
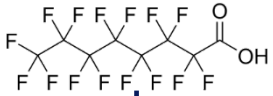
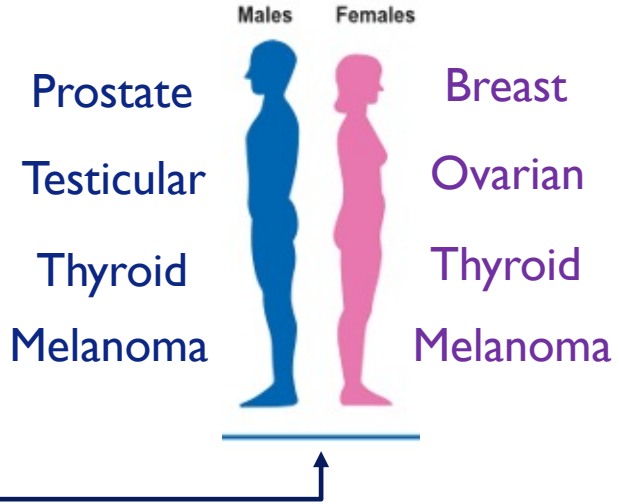


Parabens



PFAS

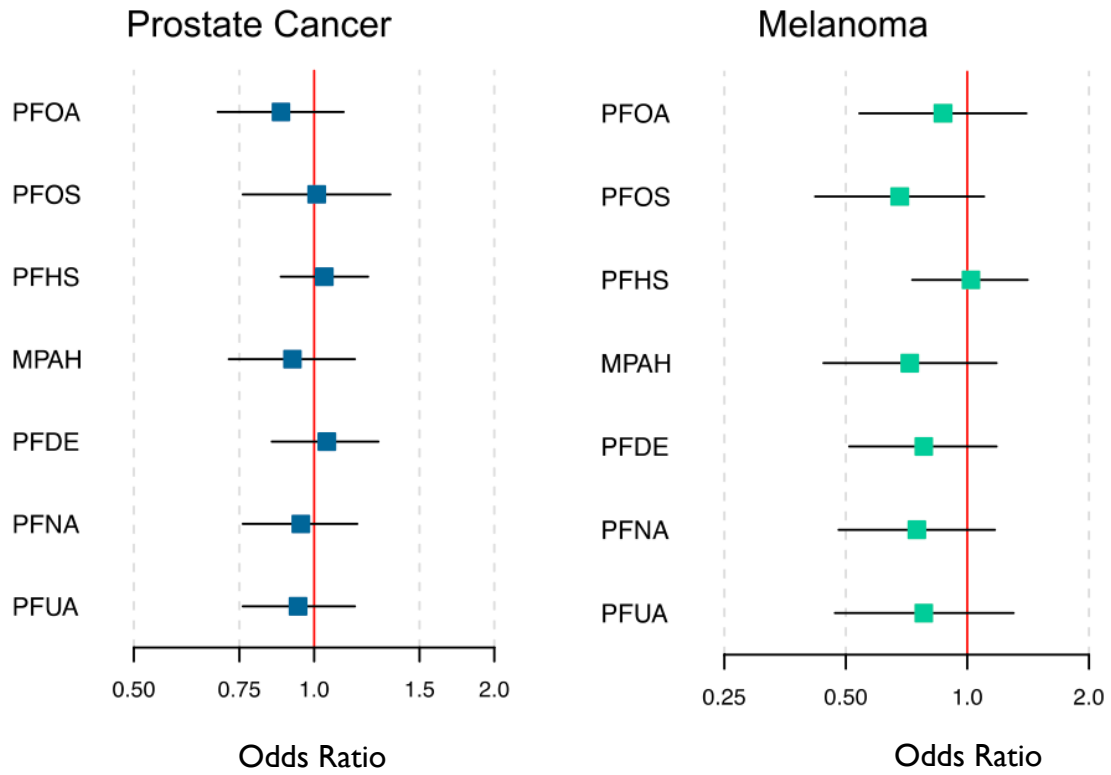




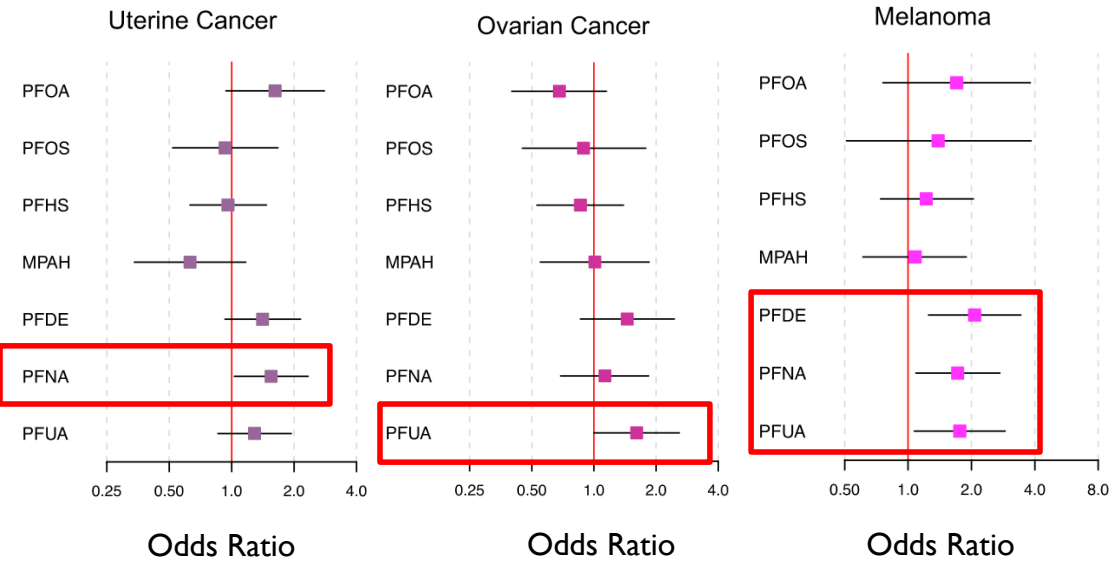
Estimate associations between individual chemicals and previous cancer diagnoses using logistic regression

Model covariates: Age, cotinine, poverty-income ratio, race, education, BMI, creatinine (for phenols/parabens)

PFAS concentrations were not associated with previous prostate cancer or melanoma diagnoses in men



Previous diagnoses of ovarian and uterine cancer and melanoma were linked with higher PFAS exposure



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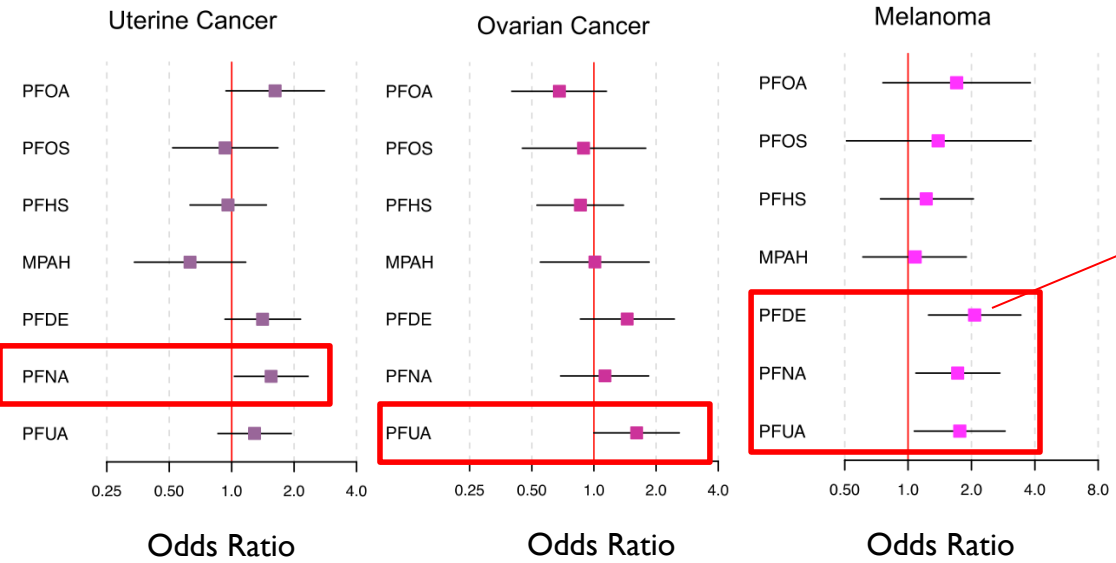

Largest magnitude was an odds ratio of 2 for PFDE

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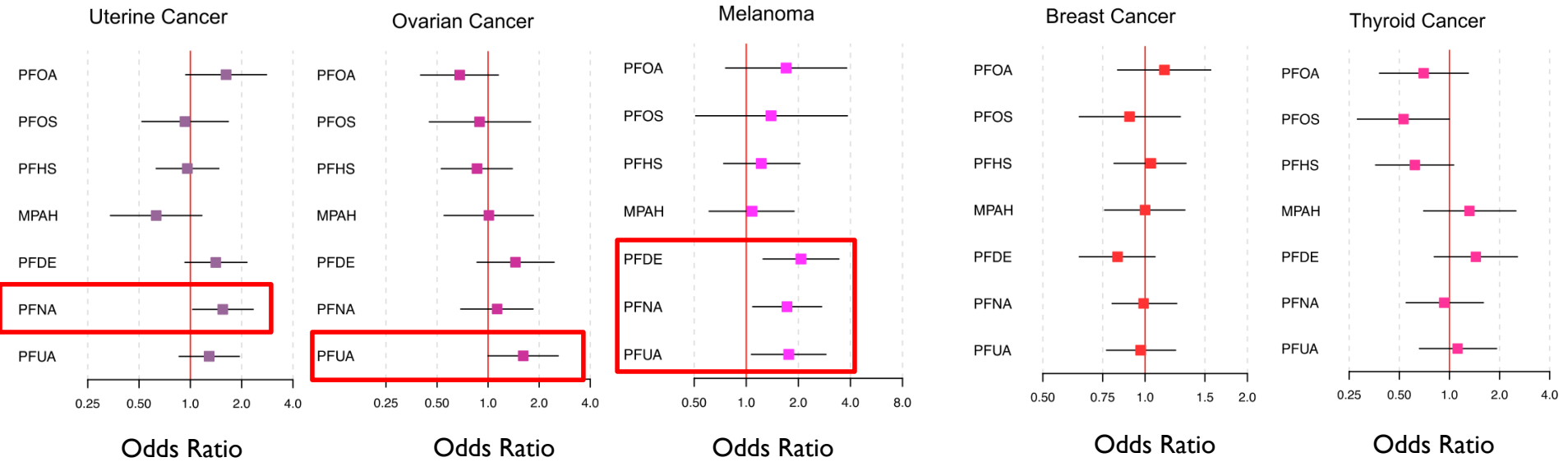
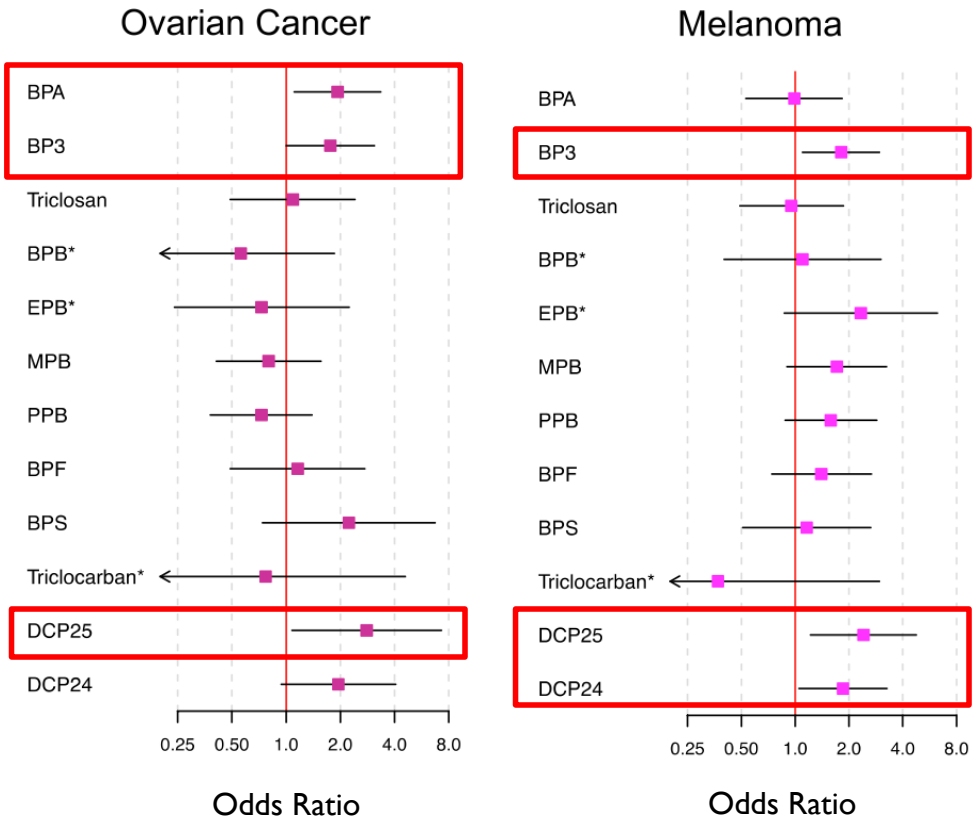


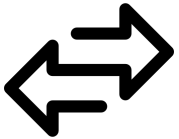
Previous ovarian cancer and melanoma diagnoses were also associated with some phenols



Major Takeaways

PFAS and phenols associations can be used to inform prioritization

Sex differences and experimental evidence underscore need for investigating biomarkers of mechanisms



Limitations in study design highlight need for replication with prospective outcome assessment

Our findings are complemented by recent reports of PFAS and cancer outcomes

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Environmental Health

RESEARCH Open Access

Per- and polyfluoroalkyl substances (PFAS) exposure in melanoma patients: a retrospective study on prognosis and histological features

Paolo Del Fiore[1*†], Francesco Cavallin[2†], Marcodomenico Mazza[1], Clara Benna[3], Alessandro Dal Monico[4], Giulia Tadiotto[1], Irene Russo[1,4], Beatrice Ferrazzi[5], Saveria Tropea[1], Alessandra Buja[6], Claudia Cozzolino[1], Rocco Cappellesso[7], Lorenzo Nicolè[8,9], Luisa Piccin[10], Jacopo Pigozzo[10], Vanna Chiarion-Sileni[10], Antonella Vecchiato[1], Chiara Menin[11], Franco Bassetto[12], Angelo Paolo Dei Tos[7,13], Mauro Alaibac[4†] and Simone Mocellin[1,3†]

Abstract

Per- and polyfluoroalkyl substances (PFAS) are endocrine disrupting chemicals which could be associated with cancer development, such as kidney and testicular cancers, pancreatic and hepatocellular carcinoma and thyroid tumor. Available scientific literature offers no information on the role of PFAS in melanoma development/progression. Since 1965, a massive environmental contamination by PFAS has occurred in northeastern Italy. This study compared histopathology and prognosis between melanoma patients exposed ($n = 194$) and unexposed ($n = 488$) to PFAS. All patients were diagnosed and/or treated for melanoma at the Veneto Oncological Institute and the University Hospital of Padua (Italy) in 1998–2014. Patients were categorized in exposed or unexposed groups according to their home address and the geographical classification of municipalities affected by PFAS contamination as provided by Veneto Government in 2018. Presence of mitoses was found in 70.5% of exposed patients and 58.7% of unexposed patients ($p = 0.005$). Median follow-up was 90 months (IQR 59–136). 5-year overall survival was 83.7% in exposed patients and 88.0% in unexposed patients ($p = 0.20$); 5-year disease-specific survival was 88.0% in exposed patients and 90.9% in unexposed patients ($p = 0.50$); 5-year disease-free survival was 83.8% in exposed patients and 87.3% in unexposed patients ($p = 0.20$). Adjusting for imbalanced characteristics at baseline (presence of mitoses), survival was not statistically different between exposed and unexposed patients (overall survival: HR 1.10, 95% CI 0.77 to 1.58, $p = 0.57$; disease-specific survival: HR 0.99, 95% CI 0.62 to 1.59, $p = 0.99$; disease-free survival: HR 1.10, 95% CI 0.74 to 1.64, $p = 0.62$). Although the magnitude of PFAS exposure was not quantifiable, our findings suggested that exposure to PFAS was associated with higher level of mitosis in melanoma patients, but this did not translate into a survival difference. Further studies are required to investigate this relationship and all effects of PFAS on prognosis.

Research

A Section 508–conformant HTML version of this article is available at https://doi.org/10.1289/EHP10393.

Exposure to Per- and Polyfluoroalkyl Substances and Mortality in U.S. Adults: A Population-Based Cohort Study

Xue Wen,[1] Mei Wang,[2,3] Xuewen Xu,[4] and Tao Li[5]

[1]Laboratory of Mitochondria and Metabolism, Department of Burn and Plastic Surgery, National Clinical Research Center for Geriatrics, West China Hospital, Sichuan University, Chengdu, China
[2]Harvard Reproductive Endocrine Science Center and Reproductive Endocrine Unit of the Department of Medicine, Massachusetts General Hospital, Harvard Medical School, Boston, Massachusetts, USA
[3]Center for Reproductive Medicine, Zhongnan Hospital, Wuhan University, Wuhan, China
[4]Department of Burn and Plastic Surgery, West China Hospital, Sichuan University, Chengdu, China
[5]Laboratory of Mitochondria and Metabolism, Department of Anesthesiology, National Clinical Research Center for Geriatrics, West China Hospital, Sichuan University, Chengdu, China

Background: Per- and polyfluoroalkyl substances (PFAS) are widespread environmental contaminants associated with diseases such as cancer and dyslipidemia. However, few studies have investigated the association between PFAS mixture exposure and mortality in general populations.

Objectives: This study aimed to explore the association between PFAS mixture, perfluorooctanoic acid (PFOA), and perfluorooctane sulfonic acid (PFOS) and mortality in U.S. adults by a nationally representative cohort.

Methods: Adults ≥18 years of age who were enrolled in the National Health and Nutrition Examination Survey (NHANES) (1999–2014) were included in our study. Baseline serum concentrations of seven PFAS were measured and individuals were followed up to 31 December 2015. Hazard ratios (HRs) and confidence intervals (CIs) were estimated using Cox proportional hazards models. Association between PFAS mixture exposure and mortality was analyzed using the *k*-means method by clustering PFAS mixtures into subgroups. Association between PFOA/PFOS exposure and mortality was subsequently analyzed in both continuous and categorical models.

Results: During the follow-up period, 1,251 participants died. In the mixture analysis, the *k*-means algorithm clustered participants into low-, medium-, and high-exposure groups. Compared with the low-exposure group, participants in the high-exposure group showed significantly higher risks for all-cause mortality (HR = 1.38; 95% CI: 1.07, 1.80), heart disease mortality (HR = 1.58; 95% CI: 1.05, 2.51), and cancer mortality (HR = 1.70; 95% CI: 1.08, 2.84). In single PFAS analysis, PFOS was found to be positively associated with all-cause mortality (third vs. first tertile HR = 1.57; 95% CI: 1.22, 2.07), heart disease mortality (third vs. first tertile HR = 1.65; 95% CI: 1.09, 2.57), and cancer mortality (third vs. first tertile HR = 1.75; 95% CI: 1.10, 2.83), whereas PFOA exposure had no significant association with mortality. Assuming the observed association is causal, the number of deaths associated with PFOS exposure (≥17.1 vs. <7.9 ng/mL) was ∼382,000 (95% CI: 176,000, 588,000) annually between 1999 and 2015, and it decreased to 69,000 (95% CI: 28,000, 119,000) annually between 2015 and 2018. The association between PFOS and mortality was stronger among women and people without diabetes.

Discussion: We observed a positive association between PFAS mixture exposure and mortality among U.S. adults. Limitations of this study include the potential for unmeasured confounding, selection bias, a relatively small number of deaths, and only measuring PFAS at one point in time. Further studies with serial measures of PFAS concentrations and longer follow-ups are necessary to elucidate the association between PFAS and mortality from specific causes. https://doi.org/10.1289/EHP10393

After doing the science….what next?

Utilizing science to inform policy and engage communities

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Vy Nguyen


Tracey Woodruff


Peggy Reynolds

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