PFAS Exposures and Seafood Consumption among Asian/Pacific Islanders in the San Francisco Bay Area

Biomonitoring California Scientific Guidance Panel

July 19th 2024

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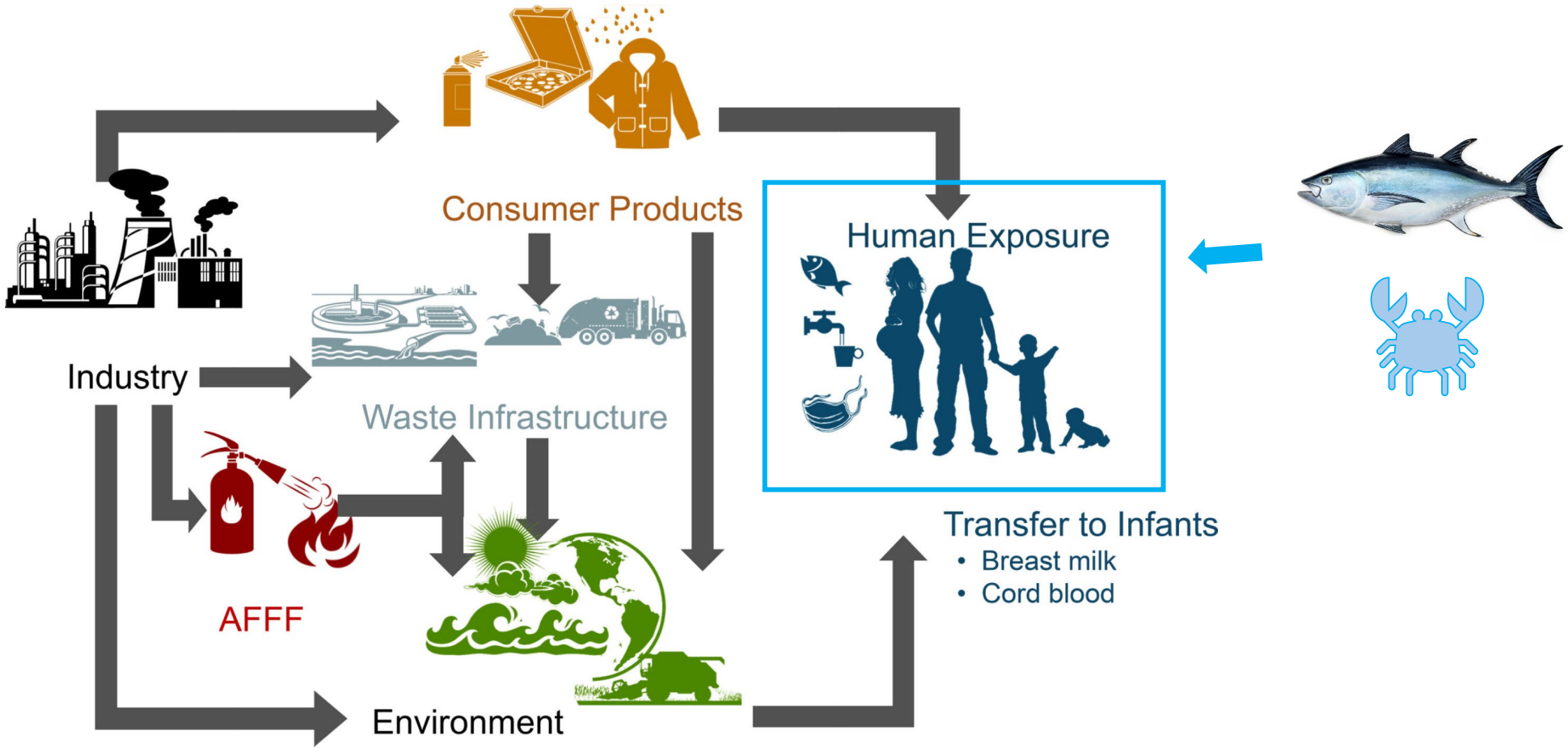
Environmental Health Investigations Branch/Biomonitoring California

Per- and polyfluoroalkyl substances (PFASs)

- **PFASs or "forever chemicals":**
  - Used to make various products resistant to oil, stains, grease, and water
  - Very long-lasting and have spread through the environment

- **Adverse health effects:**
  - May harm the fetus and child
  - May affect the immune system and liver function
  - May increase the risk of thyroid disease
  - May interfere with the body's natural hormones
  - Can increase cancer risk

Exposure pathways to PFASs



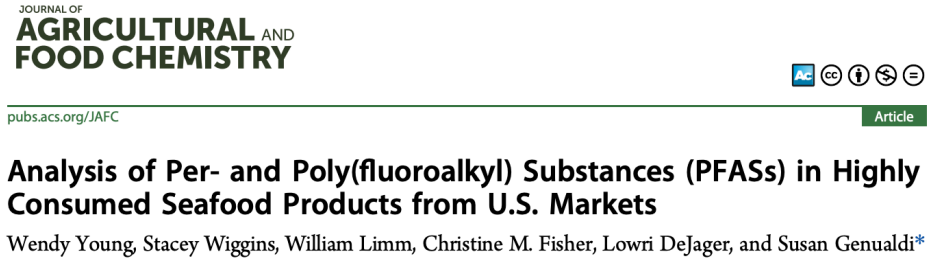
Sunderland, E.M., Hu, X.C., Dassuncao, C. *et al.* A review of the pathways of human exposure to poly- and perfluoroalkyl substances (PFASs) and present understanding of health effects. *J Expo Sci Environ Epidemiol* **29**, 131–147 (2019).

Exposures to PFASs from seafood

- PFASs detected in store-bought fish and shellfish in FDA studies
  (Young *et al.* 2022)

- PFASs detected in U.S. EPA freshwater fish
  (Barbo *et al.* 2023)

- Fish and/or shellfish consumption contributions to PFAS exposure:
  - 50% - Washington State
  - 70-80% - Maine and New Hampshire
  - 86% - European Food Safety Authority

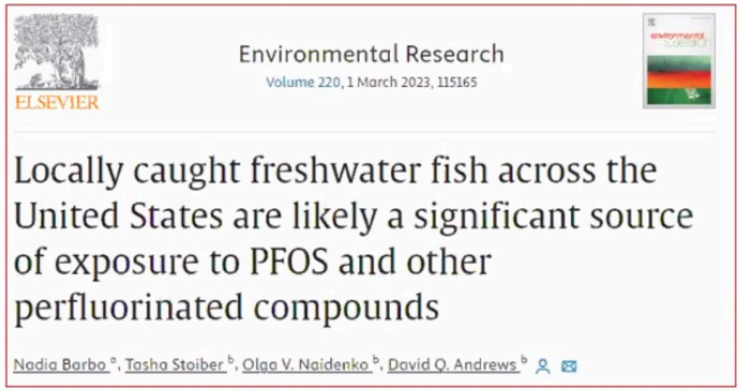

JOURNAL OF AGRICULTURAL AND FOOD CHEMISTRY

pubs.acs.org/JAFC

Article

Analysis of Per- and Poly(fluoroalkyl) Substances (PFASs) in Highly Consumed Seafood Products from U.S. Markets

Wendy Young, Stacey Wiggins, William Limm, Christine M. Fisher, Lowri DeJager, and Susan Genualdi*


Environmental Research

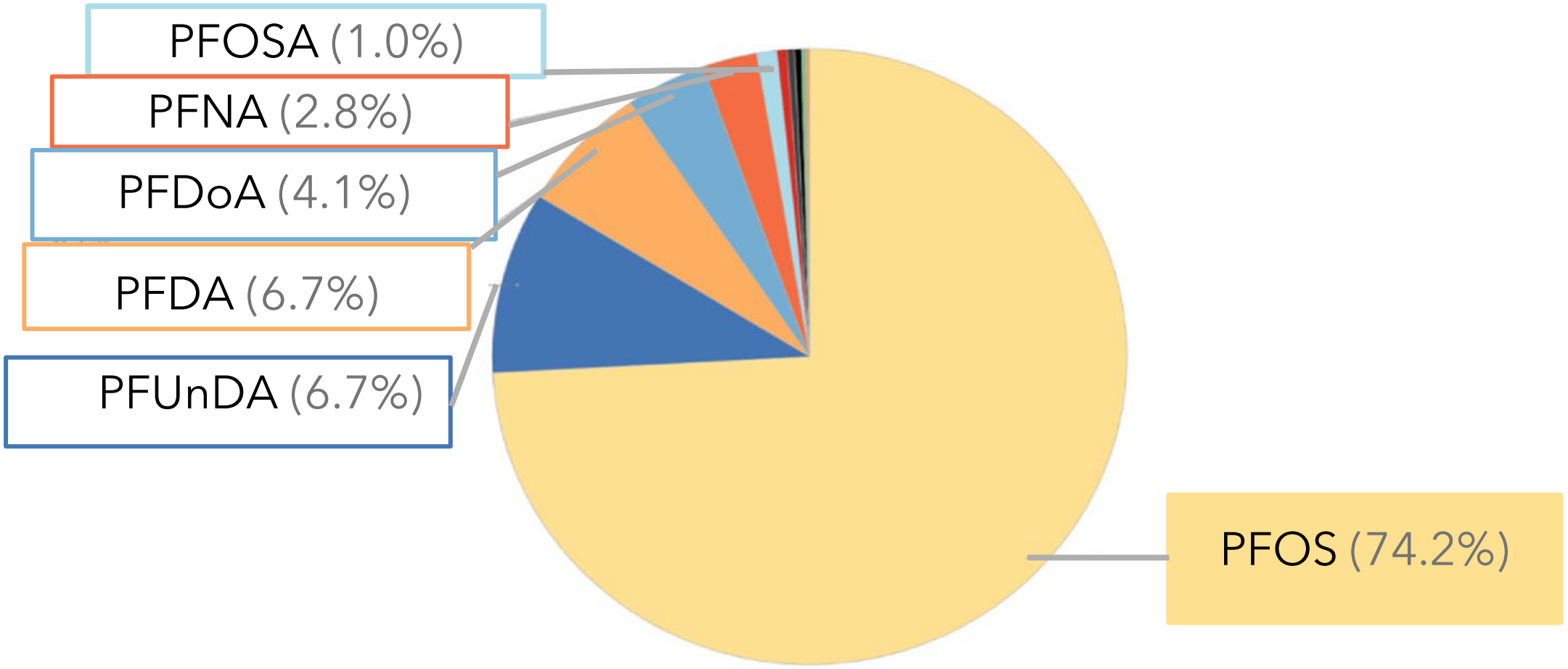
Volume 220, 1 March 2023, 115165

ELSEVIER

Locally caught freshwater fish across the United States are likely a significant source of exposure to PFOS and other perfluorinated compounds

Nadia Barbo [a], Tasha Stoiber [b], Olga V. Naidenko [b], David Q. Andrews [b]

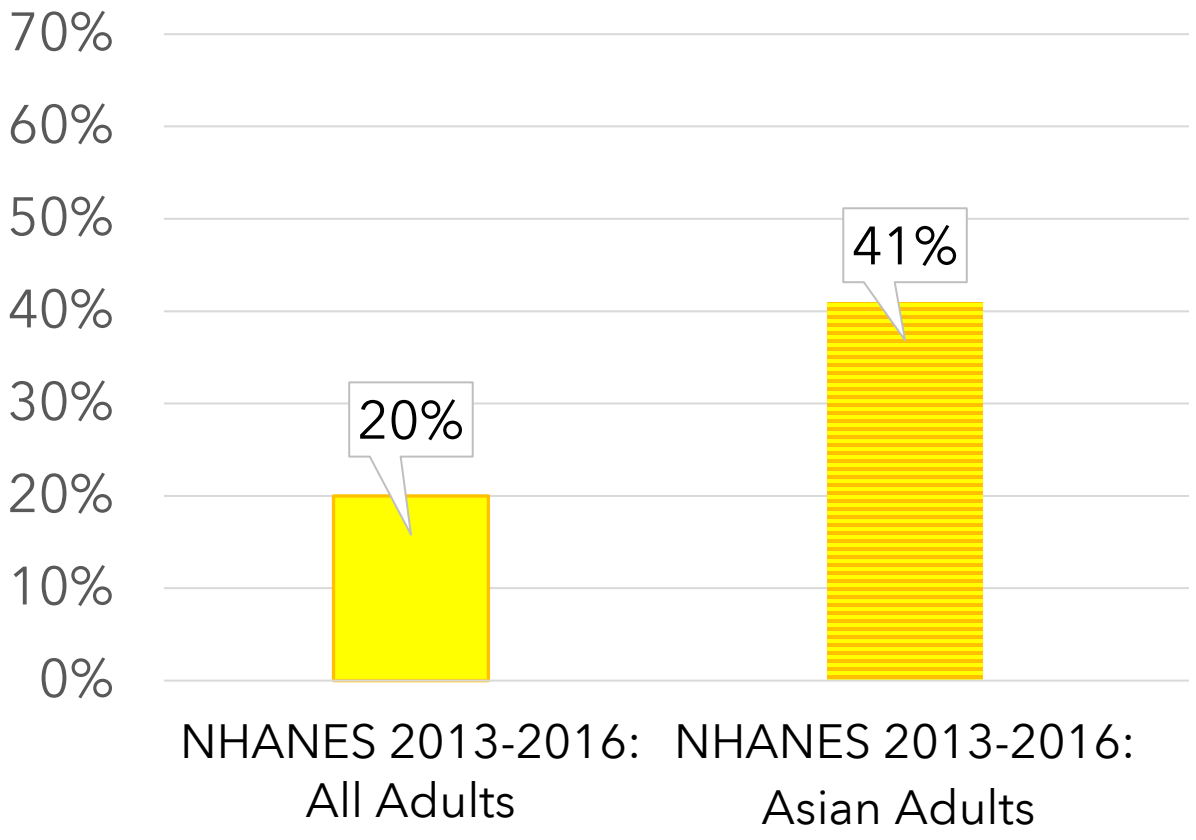
PFASs in U.S. freshwater fish samples



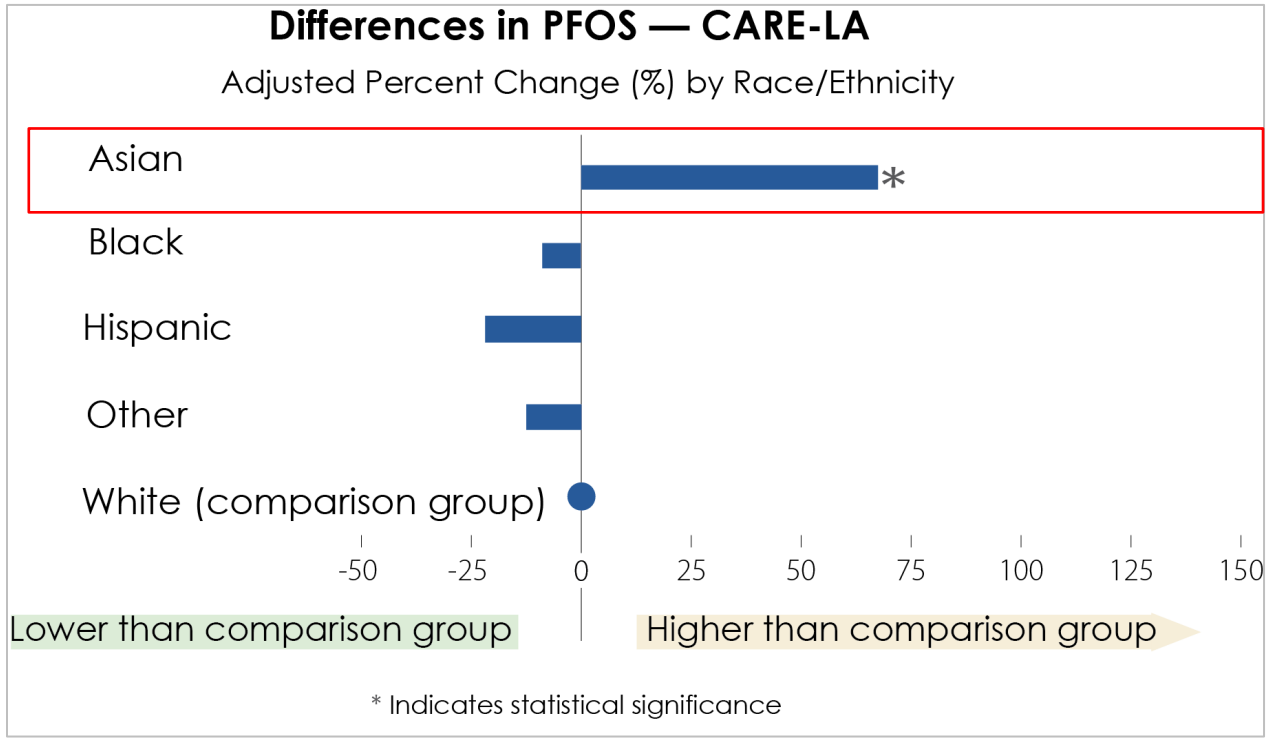
Barbo *et al.* (2023)

Asians in U.S.: higher seafood consumption

Participants reporting seafood consumption at least two times per week:

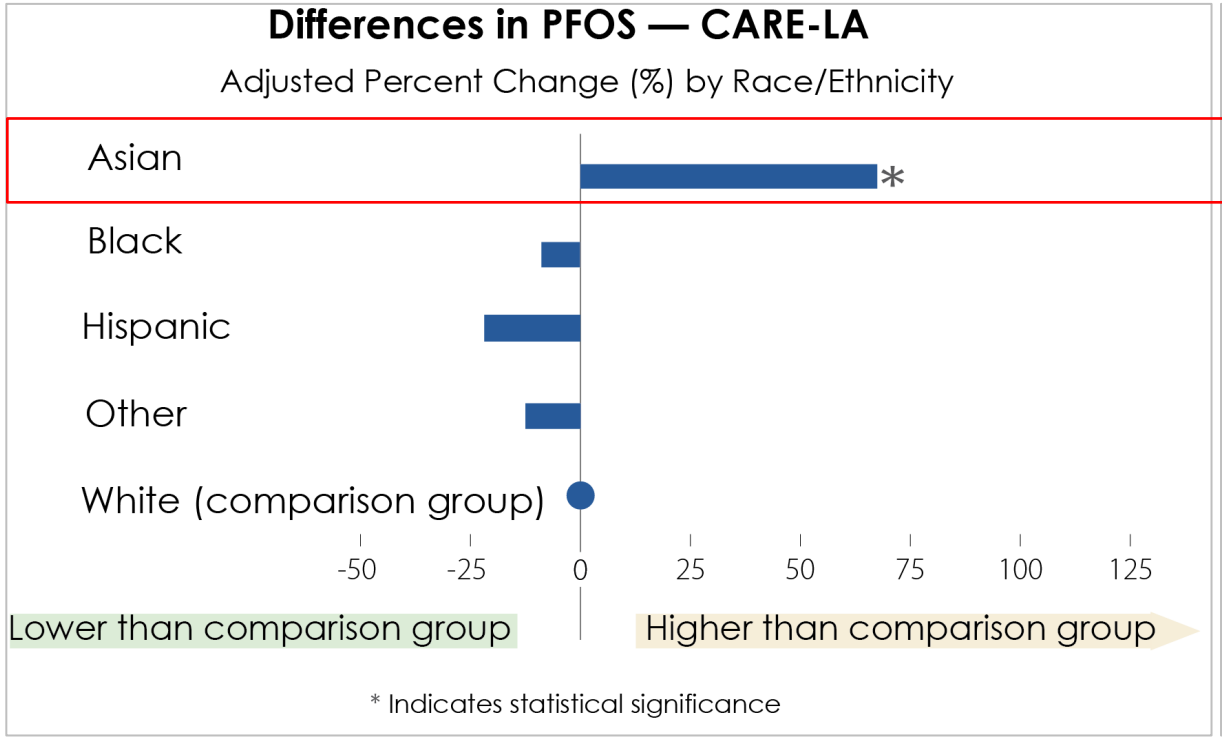


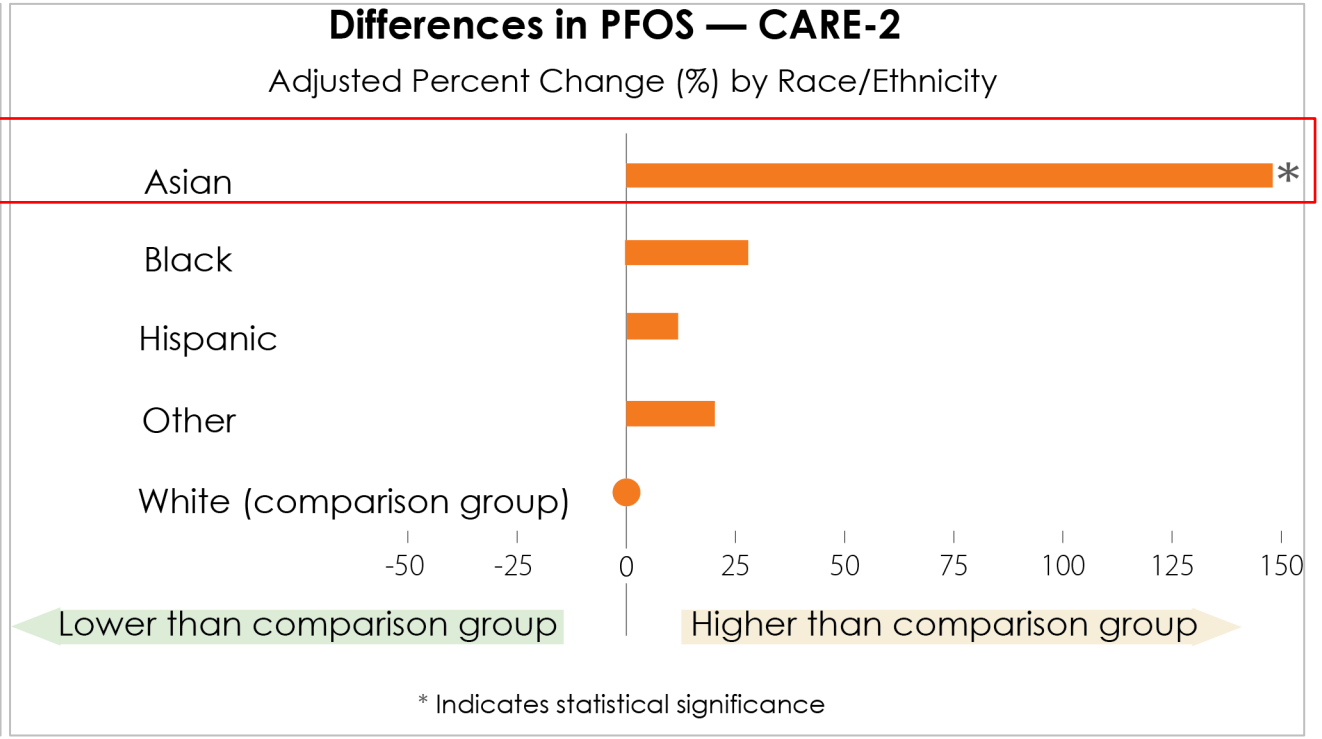
API populations: higher PFAS levels



*CARE: California Regional Exposures Study

API populations: higher levels of PFASs





*CARE: California Regional Exposures Study

Analysis objectives

1) Characterize fish and shellfish consumption in a highly exposed population

2) Evaluate associations between seafood consumption and serum PFAS levels

3) Share results with local, state, and federal partners to aid in efforts to reduce exposures from seafood consumption

Asian/Pacific Islander Community Exposures (ACE) Project

- Previous studies found higher levels of metals and PFASs in Asian Americans
- Extension of collaborations with community groups related to safer fish consumption

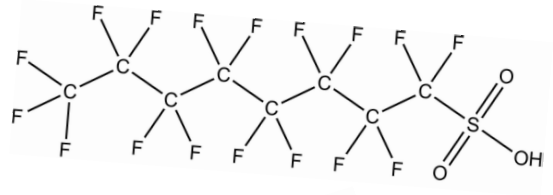
ACE 1: (2016) 100 Chinese American participants, mostly in San Francisco

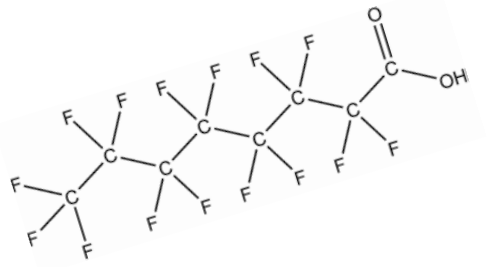
ACE 2: (2017) 100 Vietnamese American participants, mostly in San Jose

ACE Project

Chemicals measured in blood and/or urine:

- Metals: arsenic, cadmium, lead and mercury
- 32 PFASs





Exposure questionnaire:

- Demographics
- Occupation
- Personal care products
- Diet – many questions about fish, rice/rice products, seaweed

Statistical analysis

- **Log-transformed** serum PFAS concentrations

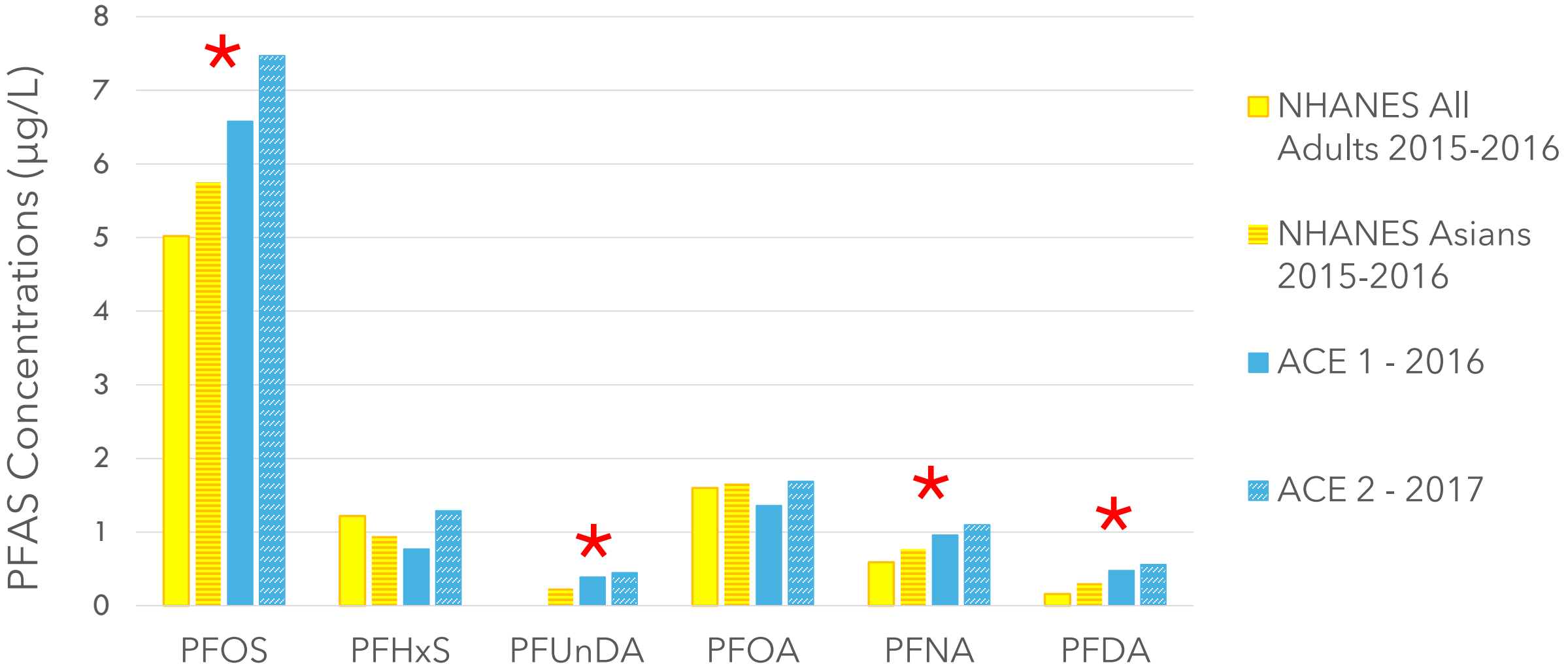
- **Associations between seafood consumption and serum PFAS**
  - Continuous and categorical measures of seafood consumption
  - Multivariable linear regression
  - Covariates: sex, age, birth country, education, portion of life in the U.S., adjustment for household clusters

- Analyzed **combined** and/or **separate** ACE 1 vs. 2 datasets

Study population

Variable	Level	ACE 1 N=96	ACE 2 N=99
Age	Mean	44	47
Sex	% Male	48%	45%
Income	< $25K	27%	45%
	$25-$75K	41%	26%
	> $75K	13%	10%
	Declined	20%	18%
Education	% Greater than high school	58%	42%
Birth country	% Outside the US	81%	96%
Portion of life in U.S.	Mean %	51%	36%
Interview language	% Non-English	57%	63%
Home language	% Non-English	79%	97%

ACE PFAS serum levels higher than NHANES*



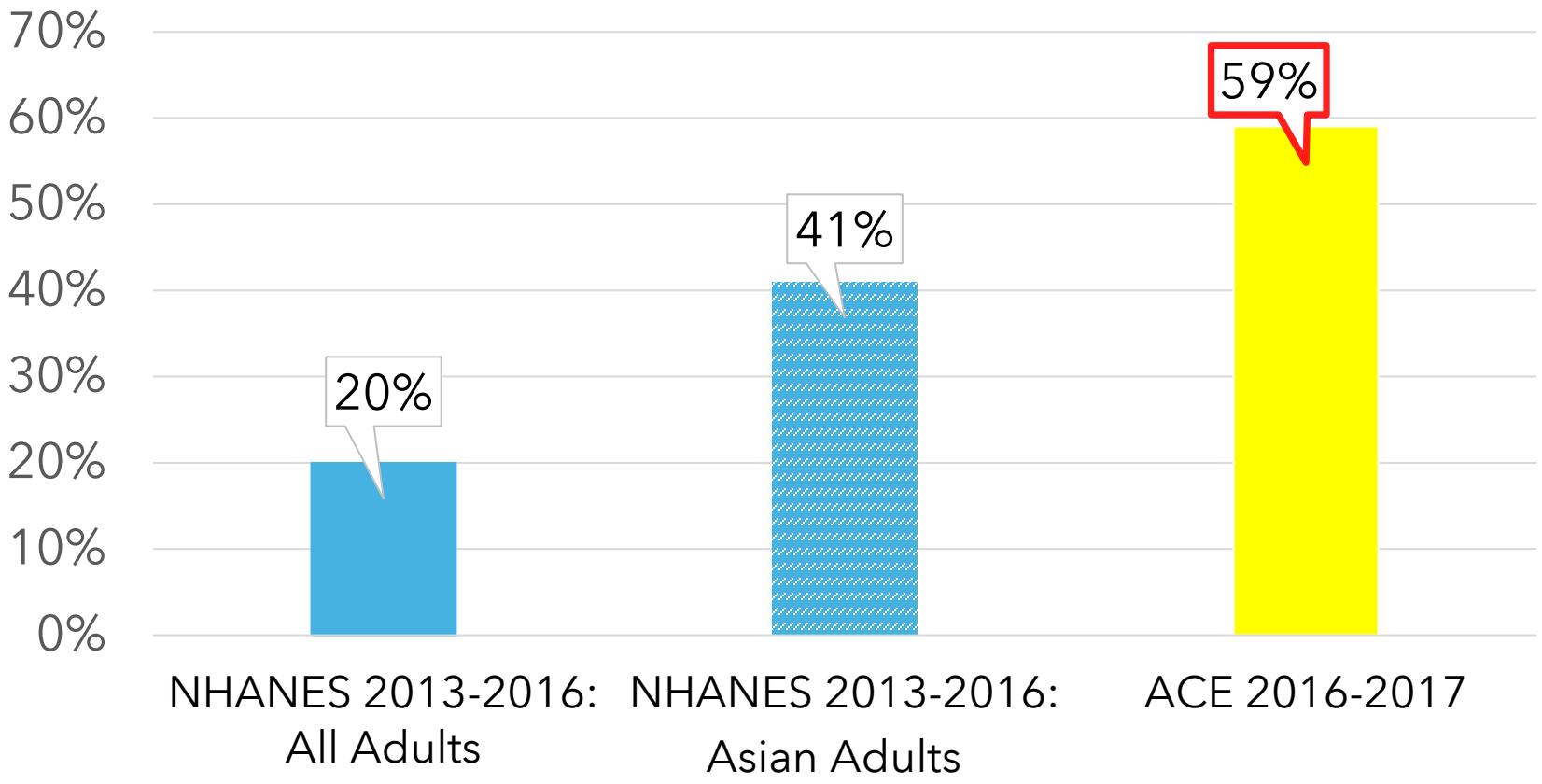
*National Health and Nutrition Examination Survey (NHANES)

National Academies of Science, Engineering, and Medicine - PFAS clinical guidelines (2022)

Sum of 7 PFAS (Serum level)	**Clinical Guidance**	**ACE 1 (%)**	**ACE 2 (%)**	**Combined (%)**	**NHANES (%)**
< 2 µg/L	- Standard Care: Adverse health effects not expected	1%	1%	1%	2%
2 to <20 µg/L	- Prioritize screening for dyslipidemia, hypertensive disorders, breast screening	79%	74%	76%	89%
≥ 20 µg/L	- Assess for kidney and testicular cancer, ulcerative colitis - Conduct thyroid function testing and dyslipidemia screening	20%	25%	23%	9%

Higher seafood consumption in ACE

Participants reporting seafood consumption at least two times per week:



Majority of ACE 2 participants consume fish parts

Consumption Frequency	Fish Eyes (%)	Fish Head (%)	Fish Organs (%)	Fish Skin (%)
Often Eat	25	35	2	55
Sometimes Eat	65	36	87	24
Never Eat	10	29	11	21

Estimated serum increase associated with monthly seafood consumption

	Bought Fish	Caught Fish	Bought Shellfish
PFHxS			
PFOA			
PFOS			
PFNA			
PFDA			
PFUnDA			

† = in ACE 2 only

Adjusting for age, sex, education, income, birth country, portion of life in U.S.

Estimated serum increase associated with 5 additional bought fish meals consumed

	Bought Fish	Caught Fish	Bought Shellfish
PFHxS			
PFOA			
PFOS	9%		
PFNA	20% †		
PFDA	17% †		
PFUnDA	14%		

† = in ACE 2 only

Adjusting for age, sex, education, income, birth country, portion of life in U.S.

Estimated serum increase associated with 5 additional caught fish meals consumed

	Bought Fish	Caught Fish	Bought Shellfish
PFHxS		9%	
PFOA		17%	
PFOS	9%	29%	
PFNA	20% †		
PFDA	17% †	32%	
PFUnDA	14%	24%	

† = in ACE 2 only

Adjusting for age, sex, education, income, birth country, portion of life in U.S.

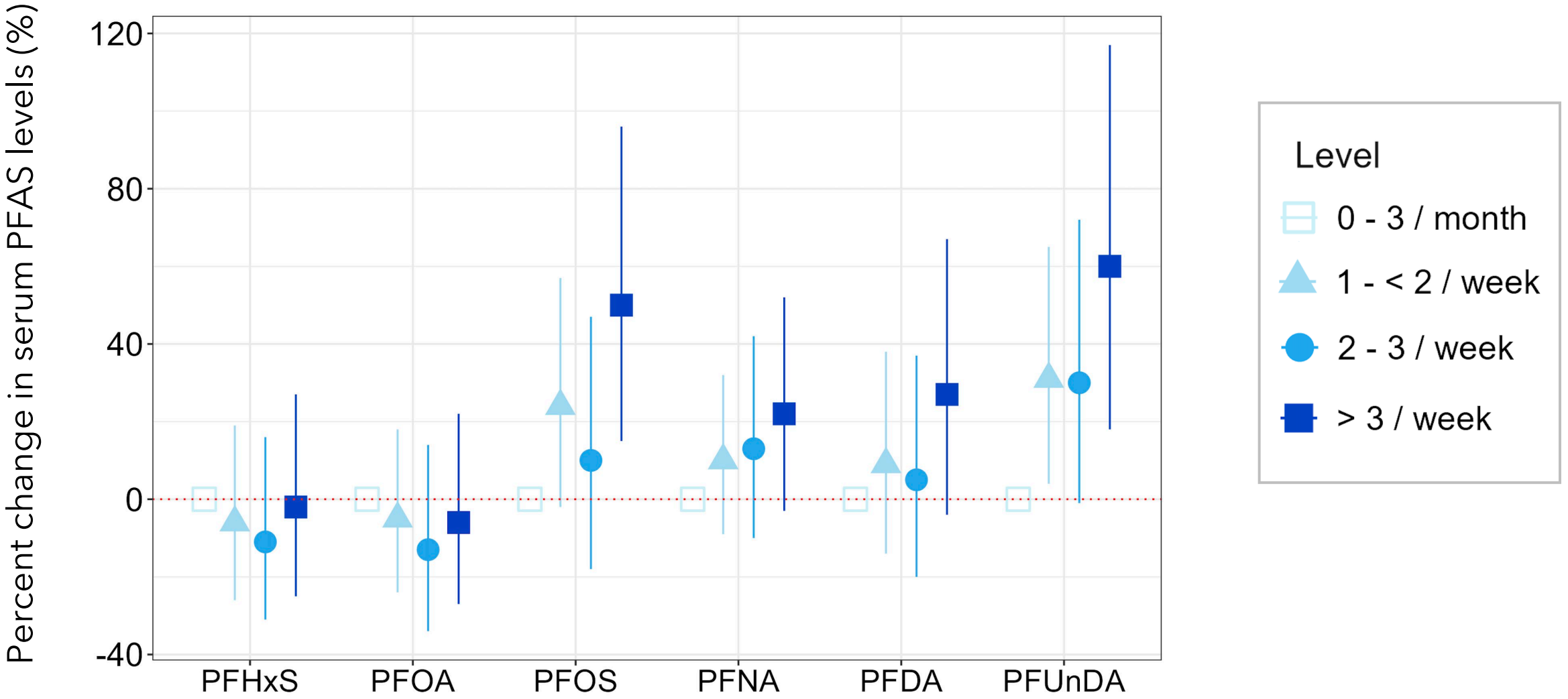
Estimated serum increase associated with 5 additional bought shellfish meals consumed

	Bought Fish	Caught Fish	Bought Shellfish
PFHxS		9%	
PFOA		17%	
PFOS	9%	29%	**11%**
PFNA	20% †		
PFDA	17% †	32%	**10% †**
PFUnDA	14%	24%	**15% †**

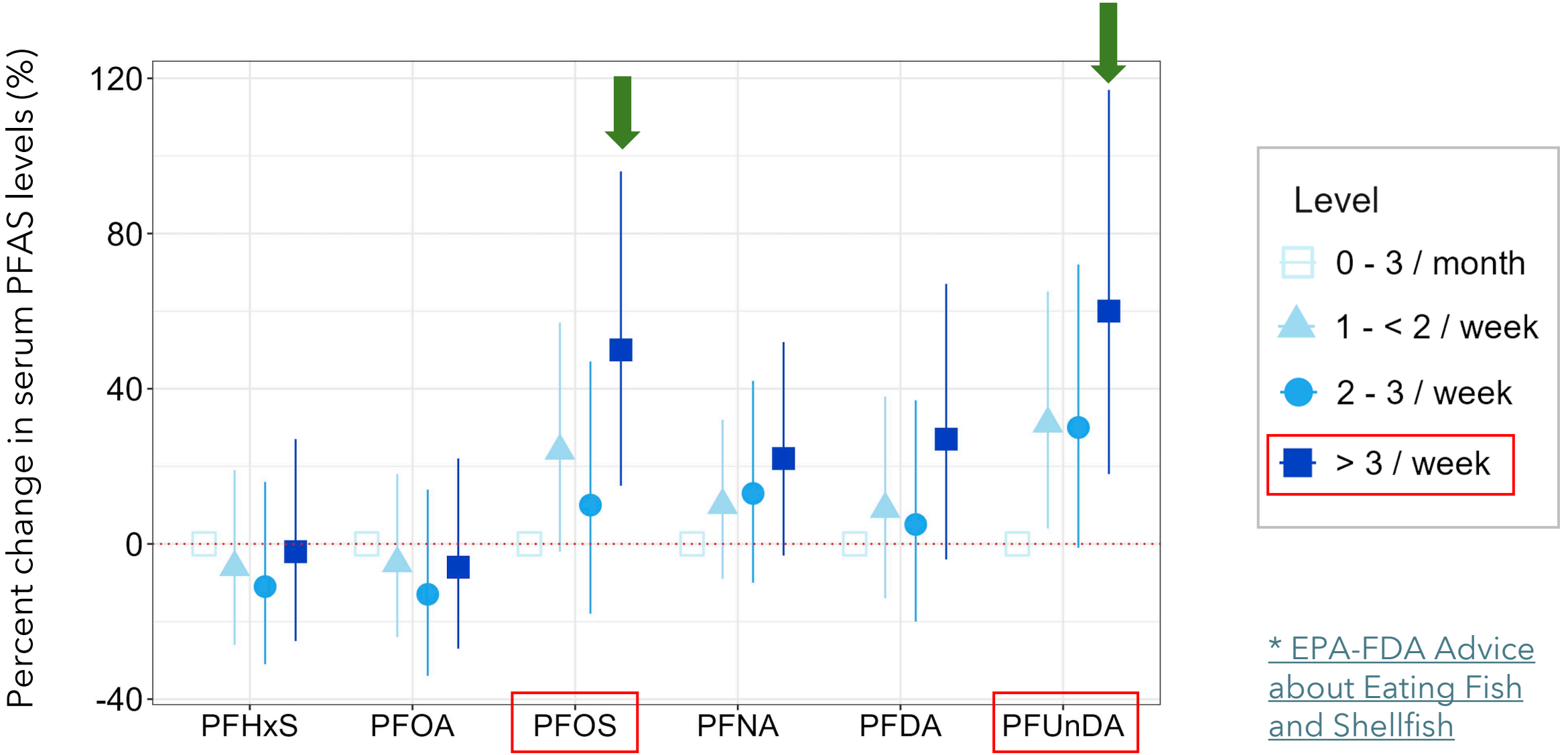
† = in ACE 2 only

Adjusting for age, sex, education, income, birth country, portion of life in U.S.

Serum PFAS levels associated with total monthly fish consumption

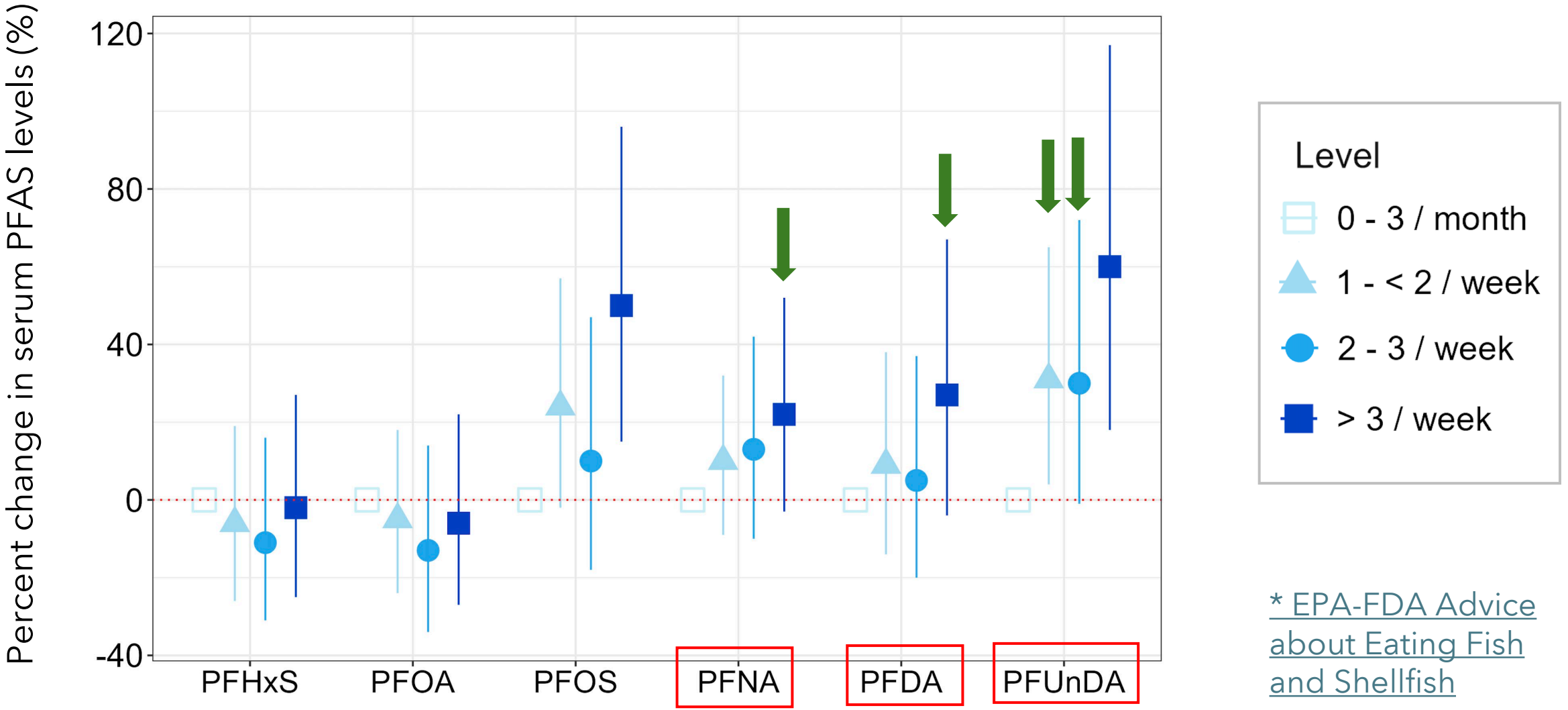


Higher PFOS and PFUnDA levels associated with fish consumption above USDA dietary guidelines* (2-3 servings/week)



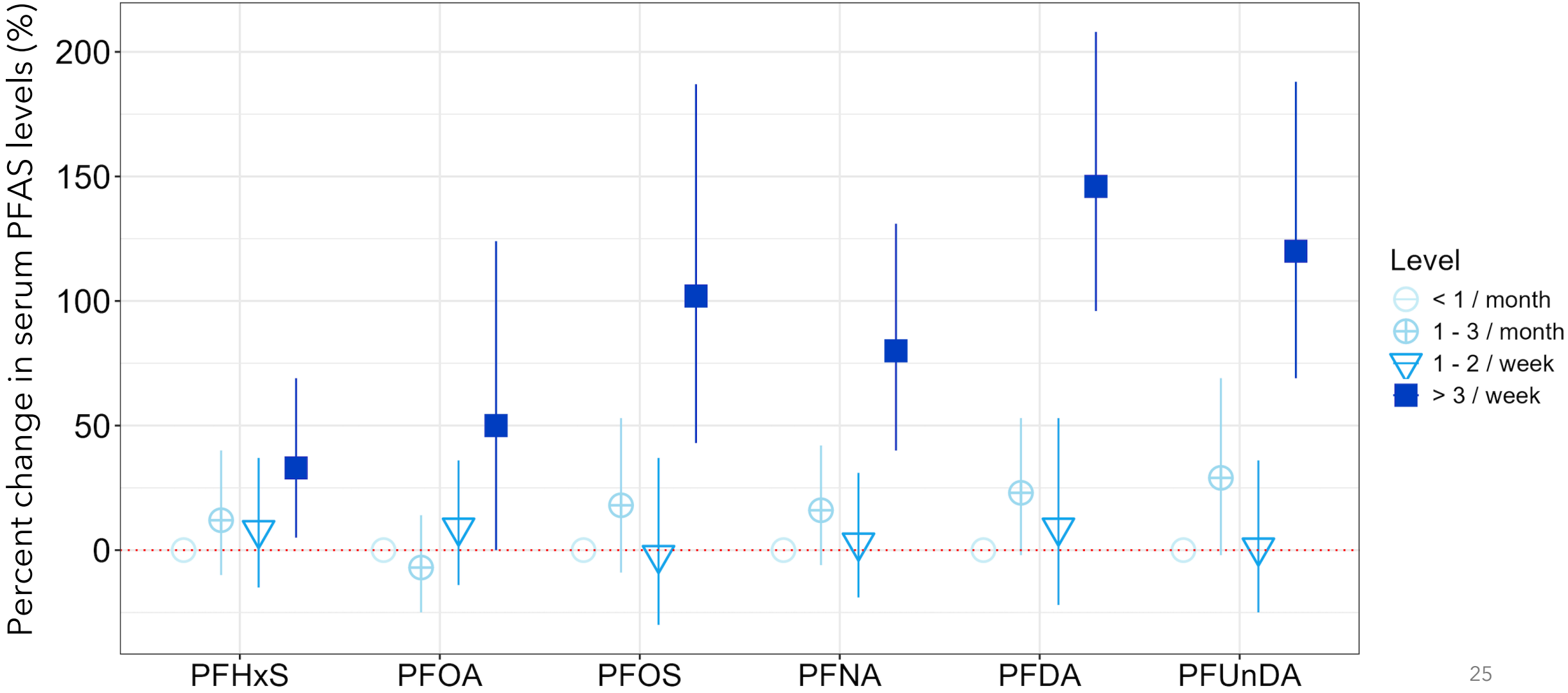
* EPA-FDA Advice about Eating Fish and Shellfish

Higher serum PFAS levels associated with fish consumption at or below USDA dietary guidelines*

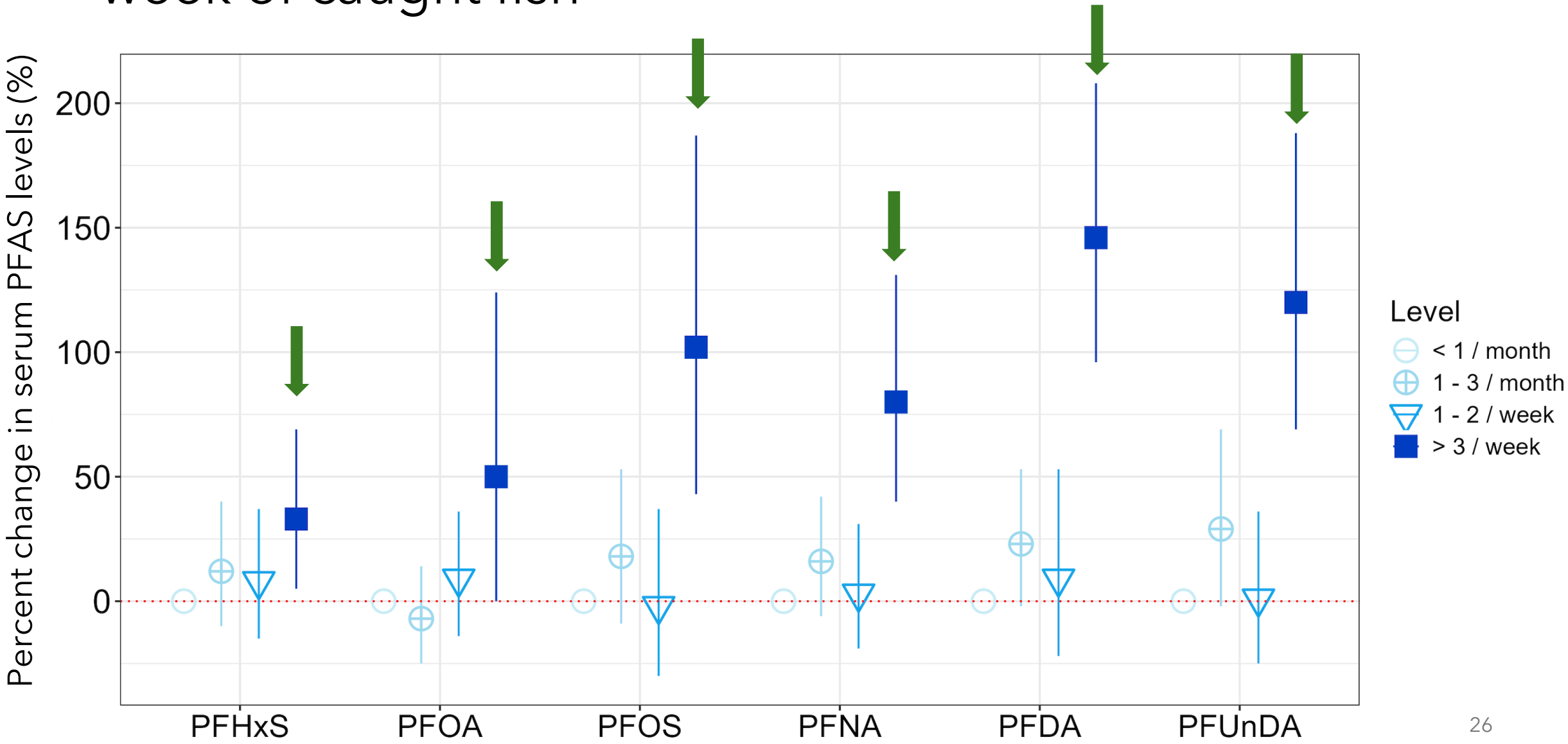


* EPA-FDA Advice about Eating Fish and Shellfish

Serum PFAS levels associated with monthly caught fish consumption frequency



Higher serum PFAS levels associated with >3 meals per week of caught fish



Higher serum PFAS associated with fish parts consumption – ACE 2 only

	Any Fish Part	Fish Organs	Fish Head	Fish Skin	Fish Eyes	Fish Paste, Cakes, or Balls	Shrimp Sauce
PFHxS	34%						
PFOA		36%					
PFOS	124%	54%	89%	71%	41%		
PFNA	49%	42%	41%				
PFDA	99%	67%	79%	48%	41%		
PFUnDA	110%	122%	65%	49%	49%		

Models for PFAS run separately and adjusted for age, sex, education, income, birth country, portion of life in U.S.

Higher serum PFAS associated with seafood products – ACE 2 only

	Any Fish Part	Fish Organs	Fish Head	Fish Skin	Fish Eyes	Fish Paste, Cakes, or Balls	Shrimp Sauce
PFHxS	34%						
PFOA		36%					
PFOS	124%	54%	89%	71%	41%		**5%**
PFNA	49%	42%	41%				**42%**
PFDA	99%	67%	79%	48%	41%	**41%**	
PFUnDA	110%	122%	65%	49%	49%		**39%**

Models for PFAS run separately and adjusted for age, sex, education, income, birth country, portion of life in U.S.

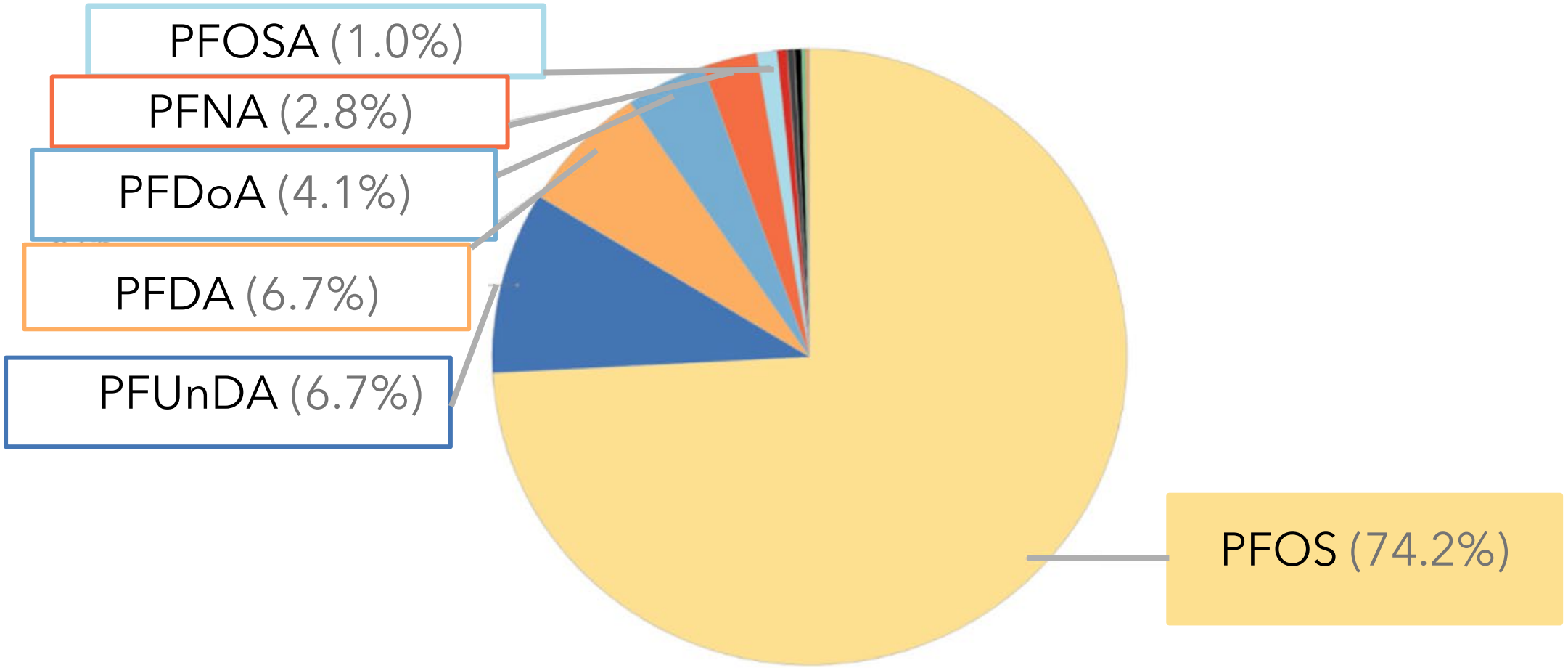
PFASs most associated with seafood consumption

	Bought Fish	Caught Fish	Total Fish < 3 / Week	Caught Fish < 3 / Week	Bought Shellfish	Fish Parts	Fish Paste, Cakes, Balls	Shrimp Sauce	
PFHxS		✓		✓		✓†			
PFOA		✓		✓		✓†			
PFOS	✓	✓	✓	✓	✓	✓†		✓	C8
PFNA	✓†			✓		✓†		✓	C9
PFDA	✓	✓		✓	✓†	✓†	✓		C10
PFUnDA	✓†	✓	✓	✓	✓†	✓†		✓	C11

† = in ACE 2 only

Adjusting for age, sex, education, income, birth country, portion of life in U.S.

PFASs in U.S. freshwater fish samples



Barbo *et al.* (2023)

PFASs associated with seafood consumption

	Bought Fish	Caught Fish	Total Fish < 3 / Wk	Caught Fish < 3 / Wk	Bought Shellfish	Fish Parts	Fish Paste, Cakes, Balls	Shrimp Sauce
PFHxS		✓		✓		✓†		
PFOA		✓		✓		✓†		
PFOS	✓	✓	✓	✓	✓	✓†		✓
PFNA	✓†			✓		✓†		✓
PFDA	✓	✓		✓	✓†	✓†	✓	
PFUnDA	✓†	✓	✓	✓	✓†	✓†		✓

EPA Updates Contaminants

To Monitor For

To Watch For

† = in ACE 2 only

Adjusting for age, sex, education, income, birth country, portion of life in U.S.

HEALTH · NUTRITION

‘Forever chemicals’ found in freshwater fish, yet most states don’t warn residents

BY **HANNAH NORMAN** AND **KAISER HEALTH NEWS**

December 1, 2023 at 11:38 AM PST

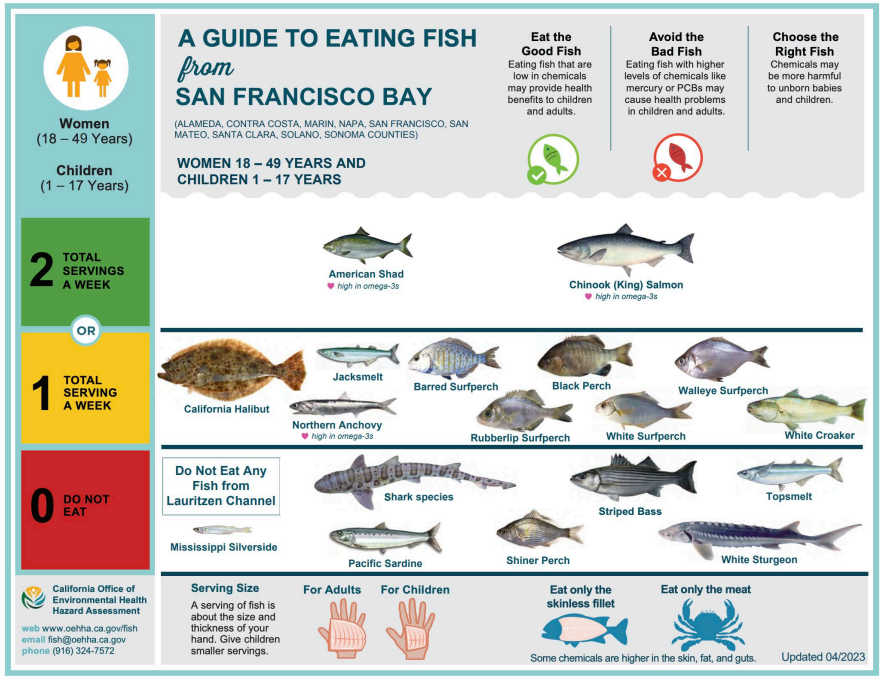
A biomonitoring project focused on the San Francisco Bay Area’s Asian and Pacific Islander community measured PFAS levels in the blood and found higher amounts of the compounds compared with national levels. The researchers also surveyed participants about their fish consumption and found that 56% of those who ate locally caught fish did so at least once a month.

Eating a fish’s fillet is often recommended, as it accumulates fewer chemicals than organs or eggs, but many participants reported eating other parts of the fish, too.

KFF NEWS - DECEMBER 1, 2023

Where are we in California?

- CA fish advisories generally based on mercury, PCBs, selenium, and other chemicals
- No current PFAS fish consumption advisory
- Some Bay Area fish PFAS levels are detected at levels that exceed other states' PFAS fish consumption advisories
- Work underway to evaluate efficacy of an advisory tissue level for PFASs in CA



Data gaps

- **Shellfish PFAS data** in California
- **Time-trends** data lacking in seafood
- **Location-specific data** needed to inform site-specific advisories
- Limited local fish data - both **species** and **non-fillet fish parts** (including whole fish)
- Limited seafood data from **stores and markets**
- Limited **PFASs measured** (samples predominantly focus on only legacy PFASs, most advisories often focus on PFOS)
- More information on how **other communities** impacted needed

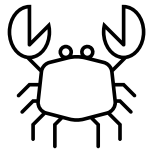
ACE has contributed to…

CA regional efforts:	• San Francisco Estuary Institute: Fish Consumption Survey
CA state efforts:	• CA Realignment • CA Long Term Priorities and Needs Assessment • CDPH Fish Group
Federal and other states:	• EPA Bimonthly Fish Meeting • Requests from NY / Great Lakes
Communication:	• Manuscript and accompanying products • Community group and stakeholders meetings • National Biomonitoring Meeting 2024 • International Society of Exposure Science 2024

Summary

- Fish and shellfish can be **contaminated,** exposing consumers to chemicals such as mercury, PCBs, and PFASs

- Fish, shellfish, and seafood-derived products **are frequently consumed** by API participants in the SF Bay Area



- **Associations** between seafood consumption and PFAS serum levels were observed within this highly exposed population

- More data on **PFASs in seafood** in California are needed to connect findings to environmental health policy and outreach

Thanks to:

- ACE 1 and ACE 2 participants
- APA Family Support Services
- VIVO
- All Biomonitoring California staff who contributed to ACE 1 and ACE 2
- OEHHA
- SFEI, EWG, NJ DEP, EPA

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https://biomonitoring.ca.gov/