CALIFORNIA ENVIRONMENTAL CONTAMINANT BIOMONITORING PROGRAM

(BIOMONITORING CALIFORNIA)

SCIENTIFIC GUIDANCE PANEL MEETING

CONVENED VIA WEBINAR BY: OFFICE OF ENVIRONMENTAL HEALTH

HAZARD ASSESSMENT

CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY

STATE OF CALIFORNIA

MONDAY, NOVEMBER 8, 2021

10:00 A.M.

JAMES F. PETERS, CSR
CERTIFIED SHORTHAND REPORTER
LICENSE NUMBER 10063

APPEARANCES

PANEL MEMBERS:

Megan R. Schwarzman, MD, MPH, Chair

Carl Cranor, PhD, MSL

Oliver Fiehn, PhD

Ulrike Luderer, MD, PhD

Thomas McKone, PhD

Penelope (Jenny) Quintana, PhD, MPH

Veena Singla, PhD

José R. Suárez, MD, PhD, MPH

OFFICE OF ENVIRONMENTAL HEALTH HAZARD ASSESSMENT:

Vince Cogliano, PhD, Deputy Director, Scientific Programs

Dave Edwards, PhD, Chief Deputy Director

Cheryl Holzmeyer, PhD, Health Program Specialist, Safer Alternatives Assessment and Biomonitoring Section, Reproductive and Cancer Hazard Assessment Branch

Sara Hoover, MS, Chief, Safer Alternatives Assessment and Biomonitoring Section, Reproductive and Cancer Hazard Assessment Branch

Shoba Iyer, PhD, Staff Toxicologist, Safer Alternatives Assessment and Biomonitoring Section, Reproductive and Cancer Hazard Assessment Branch

M. Elizabeth Marder, PhD, Senior Environmental Scientist, Cancer Toxicology and Epidemiology Section, Reproductive and Cancer Hazard Assessment Branch

Kristi Morioka, JD, Senior Staff Counsel

APPEARANCES CONTINUED

CALIFORNIA DEPARTMENT OF PUBLIC HEALTH:

Kathleen Attfield, ScD, Chief, Biomonitoring Investigations and Outreach Unit, Exposure Assessment Section, Environmental Health Investigations Branch

Jianwen She, PhD, Chief, Biochemistry Section, Environmental Health Laboratory Branch

Nerissa Wu, MPH, PhD, Chief, Exposure Assessment Section, Environmental Health Investigations Branch

DEPARTMENT OF TOXIC SUBSTANCES CONTROL

June-Soo Park, PhD, Chief, Environmental Chemistry Laboratory

PRESENTERS:

Kate Hoffman, PhD, School of Environmental Sciences and Policy, Nicholas School of the Environment, Duke University

Anna Kärrman, PhD, Deputy Head, School of Science and Technology, Örebro University

Karl Palmer, Deputy Director, Safer Consumer Products Program, California Department of Toxic Substances Control

Tom Webster, DSc, Boston University School of Public Health

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PROCEEDINGS

DR. COGLIANO: Good morning, everyone. I'd like to welcome the Panel and the audience to this meeting of the Scientific Guidance Panel for the California Environmental Contaminant Biomonitoring Program, also known as Biomonitoring California. Thank you all for participating and for sharing your expertise.

First, I'd like to introduce you to OEHHA's new Chief Deputy Director Dave Edwards. Prior to joining OEHHA, Dave was Assistant Chief of the Air Quality Planning and Science Division at the California Air Resources Board. He started at CalEPA as an Environmental Scientist at the State Water Board. Dave holds a PhD and master's degree in chemistry from Princeton and brings a wealth of knowledge and experience to the position.

Welcome, Dave.

The Scientific Guidance Panel last met on July 16th, 2021. The meeting started with an update on Program activities and planning for AB 67 -- 617 biomonitoring study, which will examine the effectiveness of school air filtration on reducing children's air pollution exposures. The remainder of the meeting was focused on using biomarkers of effect in air pollution biomonitoring informed by guest presentations on first a study of Fresno traffic-related air pollution and biomarkers of effect in

children, and second, challenges in conducting air filtration intervention studies, including study design issues.

Panel members, guest speakers, and the audience participated in an open discussion section about air pollution biomarkers of effect to delve further into study design considerations, aspects of measurement and results interpretation. Discussion topics included: Optimal timing for urine sample collection; recommendations for exposure questionnaire content, such as cooking practices and consumption of barbecued, grilled, or fried food, time spent outdoors, and mask wearing; designing a reminder such as a refrigerator magnet for parents about study activities, and; possible options for including a control group.

A summary of input for the July meeting and complete transcript will be posted on the July Scientific Guidance Panel meeting page at biomonitoring.ca.gov.

Because we're meeting virtually today, I would like to have the Scientific Guidance Panel members introduce themselves. I'll call on each member alphabetically by last name. First up is Carl Cranor.

PANEL MEMBER CRANOR: Thank you, Vince. Carl Cranor, Distinguished Professor of Philosophy at the University of California, Riverside, and member -- faculty

member of Environmental Toxicology on the same campus.

DR. COGLIANO: Thank you.

Ulrike Luderer.

PANEL MEMBER LUDERER: Good morning. Ulrike Luderer, Professor of Environmental and Occupational Health in the Program of Public Health at the University of California, Irvine.

DR. COGLIANO: Thank you.

Tom McKone.

PANEL MEMBER McKONE: Good morning. I'm Tom McKone. I'm Professor Emeritus of Environmental Health Sciences at the University of California, Berkeley, School of Public Health.

DR. COGLIANO: Thank you.

Jenny Quintana.

PANEL MEMBER QUINTANA: Hi. I'm Penelope or Jenny Quintana. I'm a Professor of Environmental Health at the School of Public Health at San Diego State University.

DR. COGLIANO: Thank you.

Veena Singla.

PANEL MEMBER SINGLA: Good morning, Veena Singla. I'm a Senior Scientist with the Natural Resources Defense Council in the Healthy People and Thriving Communities Program.

DR. COGLIANO: Thank you. I should announce that this will be Veena Singla's last meeting as a Scientific Guidance Panel member.

MS. HOOVER: I'm sorry, Vince. I need to chime in real quickly. Elizabeth, José Suárez is actually attending and he doesn't have a link. Could you send him a panelist link right now.

DR. MARDER: I'll send him a link immediately.

MS. HOOVER: Thank you so much. I'm going to text him.

Back to you Vince, and when he's on, you can introduce José as well.

DR. COGLIANO: Okay. I'll do.

DR. MARDER: If he's also -- Sara, if he has joined. I can promote him. I didn't see him.

MS. HOOVER: No, he said he doesn't have a link. He can't find a link, so I just want to make sure we sent the link.

DR. MARDER: Sending one right now.

MS. HOOVER: Thank you.

DR. COGLIANO: Okay. I'll be watching for his name to pop up. Okay. Anyway, I would like to announce that this is going to be Veena Singla's last meeting as a Scientific Guidance Panel member. Veena was appointed by the Senate Rules Committee in 2018, and prior to that,

provided input at SGP meetings as a program stakeholder. She has decided not to seek reappointment to give more attention to her many other commitments, which include work as a Senior Scientist at the Natural Resources Defense Council, serving on the U.S. EPA's Children's Health Protection Advisory Committee, the National Toxicology Program's Board of Scientific Counselors, and the Board for the Clean Air -- Clean Production Action. She did not come to this decision lightly, but is confident that she is leaving behind both a strong program and a supportive and involved SGP. We would all like to thank her for her outstanding service to the people of California and wish her the best -- the very best in future endeavors.

And now I think I will turn the microphone over to Meg Schwarzman, the Chair of the SGP who will provide more details about today's meeting.

CHAIRPERSON SCHWARZMAN: Thank you. I'm Dr. Meg Schwarzman, a Physician and --

MS. HOOVER: I'm sorry, Meg. Can you just hold? For some reason, although we have these invitations, José didn't get his and Oliver didn't get his, so can you just hold here.

CHAIRPERSON SCHWARZMAN: Should we just wait?

MS. HOOVER: Yeah.

CHAIRPERSON SCHWARZMAN: Okay.

MS. HOOVER: Let's just hold for a moment. Elizabeth, if you could follow up. We have it listed that we sent it out, so you might want -- might be able to just --

DR. MARDER: I have sent -- I have sent José's. If either wants to use the public link, I can promote them instantaneously on the website.

MS. HOOVER: Okay. Does Oliver have his -- Oliver have his? I thought that that was sent out, so you should just be able to forward it.

DR. MARDER: Yes.

PANEL MEMBER SUÁREZ: This is José Suárez. Good morning, everybody. I'm in now.

MS. HOOVER: Thank you so much, José, and sorry about that slight glitch.

PANEL MEMBER SUÁREZ: Thank you.

PANEL MEMBER FIEHN: Hello. Now, I'm in.

MS. HOOVER: Thank you so much, Oliver. Sorry for that slight glitch. Okay. Everybody is on. Welcome. Over to you Meg.

PANEL MEMBER SCHWARZMAN: I guess we should return back and have José and Oliver introduce themselves.

PANEL MEMBER FIEHN: Oliver Fiehn, UC Davis, mass spectrometry analysis of chemicals.

CHAIRPERSON SCHWARZMAN: Thank you.

José.

PANEL MEMBER SUÁREZ: I'm José Suárez, Associate Professor in the Herbert Wertheim School of Public Health at UC San Diego.

CHAIRPERSON SCHWARZMAN: Thank you. And I'm Meg Schwarzman on the faculty at UC Berkeley School of Public Health, Environmental Health Sciences Division.

And with that, thank you for getting everybody in who needed to be in and introduced and we'll start the rest of the meeting. I want to give an overview of the meeting by starting with the Panel goals for today. We will, as usual, first receive a program update with the remainder of the meeting focusing on discussion of perfluoroalkyl and polyfluoroalkyl substances, which we refer to collectively as PFASs. State staff will discuss California's activities on PFAS, including PFAS biomonitoring in surveillance studies and community-focused studies, and CalEPA's efforts to address these compounds also.

We will have guest speakers from Örebro University in Sweden, Boston University School of Public Health, and Duke University. And they will prevent -- present, excuse me, on PFAS laboratory methods and also sources of human exposure.

After the presentations, we'll hold an open discussion with guest speakers and the audience, and that will be to address questions on how Biomonitoring California can support efforts to reduce exposure to PFAS, including possible next step for the Program.

After each presentation, as we usually do, there will be time for questions from Panel members and from the audience. So let me take just a moment to explain how we do these comment periods and discussions on the remote -- in the remote format. So during the question periods that come after each talk, speakers please remain unmuted with your webcam showing, so that you can respond to questions. If SGP members want to speak or ask a question, just raise your hand. You'll have your webcam on and I can see you. And then you'll unmute yourself after I call on you and comment or ask your question.

If webinar attendees have questions or comments, please submit them via either the Q&A feature of the Zoom webinar or by email to biomonitoring@oehha.ca.gov. And please just keep your comments focused on the items under discussion and brief. We'll read aloud any relevant comments paraphrasing them if they're long.

During both the morning and afternoon public comment periods and in the afternoon discussion session, webinar attendees can also speak. If you don't want to

submit a written comment, you can speak. Then please use the raise hand feature in Zoom and I will call on you.

So with that, I want to introduce our first speaker. Nerissa Wu is the overall lead for Biomonitoring California and Chief of the Exposure Assessment Section in the Environmental Health Investigations Branch, or EHIB, at California Department of Public Health. She'll provide an update on current Program activities.

(Thereupon a slide presentation.)

DR. WU: All right. Can you hear me?

CHAIRPERSON SCHWARZMAN: (Thumbs up.)

DR. WU: Allow me to get my screen. And do you now see my slides?

Everything appear okay?

DR. MARDER: We do.

DR. WU: Okay. Great. Well, welcome everybody. Thanks for joining us, especially those of you who are calling in from different time zones. I just want to start by adding my thanks to Veena as well for your participation on the Scientific Guidance Panel and just your ongoing support for the Program. We'll miss having on you the Panel.

So I only have you for 10 minutes today. So I'm going to be brief. I'm covering some administrative updates, where we are as a Program. And then I will turn

to updates on two of our projects. So last time we met, we had just gotten news of our newly signed budget, which includes an additional $2 million annually from general fund. This is super welcome news for the Program. So we are going through all the administrative tasks. To make sure the budget -- the funding gets to the right place and is used to support the Program in the key areas we've been highlighting over the years.

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DR. WU: We've talked about the need for sustainable funding to help maintain lab staff and to keep our expertise both the labs have developed. And on the epi side, we need to be able to analyze and release data more quickly. We've talked about the need to support field work and to be able to reestablish our surveillance efforts.

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DR. WU: So towards those goals we are recruiting for a number of different positions, epidemiologists so the Research Scientists I, III, and IV levels. We're looking for Health Program Specialists and we have laboratory and chemists for the lab posted. All of these positions are available on CalCareers. They're also -- for the EHIB positions, they're also listed on our EHIB website. And I think there will be a notice going out to

our listserv as well through the Biomonitoring membership. So please pass this information along to anyone who might be interested in joining our team or if you yourself are interested in coming to be part of Biomonitoring California.

We do have a workshop planned for November 22nd to talk to people about what it's like to work in the public sector and particularly for Biomonitoring California and how to go about applying for jobs in the California State sector -- State system. So I'm happy to share links and registration information on that after my talk. Bringing in staff into the State system is a long slow process, but we hope to have some progress to report back to you at our next meeting.

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DR. WU: We do have two new staff people to introduce to you. We have Faye Andrews our new epidemiologist, also a new doctor at EHIB, and Cheryl Holzmeyer, who has recently joined OEHHA as a Health Program Specialist. And she's helping to run this meeting. They're both making contributions already and welcome to the two of you. And I also wanted to mention that this is Jed Waldman's last meeting as a part of Biomonitoring California. Although he's welcome to join as a member of the general public next year. Jed is

retiring at the end of this year and our Program won't be quite the same without him. So thank you to Jed for everything you've done for the Program as well.

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DR. WU: So on to project updates. The Stockton Air Pollution Exposure Project, or SAPEP, has made a lot of progress in the last month finalizing study tools on things like consent forms, questionnaires, recruitment materials. They've gotten their full approval from the IRB and have confirmed a school site, the All Saints Academy of Stockton, which is a small school of about 90 kindergarten to 8th graders with a very supportive principal. So they've done a site visit and they are actually starting recruitment this week.

Field work is scheduled to begin in early December. You remember this project, it involves two sample collection points, one week apart. And we'll have a much more thorough update at the March SGP meeting.

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DR. WU: We also have some progress to report for the California Regional Exposure, or CARE, Study.

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DR. WU: We had just returned results for our participants the last time we met. And we should have our summary results posted to the web in the next few weeks.

Noting that while we recruited participants following the same CARE protocol as our first two regions, the early closure of CARE-3 means that we only had 90 participants. And so there are limits to how we can interpret that data. We're also working on the CARE report, which will include detailed study methods and results.

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DR. WU: And I want to say just a word about the choice to do a report, because this is something a little bit new for the Program. The report gives us an opportunity to talk about the study in the context of our larger Program and to also get really into the details of the method and choices we made as part of the study design. And I think that will help the reader understand what the data represents and how it can be used and interpreted.

The report will have both unweighted and weighted data, which will provide better exposure estimates for the region and that will be a better comparison both for us but also for other researchers to use when we have comparative data. We'll also have data by demographics strata, which will be very useful.

So releasing a report like this does not mean we won't be publishing in scientific journals as well. As we delve more into statistical analyses, there will be other

opportunities for us to publish via that route. In any case, we hope to be finishing up this report in the next month or so and releasing it in early 2022.

Five minutes already. Oh, goodness.

As we work on the CARE report, it's also an opportunity for us to learn from our previous experiences and think about our next steps in conducting surveillance. We're continuing to meet with other collaborators and defining Program's priorities.

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DR. WU: We're also taking input from different stakeholders and recommendations from experts, like this Panel, into consideration. So these are the recommendations that you provided at our last meeting. It was after that discussion. So thanks to Meg and Jenny for summarizing these for inclusion in the Seventh Report to the Legislature.

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DR. WU: One of the prioritizations we also have to keep in mind is which chemical panel should we be focusing on? And this is not just an issue for the lab with respect to what methods they should be prioritizing, but our focus also has bearing on the design of a study, where we might try the study, whom we want to include in the study, and what questions to include in the

questionnaire.

So the topic for today's discussion is a chemical class that has been a priority for this Program as well as for State and nationwide concerns. And likely it does not need any introduction for this audience. But in case you are joining us for the first time or new to biomonitoring, these are the per- and polyfluoroalkyl substances, the PFASs. There are several different definitions in play. The definition presented here is from Buck et al., and it's the definition that this Program uses for the purposes of designation.

Tom Webster will talk a little bit more about the different definitions and the implications thereof in this afternoon's session. But again, for our Program, the definition is relevant because of what the designated list means, in terms of what we are able to measure as a Program.

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DR. WU: PFASs are primarily used to make products resistant to stains, water, and grease. And many of the products we use in our everyday lives, things like stain-resistant carpets or stain-resistant furniture, takeout containers that we want to hold soupy or greasy foods are often treated with PFASs or used in industry added to metal plating and finishing processes to reduce

toxic air emissions. And, of course, they are part of the AFFF fire suppressant foams used to fight fires. Manufacturing of the long-chain PFASs have been out -- phased out of the U.S. Many of those -- but thousands of PFASs are continued to be used and manufactured worldwide.

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DR. WU: And why do we care? Why are we concerned about PFASs? Well, different PFASs have been found to be associated with a wide range of health impacts, including thyroid disease, and some cancers, increased cholesterol, infertility, and adverse birth outcomes, altered child development, impacts on liver enzyme activity, and a weakened immune system.

As I said, many have been phased out, but as some of the legacy PFASs are persistent and bioaccumulative, we're still finding them in our bodies. And the shorter chain PFASs are still widely used. As we have seen for many chemicals, there is this opportunity for regrettable substitutions. As we move away from one set of PFASs, we introduce the use of another. This trend and use over time, the decreases in some PFASs and increases in others is the kind a scenario for which biomonitoring can be very useful to monitor how our body burdens follow manufacturing trends.

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DR. WU: So during the day, you'll hear about different lab methods. Currently, our lab has several methods available for looking at PFASs, including the method to measure the 12 legacy PFASs. There's the expanded 40-PFAS replacement for -- 40-PFAS panel, which includes some of the replacement PFASs. And then there is the non-targeted analysis for PFASs and other chemicals of concern. These are currently available in serum. And the lab is working to further automate and make these more sensitive, faster, and greener, and also validate the methods in plasma.

So with that overview, I want to conclude my portion of the talk and turn things over to our PFAS experts, but I will be open to questions after our next couple of speakers.

CHAIRPERSON SCHWARZMAN: Thank you so much, Nerissa. Yeah, and just to repeat that that we'll have a question session once we've heard from some of the other staff scientists about PFAS. So I want to introduce Karl Palmer our next speaker.

Karl is Deputy Director for the Safer Consumer Products Program in the Department of Toxic Substances Control and he will provide an overview of CalEPA activities on PFAS.

(Thereupon a slide presentation.)

MR. PALMER: Thank you, Meg. I'm just going to share my screen here. Can you see my screen?

CHAIRPERSON SCHWARZMAN: Yes, that's perfect.

MR. PALMER: Okay. Great. Well, thank you, Meg. And I also want to thank Veena for your Service on the SGP. We'll look forward to engaging with you in your other endeavors and capacities. So thank you very much. And thanks to Nerissa for the good summary.

I'm going to move ahead here, I think.

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MR. PALMER: There we go. My disclosure is I have no financial conflicts of interest as I'm the Deputy Director of the Safer Consumer Products at DTSC of CalEPA.

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MR. PALMER: So as you're probably familiar at the highest level CalEPA's mission is to really restore, protect, and enhance the environment, and ensure public health, environmental quality, and economic vitality. We do this by developing and implementing and enforcing environmental laws that regulate air, water, soil quality, pesticide use, hazardous and solid waste, recycling and reduction, and the development of safer consumer products.

I always like to say that chemicals don't adhere to the laws of man but to the laws of nature. So while we tend to regulate chemicals within these frameworks and

silos of bureaucracies, they don't pay much attention. They do what they do, which creates challenges for all of us. Our collaborative effort at CalEPA is manifested in -- one way in establishing this PFAS working group, and we've invited our partners at the Department of Public Health to join us as well. And the role of our workgroup is really to share information about what we're all doing, so that we can learn, coordinate and collaborate, and move forward in our mission.

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MR. PALMER: So I'm going to start with what's going on at the Water Board. They're doing a lot of things, so bear with me. The State Water Board statewide PFAS investigations have targeted airports in both fuel terminals and refineries, because they use aqueous film foaming flame retardants. They use -- and they look at chrome plating facilities -- the Water Board looks at chrome plating facilities, because of their use of mist suppressants which contain PFASs. And they are looking at municipal solid waste landfills and waste water treatment plants, because they receive waste that contains PFAS.

In coordination with the issuance of orders to the public water systems, they ask to sample their wells adjacent to airports and landfills, and those wells with PFAS detections from EPA's third unregulated contaminant

monitoring role sampling events and in the vicinity of those wells.

Since the issuance of those -- excuse me -- initial screening sampling events, additional orders have been issued to public water systems to expand outward from the previous detections and in the vicinity of DOD sites. Future sampling will be performed as data comes in and they determine the extent of source areas and additional sampling needs.

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MR. PALMER: To give you some look at what they've done, the primary investigatory objectives of the statewide orders are to gather information on the occurrence of PFAS in California's drinking water sources and watersheds. The data will be evaluated to identify impacted drinking water wells and identify areas where additional work is needed to ensure that communities reliant on those drinking water wells are provided safe drinking water and where additional public water supply well sampling would be appropriate. The data will also be used to inform additional areas where watershed specific source identification efforts are needed and to inform future investigation requirements.

Finally, the data collected will also continue to inform the consideration of public health goals developed

by OEHHA and eventually lead to the maximum contaminant levels adopted by the State Water Board.

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MR. PALMER: To give you some idea of what the data has shown since 2019, the results of the sampling at the public water systems are indicating that only 13 percent of those wells have an exceedance of the response level. The response levels for PFOA is 10 nanograms per liter and for PFOS is 40 gram -- nanograms per liter. And if there's an exceedance of the response level, the public water system must either take the well offline, treat the well usually through blending, or notify the public. The Division of Drinking Water will continue to require public water systems to sample for PFAS in wells outward of any of these exceedances. Additionally, sampling for PFAS will continue in these wells until further notice by the Drinking Water Division.

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MR. PALMER: This next slide is a little complicated, but essentially what it does is it reports on the results from the public water systems - those are the bars in orange - and the results from airports and landfill investigations, which are the bars in gray. And you can see the percentage of PFASs detected in those efforts. There were two different methods used for these

events. And so you can see that the data from the investigations that the airports and landfills show many more compounds specifically the shorter chain PFAAs that are being detected at high frequency.

Because of these results, the Division of Drinking Water is considering shifting from the EPA method used, what you see in the orange bars, to the DOD developed method, which shows a greater broader array of analytes captured and particularly the shorter chain PFAAs.

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MR. PALMER: Now, the importance of the information is because the Water Board is tasked with developing MCLs for drinking water standards. And so this is a multi-stage part process, the Office of Environmental Health Hazard Assessment is a key part of this process. And you can see here that notification levels have been established for PFOA and PFOS and there's recommendations for the public health goals for both those compounds. There's a -- for PFBS, there's a notification level proposed. And the hope is that for PFOA and PFOS that we'll have MCLs in place in 2025.

So also it's important to note that the Water Board has requested additional work by OEHHA to look at five additional compounds.

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MR. PALMER: This is a pretty busy slide, but it has a lot of links to really good information. The Water Board is acting for CalEPA to kind of collect a lot of the information that the different boards, and offices, and agencies are collecting. They have some really good information there. I encourage everyone to look at that.

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MR. PALMER: Moving on, I'll talk a little bit about what OEHHA is doing. And there are many people in this meeting who know better than I. But OEHHA's mission really is to protect and enhance the health of Californians and the state's environment through scientific evaluations that inform, support, and guide regulatory and other actions. They're the lead State agency for conducting health risk -- for evaluating health risks posed by environmental contaminants. They also implement Prop 65.

And so you can see here that OEHHA has completed notification levels for PFOA and PFOS. I'm not going to go into the details. You can read those there and as well as for PFBS. And then there are proposed health goals for PFOA and PFOS that are also established. These are an important part of establishing the drinking water standards and they are working closely with the Water

Board in that process.

Note that the notification levels are health-based advisory levels. They're not regulatory. And that OEHHA conducts risk assessment of a chemical and provides recommendations to the Water Board who then sets the notification levels.

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MR. PALMER: Additionally, as I mentioned earlier, the Water Board has requested that notification levels be set -- or be provided from OEHHA in the journey towards health-based drinking water standards for these additional six PFASs.

Now note -- well, I'll move on.

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MR. PALMER: Also I just want to mention that in the responsibilities to implement Prop 65, OEHHA listed PFOA and PFOS on Prop 65 for reproductive -- as reproductive toxicants, and then in March of this year, they issued a Notice of Intent to list PFOA as a carcinogen.

Additionally, there's two important meetings coming up in December, one of the Carcinogen Identification Committee that will be considering listing PFOS as a carcinogen. And December 14th, there will be a meeting of the Developmental and Reproductive Toxicant

Identification Committee to consider PFNa and its salts and PFDA and its salts as reproductive toxicants.

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MR. PALMER: Moving on to our colleagues at the Air Resources Board. They're in the process of updating their Airborne Toxic Control Measures. And what their focus is right now is looking at PFASs that are used as chemical fume suppressants in plating baths. And this is at -- particularly at chrome plating facilities. They've also funded research by UC Berkeley looking at environmental assessment methods to collect and analyze PFAS in air, dust, and soil. And this is a general challenge across the agency is -- and I know you're going to be talking more about this later is how do you assess where PFAS is in the environment and potential exposures that ultimately end up in people and other media.

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MR. PALMER: Moving on to CalRecycle. CalRecycle's primary mission is to promote the reduction of solid waste and to promote recycling as well as composting. And they're working with UC Davis to look at composting and what happens to PFAS in that environment. And so there's a lot of interesting work going on there.

They also this year adopted regulations pursuant to the Sustainable Packaging for the -- Act that was

passed in 2018. That Act required that CalRecycle put forth regulations that require food service facilities used on State properties to use reusable, recyclable, and compostable food packaging. And they've done that. And interestingly they've put in there some provisions that address PFAS and limit PFAS in those products. And you'll note that again, it's important for us to be able to how -- to assess where PFAS is, not only in the environment, but also in the products that we use, and what methods we use to do that. So they've been working on that.

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MR. PALMER: Our colleagues at the Department of Pesticide Regulation found out earlier this year that while they did an initial search to look at all of the registered pesticides to see if PFASs were used and they didn't find that any PFASs were used in the pesticides themselves however, they did come in to information that some containers contained PFAS. And that those containers had certain PFASs that had leached into the product. And so they've been working with those manufacturers and with U.S. EPA to change out and use non-fluorinated containers for pesticides.

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MR. PALMER: The area for which I'm most familiar

with and responsible for is at DTSC. And I wanted to note that at DTSC, we have three core programs. We have our Cleanup Program, our Hazardous Waste Program, and the Safer Consumer Products Program.

In the Cleanup's program, much like the Water Board's challenges, we're looking at dealing with PFAS in groundwater and remediating PFAS in groundwater to particularly protect drinking water wells.

In our Hazardous Waste Program, we're considering looking at whether we should regulate PFAS-containing wastes as hazardous wastes in California. Note that others have petitioned U.S. EPA to make hazardous waste out of -- excuse me, to include PFAS waste as hazardous waste under the Resource Conservation and Recovery Act.

And then my program, which I'm going to talk about a little bit more, but I also wanted to also note that our Environmental Chemistry Lab, which is a partner in the Biomonitoring California Program, helps us in our program and our other programs to both evaluate different media that contain PFAS, as well as consumer products that contain PFAS.

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MR. PALMER: So I'm going to talk a little bit about my program, because I know it best and because I think it's also relevant. First and foremost, I wanted to

thank the SGP for listing PFAS as a class on your priority chemicals list in 2015. That opened the door for us to look at these chemicals in consumer products, because our regulations require that we look at 23 other authoritative body lists, one of which is the SGP priority list, for chemicals that are on our menu that we can consider when we regulate these chemicals and products.

It's important to note that we are viewing this as a class approach, because one of our missions is to ensure that we don't move from one hazardous or problematic chemical to another one in the chemical whack-a-mole process that we've experienced -- all experienced. And so by treating PFAS as a class, we can, through our regulations, ensure that when we ask people to look at a safer alternative to that PFAS, they don't just move from one PFAS to another PFAS, but they have to consider the entire class and look for alternatives outside that class, which is a very efficient way to regulate when you've got thousands of chemicals that you might be considering in that class.

So we published a paper on this in Environmental Health Perspectives, documenting our approach. And we wouldn't have been able to do that without the SGP.

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MR. PALMER: What that looked like in practice

then, is earlier this year, we adopted, as a priority product in our rulemaking framework, carpets and rugs that contain PFAS. And what that meant is that anyone who sells a carpet or rug into California that contains PFAS is now subject to Safer Consumer Products Regulations, they're required to notice that -- notice us if they're selling those products and then go through a robust alternatives assessment process to hopefully find a safer alternative.

We're going to be -- we're in the process right now of adopting regulations that will capture treatment products, things like Scotchgard and other treatments that are sprayed onto textiles and leathers. And then we will be looking potentially at children's products and cosmetics that contain PFAS as well. I note that PFAS food packaging is something we spent a lot of time looking at PFAS on. We had several workshops. We put together a technical document.

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MR. PALMER: And I'm going to talk briefly about what the outcome of that was in that the California Legislature looked at that work we did on food packaging and passed a law, AB 1200, which banned plant fiber-based food packing with PFAS starting in 2023 and some other aspects of it as well. The important thing there is it

was looking at PFAS as a class using the good work that we did to support that action to accelerate regulation of those products.

Other bills that were passed, which were also related to PFAS Friedman Bill, AB 652, was for juvenile -- a variety of juvenile products banning PFAS in their use, and then note that AFFF foams containing PFAS we're also restricting from sale via SB 1044 effective this coming January.

Now, I'll also note that many other states across the country from Maine, to Washington, to New Mexico are passing states related to PFAS in a variety of consumer products, because of concerns of potential exposure and harm.

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MR. PALMER: Lastly, I'll just wrap-up by saying that in -- last month, the U.S. EPA put out their strategic roadmap for PFAS. It's an ambitious look at how they can use a variety of authorities under U.S. EPA's umbrella to look at PFAS throughout its lifecycle in all media over time. And this is -- there's a lot of depth to this. I encourage people to look at it. It's very ambitious, but we certainly need to move forward with this class on so many different fronts.

And hopefully what you see in my brief overview

of what's going on at CalEPA, that PFAS touches each one of our departments. It doesn't pay attention to our political or regulatory bureaucratic barriers and there's a lot of work to do.

So with that, that summarizes just a brief look at what we're doing at CalEPA.

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MR. PALMER: This is my contact information. I'm happy to answer any questions.

Thank you.

CHAIRPERSON SCHWARZMAN: Thank you so much, Karl.

Again, we'll have time for questions after our third panelist -- or presenter right now, who is Katherine -- Kathleen Attfield. She's Chief of the Biomonitoring Investigations and Outreach Unit, which is part of the exposure assessment section in EHIB at the California Department of Public Health, DPH. Kathleen will discuss Biomonitoring California's findings on PFAS from the CARE study and some earlier work.

(Thereupon a slide presentation.)

DR. ATTFIELD: Good morning. Can you hear me properly?

CHAIRPERSON SCHWARZMAN: Yep, that's good.

DR. ATTFIELD: Wonderful. And you can see my slides?

Okay. So good morning. Again, my name is Kathleen Attfield. I'm with the California Department of Public Health in our Biomonitoring California Program. And I want to provide some updates on our activities as related to PFAS.

CHAIRPERSON SCHWARZMAN: Kathleen, I'm not seeing your slides, but that might be a problem with mine not with others.

PANEL MEMBER CRANOR: No, they're not available.

DR. ATTFIELD: Okay. Excuse me. Sorry.

CHAIRPERSON SCHWARZMAN: Perfect.

DR. ATTFIELD: Okay.

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DR. ATTFIELD: So before I launch into my talk, I'd like to quickly revisit that our studies of PFAS are situated within the Biomonitoring California's mandate to determine biological levels of environmental chemicals in Californians, to establish trends in these levels of chemicals in Californian's bodies over time, to help to assess the effectiveness of public health efforts and regulatory programs to decrease exposures to specific chemicals.

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DR. ATTFIELD: Biomonitoring California's general approach to understanding pollutant biomarker trends has

been to conduct surveillance activities and look for indicators of concern where we may then characterize specific populations using community-based approaches. And these might be in specific geographic areas and specific racial or ethnic communities, or occupational groups, or in sensitive subpopulations, such as with pregnant women.

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DR. ATTFIELD: In today's talk, I will visit some of the different populations we have assessed with PFAS within and dive into demographic trends we have observed, including ethnic and racial disparities. And since the program has conducted a number of studies to date with a lot of valuable information waiting to be explored, I will end with a discussion of opportunities for further data analyses and asking for the Panel's suggestions for prioritizing these in terms of their best impacts on public health and regulatory efforts, and learning more on exposure sources.

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DR. ATTFIELD: So here's a list of the Biomonitoring California studies that have measured PFASs from 2010 to 2020. In most of our studies, we've been measuring the 12 common legacy PFAS, but we have a couple studies where we have measured up to 30 PFAS.

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DR. ATTFIELD: So the ones I'm going to spend the most time today in speaking with -- speaking about are the CARE regional exposure studies, the California Regional Exposure studies primarily on our first two regions in LA and CARE-2, eastern and southeastern counties. I will also talk about opportunities that we have with the ACE studies of Asian Americans in the San Francisco-San Jose area, the MAMAS studies of pregnant women, and our back -- harkening back to our very first population-based study with Kaiser members that is called the BEST study.

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DR. ATTFIELD: So from these various studies in the past, we are look -- we have been learning, as -- from these in order to look at our data from our CARE studies. We have seen a number of trends from these prior studies, including very high detection frequencies, PFNA PFOA, PFOS, PFHxS when it's over 95 percent detections in those three studies, and also very frequent detections of others.

We've seen levels that increase with age, differences by sex and gender in which males often have higher levels, and also differences by race and ethnicity where Asian populations tend to have higher levels of many of the PFAS.

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DR. ATTFIELD: So for CARE, the California Regional Exposure studies, we have presented periodic updates to this Panel. And for these, we have recruited across each region to represent the demographics of that particular area using a quota sampling approach. In CARE-LA, we visited the entire county of Los Angeles in the spring of 2018 and garnered 430 participants. At our second region, CARE-2, from Mono all the way down to Imperial counties, we recruited 359 participants over the spring of 2019.

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DR. ATTFIELD: Our participants who completed the studies ended up skewing slightly female with a median age of 51 and race percentages generally reflected the population of the region.

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DR. ATTFIELD: However, to improve our ability to use our central estimates as population estimates and to better enable comparisons across regions, we are currently undergoing a calculation of weights that Nerissa alluded to and we'll be using those in the future. For the rest of this presentation today, however, I'll be referring to interim analyses performed with unweighted data.

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DR. ATTFIELD: So among these 12 PFAS that were measured in these two populations, we found PFAS in almost all or all participants in CARE-LA and CARE-2 of just one person not having a detect -- any detections in CARE-2, and on average, six or seven of them per participant.

So the red box here is drawn around the PFAS for which we have detection frequencies over 65 percent. And that's the threshold we use for diving in deeper to look at particular trends in those analytes.

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DR. ATTFIELD: So our first step would be to say how did these regions differ or are similar to national levels? So to compare here with NHANES from the most recent cycle for which there is available data, 2017 to 2018, I first have to make a slight caveat about the methods used here, in that NHANES has higher levels of detection than our DTSC lab. So to make the comparisons, we do have to re-censor the data to the NHANES LOD. And that meant that three PFAS there listed on the bottom PFDeA, PFUA, methyl PFOSA, then we wouldn't be comparing as they drop below that 65 percent detection threshold.

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DR. ATTFIELD: But for the four remaining, they do seem to be lower than national levels. I'll give you a moment to eyeball that.

We do have to keep in mind though that there's still one to two years difference in these comparisons. So there still could be a small remaining role for temporal effects. As we know, many of these are declining over time.

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DR. ATTFIELD: These two CARE studies are focused on the general population, so it's not too surprising that our 95 percentiles are way below those of highly impacted communities, such as these in the examples from West Virginia, Alabama, and New Hampshire.

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DR. ATTFIELD: Analysis of demographic trends displayed the known impact of gender and sex with the largest impacts seen in PFHxS with 87 percent higher in males for CARE-LA, 80 percent in CARE-2. And we actually didn't see a statistical difference for methyl PFOSA and PFDeA, but we do see it in those others.

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DR. ATTFIELD: You see the impact of increasing age for all six of these PFAS. And this is by decade of age of participant. And the most substantial effect is seen with PFOS with 20 to 22 percent increase by decade of age of the participant.

I'm sorry, my slides are not advancing.

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DR. ATTFIELD: There it goes.

Patterns in race and ethnicity followed the general trend of Asian participants having the highest levels, followed by White participants, Hispanic, and Black participants. In these tables, I've ordered the PFAS from left to right to indicate the largest effects on the right-hand side and in darker shades of blue.

Here, we see the PFDeA has the greatest differences between Asians and all other groups, ranging from 84 percent there at the bottom compared to White participants in CARE-LA up to 144 percent higher than black participants in CARE-LA.

PFOS was the next largest in differences up to 132 percent greater than blacks. And I should note that because of the fewer number of Black and Asian participants in CARE-2, some comparisons did not reach statistical significance here.

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DR. ATTFIELD: So extending to other com -- other group comparisons, these are not as great, but still we see levels higher in White participants than Black and Hispanics primarily in PFOA with the largest difference compared to Black participants for CARE-LA with PFHxS.

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DR. ATTFIELD: An interesting little side note is that the PFOS precursor, methyl PFOSA, uniquely had a different racial pattern than the others, though often this did not reach statistical significance. For the one in which it did, levels compared to Hispanic participants in CARE-LA were significantly different at 38 percent greater concentrations.

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DR. ATTFIELD: From our exposure questionnaire, we had begun to look into the contribution of fish and shellfish consumption to these demographic patterns we're observing. In these regions, there are not known large local PFAS contamination sites, those similar to many parts of the rest of the country. As Karl just talked us through, PFAS have been measured in some drinking water systems and groundwater.

Fish and shellfish contributions have been linked to studies of recent PFAS biomarkers, including in our own BEST study in California within NHANES data from 2003 to 2014, and in San Francisco pregnant women in 2014 to 2016 data. These are usually most often seen with PFOS, PFNA, PFDeA, PFUdA, so the longer chain PFAS there, the decanoic and the undecanoic versions, the 10 and 11 carbon chains.

These studies also had looked at other dietary contributors. But for what I'm going to talk you through

today, we're going to mostly focus on fish and shellfish.

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DR. ATTFIELD: So I'll start with CARE-2, where we have been able to look across many different exposure variables. PFDeA was the only PFAS positively associated with fish and shellfish after multi-variable analyses. Just for your information, we had asked about fish and shellfish in two ways, those that you buy in the store and those that may be caught by someone known to the participant. So this is primarily for our metals analyses for looking at local fish versus fish that might be more wide -- sourced from a wider area of the world, but also could be useful for PFAS analyses.

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DR. ATTFIELD: I have combined them here, so when bought and caught fish are looked at collectively, eating fish one to three times per week increased concentrations by 22.4 percent. And if you look at it in the next exposure category, up over three times per week of each, we reached 60.6 percent higher levels.

Shellfish was knocked out of the final model and attempts to make a combination variable with the two did not increase our explanatory power.

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DR. ATTFIELD: So fish consumption seems to have

impacted the estimates for differences by race, looking here at the Asian participant breakdown. So the adjusted change moved from 73 percent to 62 percent. And this may be showing a potential current or historic exposure source among this region's population.

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DR. ATTFIELD: Now, moving on to CARE-LA, for this, we've only managed so far to look at single exposure sources in tandem with demographics. And here, we still see an association of PFDeA with fish consumption, so up to 43.5 percent higher in the group eating over three times per week of each of those bought and caught, but less of a modification of the estimates tied to race and ethnicity.

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DR. ATTFIELD: However, in PFUdA, the undecanoic PFAS, we see a large impact with fish consumption, 181 percent increase over those eating less than once per week and those that eat over three times per week. And we see a fair decrease in the estimates of the contribution for Asian identification.

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DR. ATTFIELD: The benefits of having a study that looks at multiple panels is that some of the panels do end up being correlated based on exposure source. So

we had the opportunity here to look at the blood mercury levels, which are also an indicator of fish and shellfish consumption. And for CARE-LA, six of these -- all six of these had a correlation with blood mercury, and three for CARE-2. And our strongest correlations are with the two that I was just showing you previously, so with PFUdA and PFDeA.

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DR. ATTFIELD: So marching on with the current work that is happening with CARE data. We do have those 90 people from San Diego and Orange County, for which we are readying data for CARE-3 to be placed on the web repository. As mentioned, we are working on weighting our participant data for better population estimates. And as Nerissa detailed, we have a report in progress on CARE-LA and CARE-2 data. We also have a new effort on population-based pharmacokinetic modeling with --

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DR. ATTFIELD: -- Matt MacLeod out of the University of Stockholm, where his team will be simulating lifetime intakes -- excuse me -- body burdens, and elimination kinetics at the population level.

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DR. ATTFIELD: Looking forward to other opportunities with CARE data. We can follow the work

further on fish consumption and PFAS relationships to be able to understand where there may be links to intervention efforts. We can extend data analyses to address other exposure sources where we have suitable information in our survey data to link with the potential for evaluating ongoing policy efforts.

We have address information, so we may be able to look into links to drinking water. And as Tom Webster will talk -- discuss in his talk briefly, we had the opportunity to investigate profiles of PFAS, which some researchers are beginning to use to be able to tease out different relative sources of PFAS.

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DR. ATTFIELD: Before moving on to our other studies, I did want to contextualize our work within other biomonitoring investigations of PFAS in California. So other populations under study are middle aged women in the California Teachers Study, female firefighters and office workers, pregnant women and children, and, as Kate Hoffman will later describe, Orange County residents are being recruited for the multi-site ATSDR PFAS studies. And lastly, firefighters at military sites across the U.S. including California will have started having PFAS biomonitoring as part of their physical exams, which began this past fiscal year.

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DR. ATTFIELD: From these cohorts, recent publications described descriptive distribution or detection data, such as developing non-targeted suspect screening workflow on blood samples in concentrations in those female firefighters and office workers. They also addressed dietary predictors of PFAS and links to the health endpoints of birth outcomes, offspring, and telomere length.

Now to revisit some of our prior studies, for which we have on -- some ongoing work, but also many opportunities. And we hope you will help us with thinking about prioritization and collaborations that could expand the reach of our work. We are currently also working on weighting this BEST -- this data, because it can give us an ability to better describe population estimates. Opportunities here exist with prior analyses on demographics and diet that have not been finalized or published, and potential, of course, to work with other data sources, such as looking at links to drinking water.

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DR. ATTFIELD: In the ACE projects, which were with Asian-American populations in the San Francisco and San Jose areas, we have seen interesting demographic trends within these, but we have the wonderful opportunity

that we had very detailed dietary questionnaire for these studies that are not as much in the same depth in our other studies, and it seemed so far some interesting associations with organ meat consumption.

We also have the potential to learn more about the impacts of California -- of immigration in California and whether the associations we have seen with birth country and time in the U.S. are truly indicative of transported body burdens.

As a targeted study, they can also help inform us in strategizing around designs for future targeted studies, because of the strengths and limitations involved, one possibly being the limits due to homogeneity of exposures within a targeted group. We also have the interesting opportunity of the -- what may be revealed with PFAS profiles here and how they may be illustrative of different exposure patterns.

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DR. ATTFIELD: And lastly for our work with the MAMAS studies, and these were with obtained maternal samples from different areas of California through the Genetic Disease Screening Program, we have newly finished laboratory data from 2015, 2016 - thank you, labs - that we are readying to place into our web repository. We also have a number of interesting opportunities in that we can

use weights more cleanly here and into the future in order to really examine time trends as we go forward. And then also, we have received the information from GDSP in an anonymized fashion. So this would enable us to be able to do non-targeted screening approaches, because of this not incurring our report-back requirements.

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DR. ATTFIELD: So with that, here's my list of references and I'll be interested in our discussion.

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DR. ATTFIELD: I want to thank our participants across all of our studies for their time and their willingness to give us their biological samples, and our supporting organizations as well as Biomonitoring California staff, and our State and federal funding.

So with that, I will wrap-up.

CHAIRPERSON SCHWARZMAN: Thank you so much. Kathleen and also to Karl and Nerissa. So we have our time now for questions for each of these three presenters. Just as a reminder, we'll do questions from the Panel first, and then we'll have public comment, and then we'll have a Panel discussion on -- you know, specifically addressing some of these questions that Kathleen has invited input on.

So if the presenters could have their cameras

back on and we'll be able to -- maybe if I adjust my view, I'll be able to see our panelists better. There you are.

And we have ten minutes now for questions from the panelists on any of these three.

Tom.

PANEL MEMBER McKONE: Sorry. I'll get my mute off. And if you hear -- I apologize. There's some construction going on nearby. It tends to come in.

First of all, I want to thank the presenters. This was really, really interesting. Just a lot to digest. I'm actually trying to digest it. But I do have a question and I think -- I mean, it's kind of directed at Karl, but at all three talks. But Karl Palmer, who did a really nice job about how this has to be integrated across so many different organizations.

And I was sort of looking at numbers and pathways, and one of the things that comes up is, you know, the level of communication about health levels and -- for example, in looking at the effort at OEHHA to develop notification levels and MCLs mainly for drinking water. You know, and I was wondering, well, when we see the later presentations -- or Kathleen's presentation about where it seems to be coming from in the biomonitoring level, it's coming from a lot of food pathways. And so is there some effort to say, you know,

we have to -- like when we set a drinking water standard, we're going to have to realize that that's only going to control a small part of it. We have to be aware of the -- either the relationship of water to food, but also, you know, food operates independently. Food comes from all over the place. It's not just a California food source.

So I guess what I'm getting at is how do we stand back and look at like the cumulative exposure and really understand that better, and then how do we ultimately think of the health effects in terms of biomonitored levels, so we'll know how to give guidance -- not we. I mean the State will know how to give guidance about what levels -- what biomonitored levels should be -- require notification or concern?

So it's kind of a long-winded question, but I guess I'm just focusing more on understanding a little bit better on how the exposure pathway analysis and biomonitoring really worked together to help us really understand the cumulative different pathways of exposure and then what actions -- what action is needed and what actions can be taken? So I'll leave it at that.

MR. PALMER: Well, I'll go first and others can chime in. Thanks, Tom. Good question.

I think part of -- I look at this as there's different buckets of issues here. One as I kind of

highlighted, each of the agencies has our own perspective that it's -- that's provided to us by our authority, and our mandates, and our resources. And so we do the best we can to collect information from others who are looking at things that intersect in the real world. But it's very challenging, because we don't have the science for cumulative impacts really well defined. It's not in the regulatory language, let alone practice, like risk assessment has been over the years.

And so I would say at the big buckets what we need is we need to have good up-front information about where we can find these chemicals. So that's a huge benefit from biomonitoring, but we need it over time, so that we can see that when we do take action, that we can measure our success hopefully or at least gauge it. And that -- so we need to be in it for the long run and we also need to keep looking under different lamp posts, if you will, for where the information is, because it comes from many different sources. Food obviously is one exposure pathway, but as we see in products, when we were looking at carpet, you know, dust, air, dermal, all of these things are factors and we don't have all the information.

So I guess what the long-winded answer is we just need to keep more of what we're doing. We need to

coordinate and we need to be strategic as best we can to go to those kind of critical path areas that will help us all meet our mandates. It's a lot of work.

DR. WU: I think that's a really good question, and Karl, I really appreciate your answer as well. And I think you've sort of summarized why biomonitoring is so hard for us to figure out our priorities, because all of these things are so important. I mean, do we want to look at legacies or the new ones? Is it more important to figure out the percentage of exposure source for -- you know, is it the bought exposures or every little exposure. Are the highly exposed individuals or the general population more important? And then is it -- you know, how do we get this information? How do we actually make an impact? How do we work with our partners to message out how people can be healthier and make more safe choices?

So all of these things are important and you would need a much bigger program to address all these things. So it is why we often have these questions, like, how do we make the biggest impact? What -- which one of these parameters would be -- would be key for us to follow through?

And I think it's great that we've had a much more robust interagency collaboration on PFAS. I think it's

one of the things that really feeds our work in PFAS and helps us kind of address all of those things. But it is a giant machine for us to be addressing with a very small Program, and so I appreciate the difficulty of it.

CHAIRPERSON SCHWARZMAN: Sara, you have something to answer. And then I just want to say, it sounds like Kathleen has something to add to this question, and then we'll move on to Ulrike's question, and I see Carl next.

MS. HOOVER: I just had a quick logistics matter. Just for the benefit of the transcriber, particularly if your camera is not showing, make sure to identify yourself. So that was Nerissa, which I'm sure Jim will figure out. But for those of you who are visible, it's pretty easy for him to figure out who is speaking, but make sure you identify yourself again when you speak.

Thanks.

CHAIRPERSON SCHWARZMAN: Thank you.

Kathleen.

DR. ATTFIELD: Thank you. And apologies, my video does not seem to be working. So I will try to speak clearly. Kathleen Attfield.

I also wanted to point, Tom, this -- you know, this is the huge question and point Tom to our later speakers, who are going to help us with thinking about other ways that we are looking into being able to

understand exposure sources. So we do have -- of course, biomonitoring is cumulative across many different types of exposure sources and we have questionnaires, but, you know, that is only going to inform us so far. We do not have, so far, information on people's general dust levels or, of course, drinking water, and, of course, PFAS have bioaccumulated in our bodies for such a long time, so questionnaires definitely have their limitations as far as being able to reveal historic sources. But more conversation on that from the presentator -- presentations coming after us.

CHAIRPERSON SCHWARZMAN: Thank you.

Ulrike.

PANEL MEMBER LUDERER: Yeah, I wanted to also thank the presenters for those really interesting and thought-provoking presentations. My questions I think though are maybe more for Kathleen. And they relate to these associations of the racial disparities and association with seafood consumption as regards some of these PFAS results.

And so one question I had was whether -- so you looked at mercury, and you saw that with blood mercury, there was also -- that that seemed to -- you know, that also was associated -- had the same kind of racial ethnic disparities. And I was wondering if you did speciation of

arsenic, which is also very strongly associated with the organic forms of arsenic with seafood consumption, and whether you saw similar results with that, if those -- the speciation was also done, because that would help to I think maybe support that association even more.

And then another question I had was whether you had information about the specific types of seafood they were eating? And I think with these long-lived PFAS you would expect that the -- you know, the predatory species higher up in the food web would have a stronger association. So those were my two questions. Thanks.

DR. ATTFIELD: Thank you, Ulrike. For arsenic, we do speciate when they hit a certain threshold. And so we don't have that information across the entire CARE study, but it does mean, yes, then we can look a little bit more in those folks that have been speciated.

And your other question was about the specific types of fish that are consumed. So, no, for CARE, we don't have that granularity of information and those types of questions are about general consumption patterns, so not tied to a particular time period. However, in the ACE studies, we've got quite detailed questions about the types of fish and shellfish that people have been consuming, not only kind of general and over the past year, but in the last 30 days.

So different time periods can tell you different things and tie differently to the analytes of interest.

CHAIRPERSON SCHWARZMAN: Thank you. I had the same question about the species of fish, thinking does it travel the same way mercury does and can you give advisories about consumption in that same way just because it's a -- they're persistent and bioaccumulative compounds?

Thanks.

I think Carl is next up with a question. And it could be tricky to remember to put your hand down on the Zoom interface. So if you can do that when you're done, that will help us.

PANEL MEMBER CRANOR: Thank you. I thought those were terrific presentations. One of them caught my eye. It's always the shortage of funds for dealing with these problems. I did notice that there -- one of the items I believe Carl highlighted was the possibility of compensation for spreading PFAS and their varieties all over California, and in the food and so forth. Minnesota had a very successful suit against 3M, I believe, and DuPont. And I'm wondering if there has been thought given to that, because they had a -- in Minnesota they have a huge clean-up problem. They also have huge clean-up problems in West Virginia and northern and southern Ohio.

And I don't know how detailed their health effects had to be, but that was part of it. And I have a legal document that was used in the Minnesota case as evidence.

MR. PALMER: Can I just make a quick comment to Carl's point. So one of the things that U.S. EPA is proposing in their roadmap is to list PFAS as a CERCLA hazardous substance, which would then bring it into the domain of the clean-up authorities that many states have, and they have at the federal, and the liabilities and responsibilities that come with that. Similarly under the Resource Conservation Act -- Recovery Act, EPA has been petitioned to add PFAS containing waste as RCRA hazardous waste. So many of us, whether it's in hazardous waste or in water, you know, you have certain authorities, only if you're captured in the regulatory framework.

And I think the other thing is -- that's relevant is that what we're talking about is moving upstream hopefully, which is rather than waiting till we see it in people and the environment, what can we do to encourage using safer alternatives. And that's difficult as well, because we don't have the authority and we also don't have the knowledge of where all these chemicals are used in the supply chains.

And we see it in the environment. We see it in

fish. We can measure it in people. We need to do better to coordinate on that, but we also need to move upstream to find out why these chemicals are actually being used and if there are safer alternatives.

PANEL MEMBER CRANOR: Thank you.

CHAIRPERSON SCHWARZMAN: Thank you.

So that's -- José, did you have a question. We're just about out of time for Panel questions, but then we'll come back after a moment of comment to Panel discussion. So if it's a longer point.

PANEL MEMBER SUÁREZ: It can wait.

CHAIRPERSON SCHWARZMAN: Great. Okay. We'll hold it till then. So I think we have 10 minutes for public comment here and I want to start that by just reading a question that was put into the Zoom chat from Silent Spring Institute. And Sara, you can tell us if we need a name or if that's sufficient identification?

MS. HOOVER: I'll just -- this is Sara answering Meg. Sure, if they're willing to identify themselves, that would be great for the transcript. They're not required to, but yeah.

CHAIRPERSON SCHWARZMAN: So the question is, "Are the CARE participants provided with their individual results and translational resources to understand their significance"? My understanding is, yes, under the

statutory requirements, but I'll let someone in the Program explain more.

DR. WU: The answer is yes, as you have said. In accordance with our legislation, all participants with biomonitoring studies are -- their results are made available to them. And about 98 percent of our participants do elect to receive their results. And so production of these packets, which include not only their results, but comparison to NHANES and study statistics, but also potential exposure sources and associations with health impacts are provided to participants of all of our studies. The one exception that Kathleen alluded to is the MAMAS study for which we don't have the identification of participants. It's an anonymous sample, for which we only have some demographic guidance.

CHAIRPERSON SCHWARZMAN: Great. We have a comment here from Nancy Buermeyer of BCPP, Breast Cancer Prevention Partners. Thank you to the SGP Biomonitoring California -- that is, I'm just going to read the comment.

"Thank you to the SGP Biomonitoring California and the Safer Consumer Products Program for your work and specifically for considering and prioritizing PFAS as a class. Not only did it support passage of the food packaging, juvenile products, and firefighting foam PFAS ban bills, the class approach has also allowed us to

require disclosure of all PFAS in various consumer product sectors, including cleaning products, fragrance and flavors, and personal care and cosmetic products, feminine products, and most recently cookware".

So let me check in with staff about whether there are any comments on the emails -- submitted by email.

DR. HOLZMEYER: There are not.

CHAIRPERSON SCHWARZMAN: And I can't see participant requests to speak, can you Cheryl?

DR. HOLZMEYER: I --

DR. IYER: Hi. This is Shoba Iyer. I'm monitoring for any raised hands amongst attendees and I am not seeing any at the moment.

CHAIRPERSON SCHWARZMAN: Great. I have another short comment in the question and answer section from Sharyle Patton. "Two pesticides containing PFAS are registered for use in California. They are hexaflumuron and novaluron". Just to add on to the discussion of pesticides that showed up earlier.

I want to leave just another moment for public comment, since we are not out of time for that yet and it could take a minute to navigate the interface and get a question posted or raise a hand and have it spotted.

So as long as Shoba and Cheryl don't see -- oh, Sara, did you want to --

MS. HOOVER: I'm just -- I'm just respecting the pause. But when you're done with your pause, I wanted to chime in on one of the questions that was raised, so whenever that's appropriate.

CHAIRPERSON SCHWARZMAN: Maybe I'll just check with Cheryl and Shoba that there's no additional requests for comment or submissions online through email. And then, Sara, please go ahead.

MS. HOOVER: Okay. For those of you who have been around for a long time, this will be of no surprise, but not everyone is aware of OEHHA's very early and foundational work on developing chemical groups and classes for identifying for biomonitoring. So that's an approach that Gail and I came up with very early in the Program. We started with flame retardants and we extended it. And that has been the standard approach that we've used for chemical selection, including for PFASs.

So Gina Solomon, who is a former SGP member, actually encouraged us to write it up in a paper, which we did, and it was published in EHP. So I'm going to drop that into the Q&A and we'll link to it on the meeting page as well.

CHAIRPERSON SCHWARZMAN: Great. And I want to second that just from somebody who wasn't involved about how influential I've seen that be, the fact that

Biomonitoring Program scientists really went through the tremendous amount of work that it requires to designate and defend a class, and how then that ripples through, and the way that Karl Palmer described how other groups both within and outside of government can pick that up and use it in other purposes. So I think it really has been a tremendous contribution that the Program has made. And then I was very happy to see it published and appreciate that and I've given it to students and appreciate it being in the literature.

So we have time now for Panel discussion. We have 15 minutes. Actually, we're like five minutes ahead of time, so we're okay. And I wanted to start with José, who didn't get his question asked earlier.

PANEL MEMBER SUÁREZ: Thank you and thank you very much for the presentations. One general question. So right now, are the data made available say for interested researchers in analyzing some of the CARE study data and obtaining information of variables available, in particular, addressing these questions that will be pertinent to exposure sources of PFAS? I'm sure that the questionnaires have captured a lot of information. Yet, it might be, you know, interesting to have multiple people starting to understand what are the main sources of these exposures -- or at least exposures that are associated

with P -- greater PFAS concentrations within these California groups.

DR. WU: Kathleen, are you answering the question? I can also take it.

DR. ATTFIELD: Sure. Sure. Sure. So what is available readily online is our distribution data, but we do have the policy of wanting to work with outside researchers. So there's a application process I think detailed on our website. I was going to give a little more information about what kind of questionnaire data is available for CARE. So there is, as I said, some information related to general dietary habits, as well as occupation, drinking water source, some consumer product use, such as water resistant sprays or water and stain resistant clothing, and furniture. So there's a good number of items that it covers.

And of course, for women, we have information on pregnancy, because that is, of course, correlated. We do not have weight and height, which is a limitation of the data. I think that covers most things.

PANEL MEMBER SUÁREZ: And just as a follow-up. So I'm actually on the website. Is it easily available to obtain that information from the website? Is that something you want to have available?

DR. ATTFIELD: I'm sorry. Are you asking the

types of questionnaire data that are available?

PANEL MEMBER SUÁREZ: Yeah, for that matter, I mean, what is available for a researcher to be able to ask you a more direct question about maybe you want to get these variables and look at these associations. Is that on the website? I'm just -- haven't spent too much time with it.

DR. ATTFIELD: If you -- José, no, it is not currently on the website and I will punt that to Nerissa, as far as that has definitely been something we have wanted to do.

DR. WU: So what is on the website are our questionnaires. I believe both the ACE and maybe the CARE questionnaire are available, which would give somebody starting to think about this an idea of the kinds of questions we ask. Of course, the next step is to talk to us about, you know, how did a question work? Was there homogeneity or heterogeneity in the answers? Is it a question that we're really going to be able to do analyses with. But I think as Kathleen has described in her talk, there are lots of opportunities for research. And it's beyond what we as a program can do. And one of our -- one of our big challenges is to get to all of this analysis. We ask all these questions. We have piles of data. And for those of you in academia who may have students looking

for projects to work on things, we are very happy to work alongside your students.

PANEL MEMBER SUÁREZ: Yeah, I mean, and just the final piece -- and this is -- can be a little more complicated, but could help very profound -- it's -- it could be a profound way to also involve people from the community -- is in some sites, if somebody wants to just log in there and just click, click, click away, as, you know, one of the exposure concentrations in certain groups sometimes some sites have ways in which you can click and look at that, and then you get some summary output statistics. Of course, that involves some investment from the other side, right, from the website generation things, but it could be something to start getting the community a little more engaged, so they can look at these things.

Any comment in that regard, the feasibility of doing something like that or maybe you're doing something like that already?

DR. WU: I think our web platform is not as sophisticated as some private organizations. And so I think there are limits to what we might be able to post on our website. One of the reasons we are putting up the CARE report is so that data will be available. And it's not in a clickable easily accessible format, but it will get into more detail about, you know, different cells

within our -- within our study population. We'll get much more into exposure questions that were considered and why or why not they were -- we followed them with additional analyses.

So the report is kind of our step in that direction to make more transparent and more available the kinds of information we've done. And it's a learning process for us if a question doesn't work, you know, why or why not, and that informs our next questionnaire. But we also want to have that kind of information available for other researchers who might be thinking of asking a similar question.

So I think your question -- your proposal is a good one. I think it's -- IT work is very -- is fairly difficult for us to accomplish in the Program, but the report is one way we'll try to accomplish those goals.

PANEL MEMBER SUÁREZ: Thank you.

CHAIRPERSON SCHWARZMAN: So maybe just to flag for the moment that because Kathleen was specifically sort of requesting for collaboration and essentially help analyzing some of the data that are available, and José is asking about accessibility of the same information, it sounds like some of it may not be, you know -- you can't passively access it, but there's an open invitation to engage with the Program and do more analysis of the data.

So I just wanted to flag that, because I think that's what I took from that part of the discussion.

PANEL MEMBER SUÁREZ: Yeah. I mean, and it would be nice to make it maybe perhaps a little more explicit. Just by looking at the website, I have to get -- so the options are to learn more about the study and then it talks about the CARE study in LA County and frequently asked questions. But it might be good to have a section saying, well, for -- if you want to find out more how to get data out of what it is that you need to do or what data is available, first of all, so a researcher can first see what's available, and then have a more direct question to you, so you don't have to start explaining the same thing over and over as to what data is available and things like those.

CHAIRPERSON SCHWARZMAN: Great.

Veena.

PANEL MEMBER SINGLA: Thank you. Thank you so much to all the presenters for really informative slides. And I wanted to really express my appreciation to Vince and others who -- for their kind words on my service on the Panel. And, you know, I'll say this is definitely not the last of me in these meetings. I'm sure I will be back. So it's not goodbye, just until next time.

And I had a comment and a question related to the

discussion of sort of the priorities around PFAS biomonitoring for the Program, because as usual, there is no shortage of work to be done here and many, many different avenues and angles that are worthy of exploration. So, you know, I did want to second a comment that Karl had made around gathering data and evidence relevant to understanding if policies are effective.

So we heard about a lot of great legislation and work at the agency on kind of different sources and products, so, you know, drinking water, food packaging, food serviceware, juvenile products. So, you know, I think to the extent that data and study designs can really help speak to how the -- those policies, as they're being implemented, are effective, and changing or affecting PFAS exposures would be extremely valuable.

And then my other question on kind of the priorities piece is the sort of ability to kind of get input from communities or partners as to their priorities moving forward, because I know the Program has really good relationships with some of the groups they've partnered with like for the ACE study and other studies. So I think that could also be a really good discussion to inform priorities moving forward to kind of reflect what is most important to communities and what they want to know.

CHAIRPERSON SCHWARZMAN: Thank you, Veena.

I kind of want to echo something that you just said sort of with illustration from my own work. I think this has come up in past -- our past discussions too. And I think maybe we have echoed each other's points on this, but as people who, I think, both of us work with sort of finding evidence for and against various policy interventions, and that in my work on it what has proved the most challenging is finding data from which you -- that you can use to establish time trends. And I think we all understand why that's hard. You know, you were -- you have to come back and measure either the same or comparable populations with the same or comparable methods for the same chemicals over time. And so to manage to have done that for a lot of different chemicals over a long period of time probably requires a level of resources that has never been put into biomonitoring essentially, you know, somewhat, of course, through NHANES at the federal level.

But just to -- just to kind of echo what Veena said about when we're looking at the impact of policies, what we really need is to be able to suss out time trends, because there was one level of exposure. There were things that happened in the interim and then we want to know what is happening to the other exposure levels, and just acknowledging how -- what a big ask that is of a

research study to create that data, but that that is kind of the Holy Grail in terms of being able to see what's happening over time and make some guesses about which interventions have the greatest effect. So just to sort of echo that point and how hard it has been -- how hard it has been to find data on that.

Jenny.

PANEL MEMBER QUINTANA: You just said very eloquently one of my points about time trends -- the importance for policy and seeing that public health policies work. But the other point I wanted to add on top of that was -- and to get you back to your original question about what should be our priority -- priorities for Biomonitoring California, I think that also monitoring disparities and changes in disparities over time is important. I think we saw that a little bit with the flame retardants that exposures change and then they changed over time with, you know, increasing or continuing exposures in certain populations and reductions in others. So I just wanted to add that as a priority I think for the Program.

CHAIRPERSON SCHWARZMAN: Great.

Tom.

PANEL MEMBER McKONE: So this is sort of a comment and a question. And it follows the trend. I

mean, this is one of the hard things to do when you're just looking at tissue levels or biomonitored levels is to really understand what's going on. And I think -- I mean, we brought this up many times about multiple pathways.

So in making this comment, I have to, you know, first reveal my conflict, or bias, or whatever. Matt MacLeod was a post-doc with me about 20 years ago for two years, so I'm -- and I've collaborated with him a lot.

But I raise that -- so I was impressed to see that you're working with his group in Stockholm. I mean there are other groups who are as good and -- but I think they're outstanding. And the reason they're useful for trying to under -- piece this together is that Matt is a modeler who sees models not for prediction, but for understanding. And I think that's what we need in this and that's why I say I'm biased, because I think that way too. I don't -- I don't think models are tools that you go out and say this is what -- you know, we're going to predict what happens, we're just trying to see if they're -- you know, if we can begin to connect more dots and put things together.

And so my question is I hope that there's some continuing collaboration, either with Matt MacLeod or other people who do that kind of cumulative exposure, multiple pathway exposure linked to pharmacokinetics to

try and see if we can make sense of what's happening in the relationship.

DR. ATTFIELD: Well, this is Kathleen Attfield.

I'll respond to that in that we're just in the beginning stages of that collaboration.

PANEL MEMBER McKONE: Okay.

DR. ATTFIELD: So it will be continuing. And it actually had started a couple years ago, but he had a delay. So the upside of that being that now we have CARE-2 data that he can work with as well.

CHAIRPERSON SCHWARZMAN: Any other responses or thoughts from the Panel based on the morning's presentations so far?

Ulrike.

PANEL MEMBER LUDERER: This is sort of a minor and specific question, but something that I found intriguing in -- I think it was in Karl's presentation related to the chrome plater -- platers as a source of exposure to PFAS. And I noticed on the map that the location of the chrome platers was only suspected. And I was wondering if you can say more about that, because obviously knowing where these exposures are coming from is really important. And if there's not information about where chrome plating is happening, that's a potentially important source of information that there may be a

lack -- you know, may be lacking actually.

MR. PALMER: Yeah. Thanks for the question. I'm not sure the Air Board specificity on that. I do know, having worked with chrome platers for many years, is that we know where -- I know the Air Board knows where most of them are. Part of the big question is what are they using, because there's a variety of different bath that they use in processes. And they purchase these chemicals based on a spec and a function, not on content.

And so oftentimes, the platers don't -- themselves don't know what are in those chemicals. And even some of the companies that provide them may not know, depending on their supply chain. So it's complicated, but I think Air Board does know where all the chrome platers are, but I think the bigger issue is the chrome platers may themselves not know what's in the materials that they use.

PANEL MEMBER LUDERER: Thank you. That is -- that's a huge issue for sure.

CHAIRPERSON SCHWARZMAN: Yeah. I'm just going to say like another illustration of the problem that has plagued the use of chemicals in products and materials since they were invented, at least in our system of governance.

We're just about to move on to our next

presentation, but I just want to check for any final comments.

Yes, please, José.

PANEL MEMBER SUÁREZ: Just one final -- just more of a methods comment. Given the vast distribution of PFAS, how much thought or concern was there for the methods during the sample collection, sample storage during aliquoting and things like those to reduce some of the PFAS exposures that may be coming in say from cryovials or other storage media in which you have?

DR. WU: Well, our lab - I think June-Soo is on - could address that, other than I, but we do run blanks for everything sealed and lab blanks. June-Soo, do you want to weigh in on this?

DR. PARK: Yeah. Sure. Thanks for the question. Not only the carrying -- to collect field blank, but also it was wider goal before we decided to use the test to collect the blood, we tested them -- we purchased and tested them for PFAS background. And we confirmed the -- it has a background free from PFAS compound. Then we decide to purchase work and send them out for the field collection. That's what happened. So not only covered by method blank, field blank, but also we already tested it out -- test it totally before we choose that brand. That's what we always do for Biomonitoring Program. I

hope I answered your question, José.

PANEL MEMBER SUÁREZ: Yeah. Yeah. And just out of curiosity, so you found -- did you find a wide range of PFAS concentrations just in the like vacutainer tubes or -- I mean, I'm not picking on the brand, but on the blood collection tubes?

DR. PARK: No, we didn't. Yeah, we didn't. We tested, I believe, a couple of brand, so -- but we didn't. Also, we stopped using the red-top tube to -- in order to -- the easier implement -- you know, for field staff, we choose using the serum-separation tube, but we didn't find much background for the test tube with that brand we tested, yeah.

PANEL MEMBER SUÁREZ: And then was this measured in plasma or in serum for PFAS? And then the next question is were there samples that were stored in other cryovials and did you get a chance to look at PFAS in some of those cryotubes for instance?

DR. PARK: Yeah. Go ahead, Sara. I can answer.

MS. HOOVER: I just wanted to suggest that you hold this for the later discussion, because we really do need to move on to stay -- to stay on our scheduled time slot. And we have a whole hour later to talk about these issues.

CHAIRPERSON SCHWARZMAN: José, will you just make

a note so you don't forget.

PANEL MEMBER SUÁREZ: Wonderful. Will do.

CHAIRPERSON SCHWARZMAN: Okay. Thank you.

DR. PARK: Thank you

CHAIRPERSON SCHWARZMAN: Thanks very much. And thank you to the staff who updated us this morning.

We're going to move on and I want to introduce Anna Kärrman. She's Deputy Head of the School of Science and Technology and Associate Professor of Environmental Chemistry at Örebro University in Sweden. Her main research agenda is to unravel the drivers of toxicity by seeking relevant and sensitive methods, including applying non-targeted methodologies to identify and quantify organic pollutants. She focuses on analytical chemistry and emerging organic pollutants, their distribution in the environment, sources, and human exposure. Anna has conducted studies on per- and polyfluoroalkyl substances, microplastics, and other contaminants of concern. And here she'll be discussing novel approaches for expanding the range of PFAS analyses.

(Thereupon a slide presentation.)

DR. KÄRRMAN: Thank you very much, Meg, for the introduction. Can you hear me okay?

CHAIRPERSON SCHWARZMAN: Yep. Perfect.

DR. KÄRRMAN: Thank you.

Well, good morning and good evening, I could say at the same time. I'm going to share my slides here. So I'm currently in Sweden at the -- in Örebro, and I will talk to you about measuring PFAS. Let's see if I can get it in the right mode. Is this the --

CHAIRPERSON SCHWARZMAN: That's good. Perfect.

DR. KÄRRMAN: Okay. Excellent. Thank you very much. Thank you for inviting me to talk about measuring PFAS.

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DR. KÄRRMAN: I would like to start with a short disclosure that I have no conflict of interest to disclose.

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DR. KÄRRMAN: So I would like to take the opportunity to focus on the analysis of PFAS as a whole group and present to you some of the possibilities and challenges that I have identified in the last couple of years trying pursue this measuring method. And more specifically, I would like to present some of the experiences you've seen in combustion ion chromatography analysis. So I will present a few studies on environmental and human matrices using this CIC method and compare it to target PFAS screening. And also, we have done a little bit of quality control using this method.

And finally, I will present some of the conclusions from my work.

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DR. KÄRRMAN: So in the sake of discussing PFAS as a group, I would like to focus on fluorine in my introduction. So the most common form of fluorine found in nature is fluoride. So here it exists as different mineral salts in quite high abundances in some environmental compartments.

There are only a few examples of natural occurring organofluorine. So one example is the molecule that you can see in this picture. And it's fluoroacetate, which is being produced by some plants as a protection against grazing. There are also a few known examples of natural occurring organofluorine compounds from volcano activities.

But the large proportion of organofluorine that we might find in nature is anthropogenic organofluorine, such as PFOS. And this belong -- these compounds then belong to per- and polyfluoroalkyl substances that represent the class of substances depending on the definition, but I have chosen to use the latest OECD definition saying that they should contain at least one perfluorocarbon moiety.

So, of course, it's important -- as mentioned

before today, it's important to acknowledge which kind of definition we are choosing. So this has been the -- this has been on the discussion for many years, how to define this class.

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DR. KÄRRMAN: So narrowing it down a little bit, when it comes to monitoring, it tends to be around three different groups of PFASs. So the first group is perfluoroalkyl acids. They are the perfluorinated acids. For example, the sulfonic acids or the carboxylic acids. We have a large group of precursor compounds that are semi-persistent and can be further transformed to the perfluoroalkyl acids. And we have a group that contains different kind of fluoropolymers.

And when it comes to usage in products and production volumes, it's the two classes to the right that are the most important. So they are being produced in the highest volumes, and they are being used in products the most, or even -- or more than the perfluoroalkyl acids.

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DR. KÄRRMAN: So the motivation behind monitoring PFAS is obviously that we want to be able to study these different classes, how they affect the environment and how they affect us humans. So the latest news from Europe, you might say, is that the European Union decided earlier

this year to revise the drinking water directive and include a group approach for PFAS total, meaning that the totality of PFAS will have a threshold concentration of 0.5 micrograms per liter in drinking water. So this new threshold concentration is to be served as a complement to the limit that is based on 20 individual PFAS compounds.

However, there is no method mentioned in the drinking water directive. And this new group approach should be implemented as soon as the required method becomes available. And this is quite good news for us scientists, I would say, that the European Union has adopted this group-based approach. And the motivation of this is, of course, the problem with different replacement products showing up and also about the regrettable substitution.

So with this group approach, we will have some more tools for PFAS control. And the basis of this group approach is obviously the precautionary principle that allows decision-makers to take measures, even though the scientific evidence is not really showing exactly which compounds are environmental or human hazards. But when there is really high stakes, there is no need to show the full scale of evidence. So, for example, in Sweden, we have had this precautionary principle when it comes to pesticides for a long time.

So if a substance is being used as a pesticide, it cannot end up in the groundwater. Even though there is no toxicity data, there is a rule saying that it should not end up in the groundwater regardless. So there is a limit value of all pesticides regardless their structure and properties.

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DR. KÄRRMAN: So for PFAS then, if we want to look at the total PFAS, it comes quite close to mine to look at fluorine as like a marker for PFAS. And this picture -- I will not go into so much details, but this picture tries to illustrate what we can do and how we can define different types of fluorine.

So if we start from the very top, we have total fluorine, which we might be able to measure when we take food packaging material and we take some sort of fluorine detection and we measure directly on the packaging material, we will get the total fluorine content. But we don't really know so much what the fluorine consists of. And the very opposite going down in this tree, we have the target organofluorine, which might be PFOS, PFOA, or 20 or 40 different target PFASs.

Total fluorine, of course, can consist of inorganic fluorine and organic fluorine. And we're not very -- we're not interested in the inorganic part, so we

want to try to isolate the organic fluorine. And doing that often it involves some sort of extraction to be able to take away the inorganic form.

And doing this, we might absorb the organofluorine on the carbon material, we might extract out it using different sorbents or different solvents, but there's always a risk that there are organofluorines that we will not be able to extract out.

And, of course, going from the top to the bottom in this fluorine tree, we gain increasing specificity of PFAS, meaning that we will be more certain that we are actually looking at the CF2 chemicals that we want to target.

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DR. KÄRRMAN: So there are a number of different possibilities to be able to assess the total PFAS. If we want to directly measure PFAS total, that will be very, very challenging to do. So in the literature today, you can find two other assessments that are more commonly used. So we have the extractable or the adsorbable organofluorine that I mentioned before, which means that a suitable extraction method is chosen for the sample matrix in question together with some fluorine-specific detection or total fluorine where we use direct measurement of fluorine with some sort of detection that is specific for

fluorine.

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DR. KÄRRMAN: And there's a number of methods that are being described. So a number of fluorine-specific methods are available: the combustion ion chromatography, CIC, the Particle Induced Gamma-ray Emission, the PIGE spectroscopy; we have inductively coupled plasma mass spectrometry, ICP-MS; and continuum source graphite furnace molecular absorption spectroscopy. So I will not go into any of these details.

And at the very bottom quite interesting, we can find actually specific methods for perfluorinated substances. So that is exactly that I said was very challenging, so how can we be very specific on CF2 parts or the molecule? So we do have methods that can be specific, but unfortunately the detection limits are a bit too high to be useful in all applications. But in a few applications, there's definitely good methods for perfluorinated substances.

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DR. KÄRRMAN: So what are the challenges? So at the moment, I would say that one challenge is that the high standardization requirements might prevent data from coming out on PFAS as a group. And this is data that could be very useful at the moment to do initial hazard

assessment of the whole group of PFAS.

Another challenge is that there's a huge demand for low quantification levels. So at the same time as the -- is the requirement to measure PFAS as a group, at the same time, there's also high demand for very, very low quantification levels of the target PFAS. So one example is that the European Food Safety Authority, EFSA, reduced the tolerable weekly intake with three orders of magnitude from only 2008 to 2020. So currently, there is a TWI of 4.4 nanogram per kilogram body weight per week for the sum of PFOS, PFOA, PFHxS and PFNA.

And member state has reacted to this. So in Sweden where I live, we have not really revised any of our limit values yet. But our neighbor Denmark recently launched a new limit value for the sum of the four PFAS in drinking water to 0.002 microgram per liter. So there is definitely a demand for very sensitive analytical methods.

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DR. KÄRRMAN: Another challenge is, of course, to obtain these PFAS total measurements to remove the inorganic fluoride before using any fluorine-specific detection method, which is very important, especially for some matrices.

Another question that is heavily debated is if we really want to target all organofluorines? So, for

example, there are pesticides and pharmaceuticals that are low-fluorinated compounds that might not be all too relevant when it comes to human health or even environmental health. So in Europe, at the moment, there's a large discussion about this trifluoroacetic acid, which is a transformation product from many different chemicals. And it's occurring in very, very high concentrations in our natural waters. And this has the CF3 group, which makes it a PFAS compound.

We also have some pesticides and pharmaceuticals that also contain the CF3 groups. And I have one example here of an LCM-28 substance, which is a liquid crystal monomer, which is used in flat screens, cell phones, for example, tablets. So is this what we want to target in our PFAS total assessment or not?

And finally, even though we have the detection methods needed, we do have a quite big challenge with the extraction method to be able to capture a wide range of different PFAS compound that constitute this PFAS total. So probably there will be requirements for multiple extraction approaches to capture PFAS total.

And there was a discussion about blank contamination before. And I can mention that it's like starting all over again when measuring PFAS total when it comes to checking all the lab equipment for any kind of

fluorine-containing substances.

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DR. KÄRRMAN: So I would like to continue now with one of these techniques that I mentioned that could be used for fluorine detection and that is the combustion ion chromatography, CIC. So in this technique, we can introduce a sample that can be a solid or a liquid containing all different kinds of organofluorines. And we have a combustion oven that we have it working on 1,050 degrees Celsius to be able to break the bond between carbon and fluorine. And the combustion is done together with water, so we have a hydropyrolysis forming, HF which is captured in water forming fluoride. And we can measure it using very conventional ion chromatography.

So what we also do is that we take the same sample or extract and we also measure the target PFAS in the same extract. Together, with the fluorine concentration, we can do this fluorine mass balance, so we know how much of the sample's organofluorine do we know about from our target PFAS analysis and how much is unknown.

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DR. KÄRRMAN: So I would like to just go through a few of our studies. So this a study where we did a screening on -- of many different environmental matrices

from the Nordic countries. So we extracted out organofluorine and also we targeted 73 known PFASs.

So as you can see here, we have a number of different matrices that we analyzed. The blue bars are the percentage of the known PFAS and the gray bar is the percentage of the unknown organofluorine.

And here is the average target PFAS of the extractable organofluorine in percentage. And as you can see, the lowest percentage of known PFAS was found in surface water, wastewater treatment sludge, and also effluent water. And the highest proportion of known PFAS was found in bird eggs.

So this shows -- this shows that we have quite a large proportion of unknowns. However, we have no information from this analysis on the identity of unknowns and also measuring fluorine with CIC is less sensitive than measuring the target PFAS. So we have quite a big difference between detection limits for these two methods.

So the next step is, of course, to try to find out what are the missing fraction, what is the unknown fraction. And for this one method that is frequently used by other labs as well and also including us is to do the suspect screening, to identify unknowns.

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DR. KÄRRMAN: So we used the database provided by

the Norman Network constituting of 3,236 individual PFAS. And here are the same matrices. And we have a positive hit on the red and the pink cells in this figure. So there's two -- there's two different identification levels for the red and the pink matches.

And by comparing different matrices like this, we can conclude or we can see that there seems to be like more low molecular weight PFASs in the water and effluent. And then moving up to marine mammals and to bird eggs, we have a higher molecular weight PFASs. However, we don't have that great confidence in the identification, because we don't have any standards for these compounds. We have also seen that we have some transformation products, or at least probable transformation products. So there could be a biopic transformation going on, and we will actually be able to extract out the transformation products.

Another thing is that one question that arises if -- whether the analytical method will be able to ionize all PFASs that our CIC instrument managed to analyze the fluoride from. So comparing these to instruments in the fluoride mass balance can be a little bit difficult because the detection techniques are so different. So there's definitely some challenges here.

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DR. KÄRRMAN: This is a study of human blood

samples from Sweden during the same sort of fluorine mass balance. And so this is Swedish whole blood from males and females of different age groups. And the -- you can see in this figure, the unexplained organofluorine or the unidentified organofluorine as the black portion of the bars. And after that, we have PFOA, PFHxS. We have a branched PFOS, linear PFOS. And then we have a white portion of the bar which is the sum of 60 other different target PFAS.

So what was quite interesting in this study is that looking at the fluoride -- organofluorine content of blood, females had higher levels than males. Looking at the target PFAS levels, that usually is the opposite. So we did find large variations in groups and between groups. But despite that, we could see a significant difference between men and women, but also between some of the age groups.

So this is a study that came out from our group this year from our former PhD student Rudolph Aro.

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DR. KÄRRMAN: So one can also question whether if we have enough reliability in the method. And this is a study that we also published this year looking at groundwater effluent and sludge. And we could see that between three laboratories we had quite a good coherence

using this CIC method.

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DR. KÄRRMAN: So we could also demonstrate that the methods were specific for organofluorine and that it looked to be quite promising to be used as the drinking water directives method for PFAS total in drinking water.

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DR. KÄRRMAN: So my final -- let's see, I will skip this. So my final slide here is that we do have methods for assessing PFAS as a group. They are available. And what we need to be looking at more closely, in my opinion, is the extraction methods, which are the key aspect of the PFAS total assessment.

Probably there's no single analytical approach that will fulfill the policy goals and using the extractable organofluorine CIC method shows that we do have a large fraction of unknown organofluorine in environmental and human samples that is probably needed to look into more detail.

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DR. KÄRRMAN: So I have a slide with references at the very end.

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DR. KÄRRMAN: And also would like to thank you for listening. Thank you very much.

CHAIRPERSON SCHWARZMAN: Thanks so much, Anna. That's wonderful to hear. We have until 12:25 for questions from both the Panel and the audience. And I will just check in with staff to see if there's questions from the audience as we go through.

I have a question in the chat that -- asking whether the slides will be made available. And I believe everything is posted on Biomonitoring California website, the page for today's meeting.

MS. HOOVER: Meg, this is Sara. Yes, I can confirm. Oh, sorry, Cheryl. I just chimed in over you. Yes, everything is posted.

CHAIRPERSON SCHWARZMAN: So -- and I also just want to note that because Anna is joining us from Sweden, she will not be with us for the afternoon discussion session, which is not afternoon her time. And so we have this 20-minute session now for discussion and questions for her talk because she won't be available this afternoon, so now is your chance.

I have a question in the chat here from Simona Balan of DTSC, "do your conclusions or recommendations on testing change in any way with regards to detecting PFAS in consumer products as opposed to in drinking water"?

DR. KÄRRMAN: Yes. Thank you, Simona, for that question. So I do think it's a little bit different when

considering consumer products versus drinking water, because I believe that in consumer products, we might not have the same problem with extracting out the relevant organofluorine. So my experience with consumer products is that it seems to be quite okay to analyze them directly without actually even concentrate or extract out the organofluorine, as opposed to drinking water where we do have the need to both concentrate the organofluorines and remove the inorganic fluoride in the water.

CHAIRPERSON SCHWARZMAN: Thank you.

Oliver, did you have a question or comment?

PANEL MEMBER FIEHN: Yeah. So thank you. That was enlightening. Now, not everyone of us has these methods. And these methods, as you say, are never perfect, and they need to be combined, and more extractions, which makes it harder for people to implement. If you would compare methods, can you also look for in an untargeted manner, using the mass defect of fluorine in very high resolution mass specs, like orbitraps and how would you rate those in comparison to the methods you have just shown to us?

DR. KÄRRMAN: Yeah. Thank you, Oliver. It's a very interesting question, because this is something that we are doing at the moment comparing different methods and trying to figure out where we can get the most relevant

information. And in addition to the ones that you suggested, I might also want to mention the top assay method come in -- that come out from Berkeley University. That is also something that we are using quite frequently.

I would say that with the CIC method, we will get a very comprehensive screening directing our interest to samples of interest. It might be human samples from cohorts that have been contaminated through the drinking water. We can easily detect that with our CIC without knowing which PFAS they was -- they were exposed to from drinking water. But, of course, knowing which PFAS and where it comes from, you kind of need more information than just a fluorine signal.

So my experience, using high resolution MS is that it's quite good to be able to sort out, which classes we have, which chain length we have, but to be able to distinguish immediately a contaminated cohort versus an uncon -- a normal or occu -- or a background-contaminated cohort. It's not that easy.

So I think using mass defect plots, you will be able to detect new PFASs, but you might not immediately see the whole proportion of the problem so to speak.

PANEL MEMBER FIEHN: A follow-up question. If not by mass spectrometry, you could use ion mobility. Aaron Baker from North Carolina University has shown that

fluorinated compounds, including PFAS, have a very clear, and exactly what you say, a typical pattern that separates out all the fluorinated compounds from non-fluorinated compounds.

She's done it in pine needles over decades that, you know, were sampled in botanical reserve -- reserves, and so she could see how the PFAS in different locations, for example, close to airports and so on, were, you know, sampled, even historical samples. So she did it with ion mobility. Have you considered that as well?

DR. KÄRRMAN: We don't have an ion mobility MS in our lab, but I have used one in other labs. We also had a cooperation with a group in Japan that uses that quite a lot. I think definitely it's a good instrument, a good way to go to, as you can -- as you say, compare different samples from different regions to detect whether there is an exposure somewhere that is new or different from another group.

So I do think it's quite good. But honestly in having a lab where I have the possibility to go both to the orbitrap and to the CIC, I mean, I always go to the CIC first, because it's very easy. It's fast and you get a very clear quantitative result. But having the CIC alone might not help, might not be able to -- I might not be able to give you the research question directly, only

having this instrument. So, of course, if I had to choose -- I had to choose between my mass spec lab and my CIC lab - I couldn't keep both - of course, I would keep my mass spec lab.

CHAIRPERSON SCHWARZMAN: Thank you. We have -- I think you might have just answered this, but I just want to say in the Q&A on Zoom, we have a question that says, "Did you investigate Kendrick plots mass defect CF2 for identifying fluorinated unknown compounds"?

DR. KÄRRMAN: Yes, we have done that. Also, I would say that CF2, from my experience, is not the best mass defect plot to make to be able to detect fluorine-containing compounds. But often it's quite good to include some oxygen-containing fragments as well. But, yes, we have -- we have done that in our process of the non-target screening, even though we usually use suspect screening nowadays, because of the good libraries that are available.

CHAIRPERSON SCHWARZMAN: And another question in the Q&A is, "Have you looked into the use of XRF and LIBS, laser-induced breakdown spectroscopy for total fluorine testing, and if so, how do they compare with CIC and PIGE"?

DR. KÄRRMAN: Yeah. No, unfortunately, I don't have any comparison with those two methods, how they

compare with the CIC. I've been involved in some studies comparing the CIC and the PIGE, and I am suspecting that Simona knows about those already. But for the XRF and the LIBS, I don't have any experience of those, no.

CHAIRPERSON SCHWARZMAN: Thank you.

We have just five or seven minutes remaining. And I want to check in with staff if there are any questions from the audience or attendees that we're not seeing in the Q&A that you're getting by email or with a raised hand.

DR. HOLZMEYER: There are not, no.

CHAIRPERSON SCHWARZMAN: Okay. Great.

DR. IYER: And no raised hands either.

CHAIRPERSON SCHWARZMAN: Thank you, Shoba and Cheryl.

Ulrike, please.

PANEL MEMBER LUDERER: Yeah. Hi. Thank you Anna for that very interesting presentation. I was curious about the -- you know, I think one of the last things that you said where you were talking about how females having greater organofluorine total than males, but then the men have higher levels of the targeted PFAS, whether you have any information about what specific PFAS are driving that higher level in the females?

DR. KÄRRMAN: No. That's a very good question.

And that is something that we want to look into in more depth, and partly was in collaboration with Tom Webster that's going to present later today. So there's, of course, different speculations and hypotheses why women would have a higher organofluorine level in their blood. And some hypothesis involves higher exposure from personal care products and other theories concerns more pharmaceuticals that might be used more or less depending on the gender. But there's just speculations at the moment. So this is an observation that we made and we need to look into it in more depth.

CHAIRPERSON SCHWARZMAN: One -- let's see there's two questions. We have just five minutes, but hopefully -- I think these are relatively short from the Q&A. Sophia Schreckenbach asks, "Could you expand a bit on what mass defect plots you prefer to use for PFAS as opposed to CF2? Thank you".

DR. KÄRRMAN: Oh, so that I think will be very quick from my point of view. I -- yeah, I think you shouldn't do anything opposed to CF2. So CF2 should also be included, but I think it's relevant to include other mass defect plots containing fluorine as well. So there's a few in my previous publications, but also in publications from Mark Strynar, for example, from the U.S. EPA. So I might just leave it by that.

CHAIRPERSON SCHWARZMAN: And Eric Gaudreau is asking whether CIC is sensitive enough to detect organic extractable fluorine in human serum when you only have a hundred microliters available?

DR. KÄRRMAN: Yeah. So firstly, I would like to mention that we have -- we've seen quite a lot of PFASs in the red blood cells as well. So just looking at serum will underestimate the internal body -- the internal exposure and a hundred microliter is also a quite small volume for the CIC. So unfortunately, the detection limit is much higher compared to normal LC-MS analysis. So we use at least 10 times higher than that at the moment, yeah.

CHAIRPERSON SCHWARZMAN: Thank you.

Kathleen.

DR. ATTFIELD: Thank you. Thank you for the presentation. And I was also very interested in the differences by gender that Ulrike brought up. I was wondering if you had more -- any historic samples that you were able to do a comparison.

DR. KÄRRMAN: So my colleague Leo Yeung did a time trend analysis on German blood some time ago, but it's definitely something that we would like to continue with and look into more, also the historical part of it.

We are also very interested in -- we have looked

at populations exposed by drinking water, the background population. But it also seems to be quite different depending on geographical location in Sweden, which we are not very used to to see when it comes to the target PFAS. So that is also something we would like to look into more in detail.

CHAIRPERSON SCHWARZMAN: Great. Anna, thank you so much for joining us and for your presentation.

We will break for lunch now. It's scheduled to last an hour and we will restart right at 1:25. We're asking that everybody rejoin the webinar no later than 1:20, so that we can start the afternoon session on time.

And before we adjourn, I'll just provide this informal Bagley-Keene reminder that -- for Panel members please comply as usual with Bagley-Keene requirements and refrain from discussion -- discussing Panel business during lunch or during the afternoon break.

And with that, I will adjourn the morning session of the meeting and we'll reconvene here at 1:20 to start again at 1:25.

Thank you, everyone.

(Off record: 12:24 p.m.)

(Thereupon a lunch break was taken.)

AFTERNOON SESSION

(On record: 1:25 p.m.)

CHAIRPERSON SCHWARZMAN: All right. Thanks, everybody, for coming back promptly from lunch.

I want to start by introducing our first speaker for the afternoon session. Tom Webster is Professor of Environmental Health at Boston University School of Public Health. And he holds a BS from MIT and Doctor of Science from BU. His main current research interests include PFAS and the health effects of exposure to mixtures. He's co-authored more than 30 publications on PFAS spanning questions of exposure, toxicology, and epidemiology.

And as just a fun fact, several of the speakers at this meeting were trained by Tom at Boston University School of Public Health. So Tom will be presenting on the relative importance of PFAS exposure sources for the general U.S. population.

Thanks, Tom.

(Thereupon a slide presentation.)

DR. WEBSTER: Okay. Thank you very much.

Let's see. Can everybody see the slides?

Yeah?

CHAIRPERSON SCHWARZMAN: Looks good.

DR. WEBSTER: Great. All right. Well, thank you very much for having me. It's actually nice to see some

of you, even if it's not in person. And thanks for the introduction.

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DR. WEBSTER: So, you know, the usual thing. I don't have any conflicts of interest.

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DR. WEBSTER: All right. So what am I going to be talking about today? Several different things. First of all, which PFAS exactly are we talking about, something about methods for investigating exposure to PFAS. I'm going to touch briefly on some of the major exposure routes, water, diet, and indoor exposure. Kate Hoffman will say a little bit more about indoor exposure and water. And then I'll finish up by really talking about the relative contributions.

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DR. WEBSTER: All right. So what PFAS are we talking about?

So this is a variation on the slide that Anna showed. And it's just again to underline what she said. There's substantial amounts of unidentified organic fluorine in human blood, environmental media, and consumer products. And I really like this idea of using extractable organic fluorine and then targeted analysis to look at mass balance. And this is something that, as Anna

said, we're collaborating together to try to figure out what some of this unexplained stuff is in human blood.

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DR. WEBSTER: And really I think the question I'm interested in is what is this unexplained stuff? Is it PFAS that we're not measuring? So, for example, due to lack of standards because for most PFAS we don't actually have analytical standards. And there was a very interesting case about this -- about a compound called C604, that if someone wants to ask me about it later, I'll tell you the story about that or is it something else?

The answer likely depends on the media. So, for example, in wastewater, there's some nice work out of Rob Letcher's group showing large amounts of side chain fluorinated polymers in wastewater. In human serum, again we don't know. Some of it is probably pharmaceuticals, but there may be other things in there. And it depends on the definition of PFAS, as someone mentioned earlier today.

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DR. WEBSTER: So this is actually something that I got interested in a while ago and I have a student writing a paper about this, that she presented at FLUOROS last month. And we found at least eight different definitions of PFAS that are sort of out there.

There's the bucket-all definition, which -- you don't have to read all this. You can look at it later. It's the one that California Biomonitoring uses. And it essentially -- the key thing it has to be aliphatic and it has to have one of these CF3 groups on it. There's the OECD definition, which was revised, let's see, this year that Anna mentioned. And at the minimum, it has to have a CF2 group where the carbon has four bonds, two of them are fluorine and those other two bonds are not a hydrogen or some other things.

And just to mention, there are other definitions. For example, there are several state laws that use a definition of fluorinated organic chemicals containing at least one fully fluorinated carbon atom. So to my mind, this is actually ambiguous and potentially much broader, because it depends what you mean by fully fluorinated. So if you use -- if what you mean by that is the hydrogens have been replaced by fluorine and at least one carbon, which is what is usually meant, then that could include a benzene ring that has a fluorine on it, right, because you've replaced the hydrogens. So the problem is you're not saying anything about the bonding of the carbon. And that is a much, much broader definition.

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DR. WEBSTER: So just an example of the

implications of this is this is the chemical structure of Prozac, which you have heard of. A very commonly used drug in the United States. And it has this fluorinated methyl group up here. And it would be included under the OECD definition, but not under the Buck definition, right, because it has aromatic rings. It's not aliphatic.

And I think part of the point here is that, you know, to my mind definitions can't actually be right or wrong, but you can ask whether they're clear or not and you can ask what is the purpose of the definition. Is it for descriptive purposes? Is it for regulatory purposes? Is it for surveillance?

And it all sort of depends. And so whether you want to include drugs like Prozac in your definition or not sort of depends on what the purpose of the definition is. We can have a very interesting discussion about that.

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DR. WEBSTER: All right. So the caveat about my talk is that when we -- when I'm discussing exposure to PFAS, I'm talking about what most people mean by this is it's usually legacy PFAS, such as PFOA or PFOS, for which there are actually data. Okay. I'm not talking about exposure to Prozac.

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DR. WEBSTER: All right. So how do we go about

figuring this out?

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DR. WEBSTER: So again, PFAS is sort of a very interesting situation, because we're mostly using serum or plasma. Some have -- people have used urine for biomonitoring. And we are interested in the persistent compounds that we actually target, for example PFOA. And that can result from either stable compounds or precursors. That's the external exposure. And then they are modified by pharmacokinetics to give us whatever we see in serum or urine. So you all -- you all know this.

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DR. WEBSTER: And again, biomonitoring integrates different exposure routes. You can't actually tell, per se, from the biomonitoring where it came from, because it can come from diet, or water, or indoor environment, or other things, like personal care products. And so what you see say in blood is the resulting combination of whatever was in those environmental media, things like behavior -- human behavior, which connects us to exposure, and then toxicokinetics.

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DR. WEBSTER: So we really have two primary methods, and I'm going to illustrate these for water. One we'll -- I'll call it the epidemiologic approach, because

I actually think it is an example of epidemiology. It's just that the biomonitored chemical is the outcome of interest, not a disease. And so what you do is you essentially regress serum, or blood, or whatever PFAS concentrations against water concentrations for water, okay? And you can do the same kind of thing for diet or dust.

And the other is the exposure factor approach, where essentially you take water concentrations that you measure and you multiply it by a water consumption rate that you get from the EPA's Exposure Factor Handbook, or you ask people, or whatever.

And each of these approaches sort of has its strengths and weaknesses, and we could -- I've done lots of work with both of them and we could sort of talk about those as well.

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DR. WEBSTER: I should say there are two other things that are used, maybe not quite as much, chemometrics. So this was mentioned a little bit earlier. There's been a handful of papers. A pretty good paper by Elsie Sunderland's group using principal component analysis as sort of a fingerprint idea and do the patterns of the different PFAS that you measure in blood tell you something about the sources? So I think that's -- this is

a good idea. I'm not sure PCA is the right way to do it, but there are lots of ways to think about this. It's a good idea.

The other is reverse dosimetry. And essentially, it's using pharmacokinetic models to try to estimate exposure from what you see in blood or the other way around. You try to estimate what's in blood from your exposure and then you can compare the two and try to see say how much of the -- what you see in blood is explained for by the exposure route that you're looking at. And that's been used a fair amount. There's again lots and lots of details in that and we could talk about that at great length.

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DR. WEBSTER: All right. So let's say a little bit about the major exposure routes that have been investigated.

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DR. WEBSTER: So water, I mean I'm sure you -- you're all very familiar with this. And I would consider this, at least for the main PFASs, sort of established science, that if you live in a contaminated area, you're very likely to have increased levels of PFAS in your blood.

And, you know, I've worked on a couple of these

studies, in particular one with Kate Hoffman, that you'll hear about later in the C8 studies in the West Virginia/Ohio area. And what we found is that water concentrations of PFOA in drinking water predicted serum levels near the DuPont production facility there. And you can actually use regression to estimate the increase in serum concentrations per unit increase in water. And what we found is that those were actually consistent with the pharmacokinetic estimates, which is very nice.

And you can -- so you can -- I think you -- this works pretty well and this has been done a number of places now. So we know that at least in contaminated areas, water can make a very significant contribution to what we see -- what we biomonitor.

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DR. WEBSTER: The next one I'd like to talk about a little bit more is diet. Okay. So I think someone said earlier today that diet is one of the major routes of exposure. This is certainly what a lot of people say and we can talk a little bit about the evidence basis for that. There are several U.S. epidemiologic studies of the kind I mentioned that found that diet significantly -- was significantly associated with blood levels. So just two of them. Just -- I picked these two, because I worked on them and I know them in, you know, boring detail.

There was one that we did with blood samples back in the late 90s and we found associations between various PFASs and things like fish, so you've heard fish earlier today. Shellfish, meat, poultry, these were all associated with the PFAS plasma levels that we targeted.

Another study that we did a long time ago using NHANES data, we found again in NHANES they use dietary questionnaires. And red meat consumption was associated with PFAS and PFOA -- PFOS and PFNA concentrations in blood. And then when we looked at fast food, either total calories from fast food or fast food items eaten per day, that was associated with changes in PFOA level.

And so that actually begins to suggest that there might be some differences between the different PFASs, whether they're from a -- may -- possibly food packaging or whether it's a bioaccumulation process. And it's probably both going on with PFASs.

So there is actually, I would say, quite a number of studies now that have used this sort of design and have established that diet significant -- is significantly associated with blood levels.

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DR. WEBSTER: Now, the last one I'll mention a little bit, and Kate I think is going to say a little bit more about this, is sort of indoor exposure. This is much

less steady than diet or water, but there are now sort of a small number of studies that, again using this epidemiologic approach, found that serum concentrations or plasma are associated with concentrations of the more volatile types of PFASs found in air. So, for example, fluorotelomer alcohols. Whereas, the levels in concentrations in serum were not particularly associated with dust concentrations from people's homes or very weakly.

So as an example the kind of data that we found -- changes in serum PFOS level in people's blood compared to these FOSAs and FOSEs. These are so-called pre-FOS, so they degrade into PFOS and they get in these nice relationships. This is from pregnant women in Vancouver.

And then again from the same study, we found that levels of PFOA and PFNA in serum were related to tertiles of one of the fluorotelomer alcohols, again another precursor. I would say one of the things I was interested in - I don't know if I was surprised or not - is that the diPAPs, which were huge in the dust in these people's homes, were not particularly related to levels in blood. So that's very interesting.

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DR. WEBSTER: And then finally, I think an even

less studied area has to do with personal care products. And there was this very nice paper out of Stockholm University a few years ago, and there's been a couple more since, where they've looked at PFAS in say cosmetics. And what they found was high levels of total fluorine, somewhat less levels of extractable organic fluorine and an even less identified PFAS.

And there's the potential for high dermal exposure. I would say we know almost nothing about dermal absorption of PFASs. There's just a handful of papers out there on that. I think they're -- unless there's new ones, they may all be about PFOA. So this is sort of a big unknown. Potential important source, it might be related to things like sex differences in some ways, but we just don't know very much about it.

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DR. WEBSTER: All right. So let me turn now to relative contributions. So there was a nice paper again out of Elsie Sunderland's group and they used really -- it was clever. They used stored water in serum from the Nurses Health Study dating back to the late 80s. And what they found was that tap water PFOA and PFNA were significantly predicted plasma levels among high consumers of water.

And there's -- they were able to estimate using

pharmacokinetics that they got something like 12, 13 percent of what they measured in blood could possibly be explained for by water exposure. And there's a few more -- there was a few more data points in there. But this is one of the -- one of the few studies I know of that has used empirical data like an epidemiologic approach to try to estimate this.

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DR. WEBSTER: So, relative contribution estimates other than that one I just spoke about. Almost all of them use the relative -- the exposure factor approach. In principle, you could do it either way, the epidemiologic approach or the exposure factor approach. Most of them have used the exposure factor approach. And those have very substantial uncertainties, I would say particularly the dietary ones, because it matters a lot where you sample food and how you measure it. So the detection limits are usually not very -- the levels in food are not very good. It's hard to measure PFAS in food. And so it starts to matter a lot how you treat non-detects.

You have to think about whether you're measuring precursors or not, because we know precursors are very important. You have to think about conversion rates of precursors and to the stable things we see in blood.

And then if you start moving out of diet to other

things, if you want to look at indoor exposure, inhalation rates we know petty well, but dust ingestion rates are really terrible for adults. We don't know that very well. And as I mentioned before, dermal absorption really flux through skin is very poorly understood for PFAS. And I don't necessarily believe very many of the models that are out, because PFAS are just sort of weird chemicals.

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DR. WEBSTER: This is a table that is too busy. It comes from the review paper that we put together earlier this year. But there's a column here for percent exposure via diet. I mean, basically the takeaway is that diet is the main source. There are only two of these studies that are U.S. And they're about, what, ten years old now and they were from Matt Lorber --

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DR. WEBSTER: -- if you remember him. And he estimated in this -- these papers that PFOA and PFOS were about, you know, 60 to 70 percent exposure was due to diet. But again, I think -- I think these are very uncertain. Diet is important, but I -- I'm not sure I really believe these numbers. And they're old too and things change over time.

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DR. WEBSTER: Okay. So how can we sort of

summarize that? Well, I think we have empirical data, you know, from the sort of epidemiologic approach that water, diet, and indoor air all predict blood levels of some PFAS in some populations. And it's going to vary by population and personally within the population. Water is very important in contaminated areas and there's some reason to think based on old data that it accounts for something like 10 to 20 percent, or something like that, in general populations. That's actually important when you set water quality standards that you need to have some factor to account for how much exposure is coming from other stuff, as I think Tom mentioned earlier.

Diet is generally thought to be the major route of exposure in general populations, but I think that those are very -- it's very uncertain and we don't really know very much about diet. So this is underlined by the -- a comparison of the recent studies that came out of the European Food Safety Authority and just this last year a study by FDA of PFAS and diet. And they kind of reach very different conclusions. So I think we need a lot of -- a lot more work on diet. And again, we know almost nothing about personal care products at this point. So we really need comprehensive exposure studies. And this is going to require intensive sampling to really figure this out.

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DR. WEBSTER: A little bit more relevant now towards what California Biomonitoring can do. I think it's important to think about trend -- we were talking about trends earlier and what they might imply. So vast consumables like food packaging and cosmetics as PFAS -- as some PFAS get phased out of those, there should be rapid changes in exposure.

There will be slow consumables like furniture and carpet that may take a long time to work their way through the system. Meanwhile, we have a -- we have global distribution of persistent and mobile PFASs. So there's kind of a worldwide background exposure that these signals are on top of. And so I think that part of what that will mean is that for diet is as a shift in food packaging, it may imply that bioaccumulation routes will become more important for some of the legacy PFAS.

And very important, and this was touched on before, that when we start looking for trends in how they respond to interventions, that external exposure can do -- may decline much faster than serum, because a lot of the PFASs have long half-lives, so you have to build in the right kind of lag structure.

So I think scientifically, we need to understand a bunch of things like unidentified organofluorines. I'm

really interested in that. I think we really need to do more work on dietary exposure, and indoor exposure, and dermal exposure. I think we still don't have a very good handle on real relative source contributions. I think we know a lot of the important ones, but, you know, the relative contributions I'm not so sure, and that we -- this is a rapidly changing world and we need to have exposure studies addressing the changing production out there.

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DR. WEBSTER: Someone did ask me to say a little bit about food, because it gets asked about a lot. It seems to be, at least a combination -- or it was a combination of bioaccumulation in food contact materials. And so you can imagine things like in fish, the persistent PFAS can accumulate in the fish or things can come from farming.

Food processing we know almost nothing about. I'm sure there's contamination of food during food processing, but we -- you know, this is a huge hole. Food contact materials, we do know a little bit about. There's a little bit known about the effects of cooking and then we have exposures.

So what exactly is going on with diet depends on all this stuff and it probably depends on the food and the

type of PFAS. It's worth noting for the general audience that teflon pans themselves are generally not considered to be a major source. The problem with teflon is more making teflon rather than using it, and again, that food processing is not very well studied.

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DR. WEBSTER: All right. I'd just like to end with some thoughts on what I think a biomonitoring surveillance program like that in California, which is really good. What can they do regarding PFAS exposure?

Well, public health -- and a lot -- some of these things have been touched on before. We can -- you know, I think you can point out -- because you have location data, you can potentially point out when exposure to water and contaminated communities is connected to blood levels and the science behind that is pretty well established at this point.

You can try to monitor time trends, both up and down, and evaluate interventions. Although, again, you have to think about lags with the compounds with longer half-lives. And you can certainly look at its disparities. So Kathleen mentioned several of these.

In terms of research, I -- there is a -- there is a good precedent for using surveillance methods like NHANES to try to look at exposure. And I think with the

questionnaire data that you do have, you can look at some of the non-water sources, such as consumption of certain foods or use of carpet. I think you have questions about carpet.

There are important limitations. I mean, you know, dietary questionnaire data is notoriously hard, particularly with time lags. And so you have to think really hard about that, but remarkably, it does seem to work sometime. And there are, of course, other problems like about the precursor.

And then finally, I do think the chemometric fingerprint approach is worth doing. It's not super straightforward, but it is worth looking at.

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DR. WEBSTER: So let me just end by I'd like to acknowledge a bunch of -- a whole bunch of people I have worked with, and again some of my current and former students who have worked on PFAS and some in particular, Kate Hoffman who you'll hear from in a minute.

All right. So thank you very much.

CHAIRPERSON SCHWARZMAN: Thank you, Tom. We have -- I really appreciate that overview, and a summary of the questions, and what's clear and what's not. We have time now for -- we have about 15 minutes for questions from both the Panel and the audience before Kate

Hoffman speaks next.

Any questions from Panelists for Tom?

Tom.

PANEL MEMBER McKONE: Hi, Tom, very good. I really enjoyed the presentation. Doing great work.

I guess I would -- don't -- you know, these different methods for -- I mean, I think we're always going to be limited on our understanding of some of the complicated relationships. You know, just -- there's just too many factors that come in. I mean, I think unless we really can go into people's homes and observe like what products they're using, what carpets they have, what they spray on their carpets, what -- you know, it's just going to be really hard to sort this out.

So I do think I'm kind of interested that you suggested some methods that are sort of kind of inverse -- inverse modeling or principal components. And I don't know if you could talk a little bit more, especially like if we start getting some really good pharmacokinetic models. And again, it would have to be -- I mean, the class is not going to behave the same way. So we probably would have to have it for individual specific chemicals. But, you know, would that maybe help sort out some hypothesis testing about food with some questionnaires more than just sort of brute force questionnaires?

I mean, I think -- I think it's going to be important to have a little bit better pharmacokinetics, but I also would like -- would like your thoughts on that.

DR. WEBSTER: Yeah. I mean, I agree with you. I think to really sort this out, we would have to do very detailed sampling. And I don't of any way to fund that. In our current world, you know, because we don't have an exposure study section at NIH. So it's -- anyway. So, yeah, I mean, the pharmacokinetics, you know, we could have a long discussion about. I mean, what people typically do is something very simple-minded, which is assume first order pharmacokinetics and steady state, which is wrong.

And then you have to estimate half-lives, which we have pretty good estimates for, but we have to have volume of distribution. That we don't know very well. We have to usually extrapolate. And it depends a lot on binding to albumin. It gets really com -- it gets complicated, but they do work sort of okay for at least a handful of the long-lived compounds.

So I think it's not a -- I mean, I think it's not a bad approach. You know, I do like what Matt MacLeod and company is doing, because they're actually looking at nonlinearities over time and they're not assuming steady state, which is really what you have to do, if you're

going to try to really nail those. So I appreciate what he's doing there.

And again, I think it's -- is a first order approach to trying to figure out the contribution of exposures that you understand well like water. I think we understand water pretty well. I think it's okay. Diet -- if we want to figure out diet, we're going to have to invest a lot of money, because it's really -- it's really hard and it's the -- seems to be the big one.

PANEL MEMBER McKONE: All right. Thank you.

DR. WEBSTER: Yep.

CHAIRPERSON SCHWARZMAN: I have Jenny and then José.

PANEL MEMBER QUINTANA: Hi. Jenny Quintana. Thank you for a really great talk. I have kind of a naive question, because I don't really follow nutritional biomarkers very closely. But I was just kind of wondering if one could look -- if you could comment or speculate about if you had a -- you're looking at these compounds and biological fluids, are there other compounds that would indicate sources you could look in the same fluid? And I'm just thinking, for example, if we suspected tobacco smoke, if you looked at cotinine, you know, and if other -- is there anything like fish oils you could look at to indicate a fish source, but -- so I'm kind of

looking at it from within the sample itself.

DR. WEBSTER: Yeah. Hi. Yes, I think that -- I think that's a really good idea. I don't know of anyone who's done that. I mean, one of the differences would be the sort of vast differences in time scale, right? I mean PFASs have half-lives of years a lot of them and -- I don't know, omega-3 fatty acids, I don't what it is, but it can't be very long. So we have to think hard -- and then you get into all those problems if you do one sample, you know, how much do you believe one sample and short half-lives.

But I think it's a good idea and it actually -- it reminds me of, you know, like the work that was done that the Biomonitoring people here mentioned of looking at mercury as a marker for exposure to seafood. So I actually think that's a great idea. I don't really know what they would be. I'm not a, you know, nutritional epidemiologist, but it's a good -- it's a good idea. I hope someone looks at that some more.

PANEL MEMBER QUINTANA: Thank you.

CHAIRPERSON SCHWARZMAN: José.

PANEL MEMBER SUÁREZ: Yeah. Hi, Tom. Thanks for the presentation. Good to see you. And just a quick -- a quick question. How much should we be concerned about or how much is known about cross-contamination of samples, so

contamination of PFAS during the sample collection or storage, given the ubiquitous presence of a lot of these compounds? Do you know much about that. I know that there are a lot of certain recommendations. Some people are saying, well, avoid storing -- or contacting glass containers, because PFAS -- many of them can attach to glass very readily, or avoid, I don't know, low-density polyethylene to store it, because there could be some PFAS in there if you have not tested for that. Do you have any comment on that?

DR. WEBSTER: Well, I'm not an analytical chemist, so I let my chemistry friends worry about this. But I certainly look at the blanks. I mean we always try to do blanks and when we get high blanks, then you get really worried, right? So I think that -- my feeling, you know -- and maybe Oliver can chip in here, is my feeling is that with the traditional PFASs, it's not that bad. But with combustion ion chromatography, you have to work really hard, because there's fluorine everywhere, right? And so you have to actually work really hard and that's one of the reasons they have high blanks and, you know, so they need more sample in order to get detection levels and all that sort of stuff, so it's a -- it's a -- it's a big deal.

Again, my impression for the traditional PFASs is

that it's not as big a problem as say it was with PCBs when people used to worry about, you know, PCBs coming out of the -- out of the fluorescent lights and, you know, all that kind stuff, but anyway.

PANEL MEMBER SUÁREZ: Thank you.

DR. WEBSTER: Our blanks always seem to come back pretty good for regular PFASs?

CHAIRPERSON SCHWARZMAN: I want to ask one of the questions that's in the Q&A function, and then Kathleen, and Veena, and then I have another question in the Q&A.

So from Simona Balan, "Great presentation. Thank you. Do you have any recommendations for how to assess the impact on human exposure of phasing out PFAS from carpets? How would you tease that apart from other changes in PFAS use or exposure sources"? Not unlike Jenny's question about, you know, how can we mark the sources based on other co-exposures or speciation or what?

DR. WEBSTER: Yeah. No, carpet is a good one. And it's com -- again, I, you know, really try to figure out -- you could imagine doing intervention studies, where you replace carpet and you look at people over time or something like that, right?

I mean, I -- I'm very interested in trying to trace back the compounds we find in the indoor environment like in the air or in dust to their actual sources in the

home. And it's -- that's actually hard. There's not been a lot of work done on that. And I suspect that carpets have something to do with it.

And then there may be complicated things going on. It may not just be a release of PFAS from the carpet that's just attached to it, but it could be actual abrasion mechanisms and all sorts of things. And it's kind of not very well understood. But I actually think indoor exposure is probably going to turn out to be quite important for some groups of people.

There's a -- there's a famous exam -- God, there's a famous sort of case study that came out of Canada where there was a family that was using tons of Scotchgard or something, directing -- like it -- I don't quite maybe remember the details, but they were basically treating their furniture or their carpet all the time and they had sky high levels of the hexanesulfonate, as I recall. So there are clearly going to be cases where this turns out to be true. And if we can change that product formulation, it ought to make a difference.

CHAIRPERSON SCHWARZMAN: We just have a few minutes until our next talk, so I'm going to call on Kathleen, who's beeing waiting, and then I'm going to just for the folks who have written something in Q&A, know that we'll hang on to that and bring that out in the next

question session -- question section.

So Kathleen and then Veena.

DR. ATTFIELD: I could defer mine, because it's related to what the anonymous attendee has asked, back to assessing sort of PFAS profiles. And I did want to say to Jenny and to the others I really love the idea of working across panels to give indicators. Of course, I presented that on blood mercury, but, you know, we do have a phenols panel. So we could sort of -- of course, that's a possibly different exposure window and shorter half-lives, but also there's cadmium for smoking and within metals. So there -- it's going to be interesting to think about triangulating from different panels.

CHAIRPERSON SCHWARZMAN: Veena.

PANEL MEMBER SINGLA: Thank you. Thank you for that presentation Tom. It was really informative.

I wonder like kind of thinking about reducing or preventing PFAS exposures, what do you think are some of the most important data gaps or questions, if we're -- if we're trying to think about policy approaches to reducing or preventing exposures?

DR. WEBSTER: Well, I tried to lay that out -- them out on that one slide. I mean, I really want to know what this unexplained organic fluorine is. I think that's actually one of the most important questions. And, I

mean, I'm working on it and I know a couple other people are working on it, but I really want to know. Because if it turns out that its other PFASs that we just don't have standards for, that's a really big deal. If it turns out it's mostly drugs, that's different. So they're very, very different implications of the answer to that question or if it's pesticides or something.

I think that the understanding diet is really important. If it really is one of the major reasons -- routes of exposure, we need to know what's going on there. And I mean in the meanwhile, we can do important things, like getting PFAS out of food packaging it seems like. It's great that's being done, because that might actually turn out to make a big deal. We just don't know yet and it's something we should be looking for, but I think that that's very important.

Now, if it's bioaccumulation, then we're in big trouble, right, because this stuff is everywhere out there in the world. So it will mean that we have to wait for steps to come down in the environment before we can fix that. And that will -- that will -- that's going to take a while.

So we should go after -- I think we should go after the ones that are easy and that should respond quickly, you know.

CHAIRPERSON SCHWARZMAN: Thank you for that, Tom.

We will go on now to our next speaker. I want to introduce Kate Hoffman, who is an Assistant Research Professor at the School of Environmental Sciences and Policy at the Nicholas School of Environment at Duke University.

Kate holds a PhD from the Boston University School of Public Health. Her research focuses on assessment of human exposure to PFAS, flame retardants, and other chemicals used in consumer products, as well as the health impacts of exposure to those chemicals. And she will discuss the relevance for human exposure of PFAS in indoor environments and drinking water.

(Thereupon a slide presentation.)

DR. HOFFMAN: Wonderful. Thank you so much. I am, in fact, one of those former students of Tom's. Let me just get my screen shared here real quickly.

Okay. Great. Can everybody see?

CHAIRPERSON SCHWARZMAN: Yes.

DR. HOFFMAN: I'll assume that's a yes that you can see and hear me. But if you can't, somebody please let me know.

So again, yeah, thanks everybody for the invitation to be here today. I am really excited to be joining you and to talk more about these indoor

environmental exposures and also exposures through drinking water.

Tom, gave a really nice introduction to that. And he is a tough act to follow, but I'm going to try. So to give you kind of an idea of what I'm going to talk about, I'm going to first talk about the CDC and ATSDR multi-site study, which is really geared towards understanding PFAS exposures through drinking water and their potential impacts on human health. And I'll talk a little bit about the multi-site study, specifically in California at UCI.

And then I'll also talk a little bit about some work that I've been involved in looking at exposures to PFAS and the indoor environment.

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DR. HOFFMAN: But before I do that, I just want to acknowledge that I have no financial disclosures or relevant conflicts of interest with the materials included in this presentation. I will be discussing the CDC and ATSD multi-site study and the work of colleagues related to that study. The views expressed are completely my own. I'm not currently involved in any CDC ATSDR multi-site study projects.

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DR. HOFFMAN: Okay. So as Tom mentioned, we do

think that drinking water is main source of exposure to PFAS. And the reason for that is just mainly that PFAS are highly soluble, they're detected in many drinking water supplies across the country. And much of what we know about that exposure comes from the C8 health project study, which is based in Parkersburg, West Virginia and the surrounding communities.

And that study looked at exposure primarily to PFOA and PFOS, but there's sort of this desire to know more about other PFAS compounds. And that was a really large study. It's kind of limited in the scope of compounds that we know things about from that work. And so to that end, the CDC and ATSDR started this multi-site study project, with the goal of looking at sites kind of across the United States that would have different PFAS exposure profiles and comparing exposure at those sites in its relation to different health outcomes.

The health parameters of interest include things like immune response of the metabolism, kidney function, thyroid disease, liver disease, glycemic parameters, and diabetes. And these are all kind of non-cancer health endpoints.

And I'll just say that I think there is some interest in also trying to understand cancer health endpoints, also reproductive health endpoints, but keeping

in mind that even though the multi-site study will be large and only about 10,000 participants, it still will be hard to study some of those rare health outcomes or those that take a long time to develop in this population. So that's sort of one kind of limitation. I think that's data they hope they'll get, but we'll see how that develops.

So it is a five-year study. And the sites in the multi site-study were announced in late 2019, which as all of you can imagine was a difficult time to start a large nationwide kind of epidemiologic study. So there's some challenges with that, that I'll talk about in a few minutes.

But I do think it's important to note that there are sort of seven multi-site study sites, but the study framework really comes from the Pease study, which is in Portsmouth, New Hampshire. And that study it is sort of based on the Pease International Tradesport, which had PFOA contamination of drinking water there. And so they started this study there, which outlined sort of the protocol for the other multi-site study sites.

That study has enrolled about 700 people. They started enrolling about the same time as the other multi-site studies were announced. So they've made good progress over the last couple years. And I'll just note

here that there's a link to the multi-site study website on the bottom of my slide. So if you're interested in knowing more about the sites, you can look there.

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DR. HOFFMAN: So there are sites of the multi-site study all across the United States. The one thing that all of these sites have in common is a documented history of PFAS contamination of their drinking water, but the source of that contamination is different across sites. So some of them have drinking water contamination from past military or AFFF firefighting foam applications near those sites. Others are related to industrial activities. And really importantly for your discussion today in Orange County, California, you have a multi-site study site right there in your home state.

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DR. HOFFMAN: And so at each one of these sites, they hope to recruit a thousand adults, and 300 children. So all told, if you include Pease in that, you'll get about 10,000 people enrolled in the study. As I mentioned, this did start at the end of 2019, which was a hard time to kind of get a bunch of in-person visits and study enrollments done. So these sites I looked this week at their websites to kind of see where everybody was in terms of enrollment.

So some of these sites are just starting to enroll participants in the study, and others are sort of 10 to 15 percent enrolled, I would say. So still kind of in the beginning stages of enrollment in the study.

To ensure that the data can be shared across sites, they all will use a common core protocol, as well as a common IRB and a sort of centralized data management team, so the same questions and same tools are being used at every site.

Each site is going to perform groundwater modeling and exposure reconstruction for all their participants. And this is actually one area that they've made progress in over the last couple years, where they're sort of waiting to do those in-person study visits. A lot of sites have made progress in this area.

And really importantly, they have site-specific community engagement plans at each one of these study sites. And there's some additional research I could use, which I won't get into. But if you're interested, that multi-site study website does include a link to each of the individual study site's websites so you can see what's going on at each individual site that may be specific to their exposure.

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DR. HOFFMAN: And just one thing that I wanted to

sort of highlight is, you know, while the C8 health study had kind of a lot of people with one sort of high PFOA, a little bit of PFOS kind of exposure profile, or at least we think that's what it had, these sites all have kind of different PFOS exposure fingerprints. So there's some variability in exposure across sites.

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DR. HOFFMAN: I won't go into the details here too much just to save time about what exactly is being measured. There's a lot of information on questionnaires, including residential history and water consumption information. And I'll just say that the water consumption information is more detailed than when it was collected in the C8 health study. There's information -- a bunch of health information that's being collected that's also being validated with medical records and also medication lists.

And then really importantly for the study, there are fasting blood and urine samples that are shipped for -- to the CDC for analysis of PFAS, as well as biomarkers for some of these health endpoints. So those are all being analyzed in the same lab. If you're interested in more detail about what exactly is being included in that protocol, you can click on the link there and go and see all of the detailed measurements and how

they're collecting those in the study.

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DR. HOFFMAN: It is sort of a limited number of PFAS under consideration still. Okay. So now I'll say a little bit about the PFAS health study at UCI. So this is headed by Dr. Scott Bartell and Dr. Russ Detwiler. Probably most of you are much more familiar with California geography than I am, but this study is based in Orange County, which is in Southern California. And it's primarily in the Orange County Water District, which is outlined here in this blue color.

Over 500,000 people are served by water systems within 10 miles of the University of California, Irvine Medical Center. And in that UCMR3, which was conducted in 2013 and 2015, all of these water systems had at least one exceedance of that 70 parts per trillion for PFOS and PFOA. So there is a documented history of PFAS contamination of the drinking water there.

And how this site compares to other multi-site studies, in general, it's more diverse than other sites. About 50 percent of children in this area speak a language other than English at home. And then one thing I would just point out is that the source of exposure is a little bit different or at least the presumed source of PFAS contamination in drinking water in this area is a little

bit different than at some of the other sites.

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DR. HOFFMAN: So what else makes this a good site? And one thing about that is that in California you have a lot of information about drinking water that's super valuable for a study like this. So this is a picture of the -- it's a cross section of Orange County's groundwater basin. And so because you have a growing population and years of a current drought, there's really good management by local water utilities of source water and water consumption.

So local water utilities use seasonally varying combinations of groundwater and surface water, as well as imported water to meet that demand. And there's a lot of really good data on that. And the groundwater supply is really carefully managed to that end.

One important thing that I'll just point out here is that the source of the PFAS in this drinking water supply is thought to be through wastewater treatment plants, so the reuse of that water. And I think that's an important different between some of these other communities where we think that, you know, the main source of PFAS in their drinking water is through AFFF or other military activities.

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DR. HOFFMAN: Okay. And so one thing about PFAS in the Orange County Water District, and I think a lot of other water districts particularly in California, is that, you know, once PFAS were detected in that 2013, 2015 UCMR report, those wells with the highest concentrations were taken offline. And so since that time, there's been sort of additional well monitoring and sort of changes in which wells were used at different times, including 38 wells being taken offline in July of 2020, in response to new stricter State health guidelines to sort of reduce the levels of PFAS in finished drinking water that people were receiving.

And I'll also just note that at great cost, Orange County is also currently testing advanced treatment systems for their drinking water to remove PFAS.

So I think if you kind of take this all together, and take this picture all together, it's very likely that exposure to PFAS in Orange County has probably decreased substantially since 2013 and 2015. And that's something that the study will kind of work through and help identify that.

And I think this is probably a story that's going to be true in a lot of -- a lot of other company -- or a lot of other communities as well, particularly with the new EPA roadmap.

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DR. HOFFMAN: So as we see these impacted communities with decreasing PFAS in their drinking water, it's possible that they'll become more and more like sort of general population exposures, and that other sources of exposure will become more significant contributors to overall exposure.

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DR. HOFFMAN: And one source of exposure that I'm very interested in are -- is exposure in the indoor environment. And so why I am exposure -- interested in exposure in the indoor environment? And the reason for that is sort of twofold. One, the average American spends like 90 percent of their time indoors, maybe even more than that over the last couple years. And so if you don't have a whole lot of PFAS in your drinking water, indoor exposures may be more important in your overall level of exposure.

But we also know that PFAS are used in a bunch of products in our home, right? Like they may be used in textiles, or carpets, or furniture products, maybe to a lesser extent in California, but because these are sort of slow replaceable products in our homes, we would expect them to kind of stick around for a period of time.

They may also be used in other applications like

paints, or personal care products, or clothing, So we're going to expect to detect these in our homes for a long period of time. And because they're used in so many products, we're going to expect that they're going to be found commonly in indoor dust and indoor air, presenting a possible source of human exposure.

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DR. HOFFMAN: And, you know, Tom actually talked about this in his presentation as well, just highlighting that this figure shows past research on different environmental media and their importance as pathways of exposure to PFAS. And you can see here that between dust and diet, those have been considered in about 70 percent of past studies, but only 11 percent of studies have considered indoor exposures through indoor air or dust, and what exposure through those pathways may look like.

So while these pathways may be really important sources of exposure for the general population, we know much less about them.

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DR. HOFFMAN: And so I'm going to talk about sort of one study, where we've been looking at indoor exposure. There are certainly other groups that have been doing this. And I'll try to highlight some examples from those groups as we go through. For the sake of time, I'm going

to talk about this one study, even though it has some limitations for some of the applications we'll talk about.

But I do just want to mention briefly that this study is a collaboration with Heather Stapleton and Tom Webster, as well as their students, and post-docs, that we've been working on for several years. I want to acknowledge that effort.

We call this study the Toddlers Exposure to Semi-Volatile Organic Compounds and Indoor Environment Study, TESIE. And we've been working on this since 2014. But we visited kids' homes between 2014 and 2016. We did 200 home visits in Central North Carolina during that time.

And we had kids in the study provide a blood sample during home visits and they also provided a bunch of different samples, which you can see here. The numbers on these different samples are a little bit different. And that's, you know, just due to different challenges with getting different samples from kids. I'll say a little bit more about each sample type when I talk more about them.

We measured PFAS in indoor dust and air. And when I say PFAS here, I'm really kind of, like Tom, using a pretty narrow definition. So I'm talking about those legacy compounds, and also, to some extent, some of the

precursor compounds, like the FTOHs or the pre-FAS compounds. But I'm using that as a pretty narrow definition here to just refer to the compounds that we measured. The serum samples we sent to the CDC and they were analyzed for that kind of standard NHANES type panel.

And one really important thing to note about this cohort is it's -- it is Central North Carolina. And if any of you know about our drinking water here, North Carolina does have some PFAS and water concerns of our own. But this is the -- primarily our participants came from Durham, North Carolina and using municipal water here, which has generally fairly low levels of PFAS contamination. There's a little bit of PFOA detected, but in general, the levels are quite low. We've sampled it several times and that's been a pretty consistent finding over the last few years.

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DR. HOFFMAN: Okay. So, you know, one thing I'll note is that we call this a toddler's study, but by the time we made it out to do these home visits, the kids were a little bit older. As you can see, this is one of our participants here. The participants were about four and a half years old by the time we visited them in the study. They were about 40 percent non-Hispanic white, 40 percent non-Hispanic Black, and about 20 percent Hispanic, and

about half the moms had graduated college about -- at the time we visited them.

And I'll just point here, this compares -- woops -- compares concentrations of the four most commonly detected PFOS compounds in the participant serum with those in NHANES. And this is the data from NHANES 2013 to 2014 for kids three to six. So it's a similar time frame, similar age group. And you can see the most important thing to note here is that exposure looks pretty similar to kids in NHANES. The levels are about the same and both PFOS and PFOA were higher among these particular compounds. And all of these four were detected really frequently.

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DR. HOFFMAN: Okay. So now this is some work that was done by Sam Hall, who is a Doctoral student currently here at Duke. And Sam recently published this work and there's a link to that publication here as well. So we went out into each of these homes and we collected a vacuum cleaner dust sample in the main living area. And there's a photo of the team doing that here.

And what you can see is that we detected a number of different PFAS in dust samples from these homes. The precursor compounds, in particular the FTOHs, which are shown here in red were detected at higher concentrations

than the legacy PFAS, which are shown here in blue. And FTOHs and diPAPs were both detected at medians above 100 nanograms per gram in dust or higher.

And I just want to show that slightly differently, because I think it's kind of hard with a log scale here. You can get a little -- a little bit lost in that data. But if you look on a -- and this is not like a non-targeted analysis or anything like that. If you look at just the percentage of the targeted analytes that we measured that were each of these particular compounds, the 6:2 and the 8:2 FTOH made up greater than 90 percent of the total mass of the targeted PFAS that we measured in dust. So these two compounds contributed quite a lot to the total PFAS burden of dust that we measured.

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DR. HOFFMAN: Okay. And I'll just kind of mention some good news in this story. Sam went out and got -- she collected the medians from six other studies who had data for PFOA, PFOS, and PFHxS in U.S. house dust samples and plotted those over time. And that's what is shown here. You can see that for those compounds, it really seems like there's some real significant increases -- or decreases over time in the medians in those house dust samples, particularly just noting that this is plotted on a log scale. It just seems like it's a

really substantial decrease from over the last maybe 20 years.

One kind of important caveat about that and one thing to think about is that while these three compounds are decreasing, we don't have good data on some of the replacement compounds, so it's possible there are concurrent increases in other PFAS compounds in house dust. And similarly, we don't have a lot of information on some of the precursor compounds over time. So some good news here, but potentially some bad news too, if we had more data to look at that.

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DR. HOFFMAN: And now I'll talk just a little bit about the air data from those same homes. This work was led by Jessica Craig, who's a former doctoral student of Tom's, but she defended recently. We deployed these air samplers. It's a passive air sampler, one of them shown here, and each one had sorbent-impregnated polyurethane foam disks. There's a little -- a little foam piece on here that collected PFAS in the home. These were deployed in participants' homes for about three weeks.

And kind of the main thing to note here is that like the dust, we detected these more volatile precursor compounds, really frequently, in participants' homes. Again, the FTOHs were the most frequently detected. We

also detected these pre-FOS, ethyl-FOSE and methyl-FOSE in most of the homes that we sampled.

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DR. HOFFMAN: Okay. And so now the big question, right? So were any of these things that we measured in air or dust related to children's serum concentrations? And that's something that Jessica spent a lot of time looking at in her dissertation work. And one thing I'll just point out is that, you know, we didn't have huge numbers of overlap between all of these sample types, as I mentioned, because we had some fewer blood samples or some fewer air samples.

But even with that limited sample size, she saw really strong associations between some of these pre-cursor compounds in air and PFAS in children's serum samples. So just like in the paper that Tom showed with the women in Vancouver, we saw this association between this pre-FOS compound methyl-FOSE in air and PFOS in serum, which kind of makes sense on that potential breakdown pathway.

All I know this is three dots here, but this is just the linear and branch PFOS as well as the sum total of both of those. So again, this is consistent with the results that Tom showed from that Vancouver cohort as well.

Similar associations have also been reported for the FTOHs. We didn't see that as strongly here with air, but that was certainly reported in the previous cohort Tom mentioned, but also in a cohort of office workers in Boston that Tom was involved in as well.

Importantly, there were no strong associations with dust in this cohort, so it really does look like that kind of airborne pathway may be more important in terms of tracking exposure.

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DR. HOFFMAN: And then one thing I'll talk about because I just can't hold myself back from talking about wristbands at any opportunity. I know some of you may work with silicone wristbands as well. We use these as kind of an alternative sampling tool to address some of the limitations with collecting samples in the home environment.

As you can imagine, if you collect a sample in someone's home, that's really helpful, but it doesn't capture every indoor environment that they visit, because you may go to your office, or go to school, or leave your home to go some other places, so we asked kids to wear these wristbands. And the idea behind their use is that they kind of sorb compounds from their ambient environment while they're being worn.

So we asked kids to wear those for seven days. And we saw really similar patterns of association between the compounds detected on wristbands and PFOS in serum for example. So we saw kind of similar patterns. I won't go into a lot detail just for the sake of time, but this suggests that these wristbands may be a useful tool in monitoring indoor environmental exposures.

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DR. HOFFMAN: Okay. Now, I'm going to talk about just some challenges in investigating and regulating indoor PFAS exposure and I think Tom touched on some of these as well.

One is just that sampling the indoor environment is much less standardized than biomonitoring approaches. So we can agree on how to collect a blood sample, I think. But when it comes to how to collect a vacuum cleaner sample, it's like all bets are off. You know, the -- do you collect someone's vacuum cleaner dust bag or do you vacuum it yourself? Do you vacuum the living room? Do you vacuum the bedroom? Where do you vacuum? How big a spot do you vacuum?

And so there's a -- there's a lot of challenges with that. And I certainly don't mean to say that the biomonitoring piece of that is easy, but there's just sort of these different batch of challenges. We still have to

kind of come together as a group and sort of resolve exactly how we're going to do that.

In addition to that, prior studies investigating indoor exposures have been relatively small to date and they're primarily based on convenience samples of people that we can get to come in and address that. So those are a really wide range of physiochemical properties, which I'm sure you're all well aware of that make this challenging to study.

This existence of precursor and polymer compounds, which Tom mentioned, is also challenging. We don't know exactly. You know, we've got to see what's breaking down to what and know what's actually -- what's actually being used. Those are certainly real challenges.

There are a wide range of sourced products. I know this came up in the questions previously thinking about things like, well, if you reduce carpet, how much will you see that reduction in exposure? And I think that's an excellent point.

And then a lot of biomonitoring data that we have are primarily from impacted communities, sort of on the national level. And so that's certainly a challenge we're thinking about, these indoor exposures or exposures that may not contribute as much to total exposure.

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DR. HOFFMAN: So just to summarize sort of the main points from my talk today. The multi-site study will provide important information on PFAS exposure in communities with varying levels of contamination across the United States in sort of this veering fingerprint of PFAS exposure.

As Tom said, and I think, you know, I hope this will show as well, when water PFAS concentrations are known, pharmacokinetic modeling can provide pretty good information about the contribution of that exposure to overall PFAS exposure. That's true for some compounds, but not all. You know, there are some that we don't have good pharmacokinetic assumptions for yet, and so that's kind of a challenge.

Exposures in Orange County may become more like general population exposures over time and other sources may become more important, in terms of how they contribute to that overall cumulative exposure.

And at the same time while investigations of indoor exposure pathways remain limited, extensions of the multi-site study could be really helpful in addressing those indoor exposure pathways, or just other pathways outside of drinking water in general.

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DR. HOFFMAN: So I want to just briefly

acknowledge folks who have been involved in this work, but in particular, I want to acknowledge Heather Stapleton and Tom Webster who have both been involved in the TESIE study as well as many of the other studies that I mentioned in this project, and also the UCI PFAS health study team, including Scott Bartell, Russ Detwiler and Veronica Vieira.

And with that, I know I'm standing between you and the break, but I'm happy to take any questions.

CHAIRPERSON SCHWARZMAN: Thank you so much, Heather -- you just said Heather Stapleton -- Kate who's been presenting. My apologies.

We have a couple of questions that are sort of teed up in the chat. And I think these will overlap with your work and I'd also invite Tom to chime in if it's -- if that's helpful.

One is, "There are several sort of"..., in quotations, "'...epidemiological' studies showing much higher levels of some PFAS in infant blood relative to that of mothers, for example PFOA. Could you please comment on early life exposures and its importance in PFAS risk management"? And that wasn't something that was directly in your presentation or even necessarily in Tom's, but I think you folks are well aware.

DR. HOFFMAN: Sure. So I can chime in on that a

little bit, in terms of -- so we actually, in the study that I talked about, had measurements of maternal serum, as well from this cohort, because it's a spin-off of a pregnancy study. And in that study, you know, even -- these kids were like four and a half years old and we still found associations with maternal serum for some of them.

And so, you know, clearly it's something that's still important, in terms of predicting their overall exposure. So certainly it's something to think about. I don't know if -- I mean, I'm happy to have Tom weigh in on that as well. I don't know.

CHAIRPERSON SCHWARZMAN: I'm sure that's the open question about is that from prenatal exposure or because of shared environment?

DR. HOFFMAN: Yeah. I mean, certainly it's hard to know. I mean, I think that's, you know -- and I don't think -- you know, this cohort that we have we're obvious -- it's not an ideal source to look at that, just because we have some people who moved, some people who didn't, so, you know, I don't know. But, yeah, I mean, I guess it could be both.

DR. WEBSTER: I think it's clearly both. I mean, we know PFAS crosses the placenta. We know it's in breast milk. Little kids are down on the floor sticking things

in their mouth. So, you know, I think it's going to -- and they're living in the same environment. So I think it's going to be very hard to disentangle actually, I would imagine.

CHAIRPERSON SCHWARZMAN: The next question is one that was being -- that Kathleen was wanting to echo. "From an epi perspective, how do you try to examine exposure sources of one PFAS congener to another given that they're so correlated"?

DR. HOFFMAN: Yeah. You know, and it's really tough. I mean, even in the -- you know, even in our data, we see some things at times that don't necessarily make perfect sense, right, because we see some of these associations with compounds that are like in the -- even in those precursor pathways, sometimes those breakdown pathways are not compounds that we know break down into each other. And I think part of that is because you get this pattern of people who are using similar products or people who are having similar types of things in their homes.

So I think you're going to have that problem of some of those exposures tracking together, and I think that's going to be true of a lot of things. So we actually see correlations between a lot of these compounds in dust and serum that don't necessarily follow a pattern

you would think. Like, some of these PFAS compounds are actually a little bit correlated with things like phthalates. Now, why is that? It's not because of the common use, I don't think, but, you know, is it because you have more consumption of goods in your home. So I think there will be some things like that. And it is hard to tease that apart and identify exactly what products that's coming from.

So I don't know if, Tom, you want to weigh in on that at this point.

DR. WEBSTER: Yeah. No. I mean, I think this is one of the challenges of doing an epidemiologic approach is that you actually have to think like an epidemiologist. You have to think about confounding. All right. I mean, the air and diet pathways are going to be, to some degree -- sorry, air, and inhalation, and dust pathways are going to be partly correlated with each other. And then things like socioeconomic position can influence purchasing of what's in your home and also diet, right? So all those things you have to actually think about that with that. And -- but epidemiologists, we sort of know how to do that, so it's possible.

CHAIRPERSON SCHWARZMAN: There's a brief question here about in -- with respect to Kate's note about PFAS being removed from municipal water. And the question is,

"Is it treated in any way or is it just treated as waste"? That is, what happens with PFAS removed from municipal water?

DR. HOFFMAN: I think that's going to depend totally on where you are and how it's being managed. So I think one strategy that's being used in California is when it's found in a well, it's stop using that particular well. So we're not -- we're not pulling it from that source at the time, so we're going to other source uses.

You know, and then I think there are varying degrees of success with using other products to remove PFAS from water. We did a study a couple years ago looking at the -- like how successful different home-based filtration methods of removing PFAS from drinking water were. And it's pretty variable honestly.

And so, you know, obviously, if you're just pulling that out with your home Brita, you're just throwing that filter away or recycling that filter after you're using it. So, I mean, I think that's going to be super variable depending on what water district you're in, how they're actually managing that, if it's just a purely we're just going to dilute it with some water that we think doesn't have PFAS or what kind of treatment that they're using, you know, is it an activated carbon system, or what exactly is being done.

CHAIRPERSON SCHWARZMAN: Two more questions, if you don't mind continuing the rapid fire. From Aaron Maruzzo, "Nice presentation, Kate. I have a couple of questions. One, were U.S. territories considered when selecting impacted communities for the multi-State study -- multi-site study? And more generally, can you talk about how sites were selected"? This second question is, "What are the detection limits for dust in air samples -- samplers? And the third is, "Have the concentration data been disaggregated by race and ethnicity"? And I can repeat those questions for you if you need them as we go along.

DR. HOFFMAN: So we'll start at the beginning and I'll say that I -- you know, I didn't participate in the review panel or anything like that for the multi-site study, so I don't know exactly how sites were selected for that. You know, I mean, the criteria were certainly a documented prior PFAS exposure. I am certain that those were limited to U.S. sites. I don't know what territories would have been included in that. So the first one is an easy, I don't -- I don't exactly know.

Let's see, you asked about detection limits, was that the next one?

CHAIRPERSON SCHWARZMAN: Detection limits for dust and air samplers.

DR. HOFFMAN: Okay. So they're going to be variable across the compounds that I mentioned. And they're certainly published in the papers that are linked with those. So I don't have them offhand. You know, they're not -- they're not particularly unusual. They're comparable with sort of other studies in the literature on that. I'm happy to follow up on that or you can look to those published papers on them.

CHAIRPERSON SCHWARZMAN: And the third is have the concentration data been disaggregated by race or ethnicity?

DR. HOFFMAN: Okay. So let's see, in this cohort in general -- so I'm assuming you're asking if there are sort of differences by race and ethnicity in terms of these indoor concentrations?

CHAIRPERSON SCHWARZMAN: It's not my questions, so I can't answer, but I assume so. That's how I would interpret it, so...

DR. HOFFMAN: Okay. Yeah. So, you know, it's interesting. We saw some -- so we have looked at that in terms of biomarkers in this cohort. We did not look at it in terms of the indoor exposures to the same extent. And part of the reason that we didn't do that is because we don't have as many samples. So, you know, we had 50 air samples. And so, you know, when we start breaking that up

by group, we're just a little bit limited in our ability to do that.

But I'll talk about the biomarkers for a second with that. So we did see higher levels of those biomarkers in general, PFAS biomarkers, in our non-Hispanic white participants compared to the non-Hispanic Black and Hispanic participants in this cohort. And that's sort of an opposite trend for other semi-volatile compounds that we measured in this population.

CHAIRPERSON SCHWARZMAN: Okay. I have one more here in the Q&A and then we'll have cleared our backlog.

DR. HOFFMAN: Okay.

CHAIRPERSON SCHWARZMAN: From Summer-Solstice Thomas at Silent Spring Institute. "Kate, brilliant presentation. Thank you so much. I know you talked about the difficulty of standardizing collection of indoor dust samples like the methods of vacuum collection, but from your expert perspective, is there a best practice method"?

DR. HOFFMAN: Gosh. Well, so I think the -- like it's completely out on this right now. So I think, you know, one thing that I'm really interested in right now is is there variability in these compounds within the home? I think that's something we actually don't know and that's a key thing to determine in thinking about this question.

So we sampled the main area that the child played in the home while they were awake, because we are interested in a wide range of compounds and we were thinking about this idea of hand-to-mouth exposure. Knowing that air is particularly important for these compounds, I'm not sure that's necessarily the right environment to sample. We might have wanted a sample in another location too, but, you know, I think this is a really important question. Do you see differences throughout the home?

I imagine you're going to see differences in rooms with carpet, versus rooms with no carpet, versus, you know, how does that -- how does that change throughout the house? So I'm giving you a really unsatisfactory answer there in saying that I don't know, but I think this would be a really important area of research to say do these compounds vary throughout the home, what areas are they really high in, does ventilation matter, and some of those kind of questions.

CHAIRPERSON SCHWARZMAN: Kate, you're going to be here for the afternoon discussion session, right?

DR. HOFFMAN: Yes.

CHAIRPERSON SCHWARZMAN: Okay. I see there's a hand raised in the participants and we haven't gotten to Panel questions, but since we're going to discussion after the break, perhaps we could just touch base and get any

remaining questions after the break. Rather than leaving, you know, 30 seconds for the last question here, I would suggest instead that we break and resume in 15 minutes.

So we will begin promptly again at three o'clock and pick up where we left off. Thank you so much.

(Off record: 2:44 p.m.)

(Thereupon a recess was taken.)

(On record: 3:00 p.m.)

CHAIRPERSON SCHWARZMAN: Okay. I have that it's three o'clock and we'll restart the meeting. And this sort of launches our afternoon discussion session. I want to use the Chair's prerogative to spend the last few minutes just making sure we've answered all the questions from the presentations before the break. We have one participant with a hand raised and I would invite you to unmute and ask your question.

It looks to me like you're still muted. I don't know if that's on our end or yours.

DR. MARDER: We have invited the person -- the attendee to speak. They need to unmute themselves.

CHAIRPERSON SCHWARZMAN: We can return to that person, if they're not back from break yet.

Maybe we should go to Ulrike who has a question.

PANEL MEMBER LUDERER: Thanks. Yeah. Thank you, Kate, for that really interesting presentation. I had a

question, if you could maybe tell us a little bit more about whether your study provided, you know, any clues as to what some of the main sources of the airborne PFAS precursors were that you found?

DR. HOFFMAN: Yeah, it's tough. I mean, I don't think we know and I honestly don't know that we have the questionnaire data to be able to answer that. Although, I do think there is some potential. I noticed there was a question about this in the Q&A before the break about -- thinking about carpets. And I do think there's some potential to do some of that with questionnaire data.

But, you know, this study was really geared towards looking at all kind of semi-volatiles in general. And so I don't know that we going into it necessarily had all the right survey questions at the time. It was also 2014 when we started, so I think if we had some of that data going back, it would have been really helpful.

One kind of interesting thing that we did see was some sort of seasonal variability in some of that. It's a small sample, so when you start to parse that out over seasons, there's a little bit of difficulty in looking at that. I do think there's some differences in ventilation that could be really important to think about, so that's one that's certainly interesting. It doesn't get you to source at all, but I think it's an interesting

consideration for moving forward.

PANEL MEMBER LUDERER: Thank you. Were the concentrations lower, just if I could follow up, in the seasons when you would expect people would have more ventilation, I mean, open windows, or -- you know, I don't -- I don't know what types of -- what seasons were -- had the lower levels I guess is what I'm asking?

DR. HOFFMAN: Yeah. In general, I think they tended to be lower in springtime. Although, I would have to confirm that for sure. I believe it was either spring or fall, but I think part of the reason for that is, you know, we're North Carolina. We're hot and humid. We have central air conditioning everywhere. And so, you know, I think -- I think the only time of year when we have our windows open. Maybe it was actually fall, but it was a season when we expect MORE potential window open kind of weather.

CHAIRPERSON SCHWARZMAN: Veena, go ahead.

PANEL MEMBER SINGLA: Thank you. Thank you so much for that presentation Kate. I've been a fan of your flame retardant's work for a long time, so really nice to see you.

I had two questions. One is you know that for other contaminants that we find in indoor air and dust, sometimes levels can reflect kind of infiltration or

migration from the outdoors to the indoors like, pesticides being trapped in or brought in or air pollutants infiltrating from the outdoors to the indoors. So I wondered if there's any indication that those types of patterns might be contributing to indoor levels of PFAS. And my other question was were there any sort of associations between levels of PFAS between air and dust?

DR. HOFFMAN: You know, so -- I mean, so one thing I want to be really careful of is to not make a overly broad statement about all PFAS, just because I -- you know, it is a really broad class and I touched on this at the end, but just to say that, you know, we're looking at a huge range of properties. And so for some, we're going to see different things.

So, in general, I would say for the compounds I mentioned, I think the concentrations of indoor air and dust were higher than outdoors. So I think that the idea of that coming from outdoors is probably not very likely. So I would say that probably is true for most. You know, could there be some? Potentially.

And let's see, can you remind me of the second part of your question? I lost that one.

PANEL MEMBER SINGLA: Did you see any kind of correlations between levels of PFAS between the air and dust?

DR. HOFFMAN: Yeah. You know, Tom, you can chime in too? If you remind me of this, because I know Jess did that as part of her dissertation. I think in this population they weren't super strongly correlated, I will say in some previous work, particularly Tom's office study I know, and I think probably Colleen's work, has previously shown pretty good correlations between indoor air and dust. I think in this population they were a little lower than what's been reported previously.

DR. WEBSTER: Yeah. You know, I haven't looked at these data in a while, but that's what I remember as well. One would expect there to be some association just from part -- from partitioning theory. I do know that there's some weird stuff with PFAS. I mean, we -- I've looked at some of this data before where the sort of air to dust ratios are not what you would predict based on octanol-air partition coefficients.

And I think part of it is that we don't actually know some of the P chem properties very well, because PFASs are -- PFASs are weird, right? But the other is I think some of the stuff that we're measuring dust is actually maybe bound to the carpet or whatever it is. And so it's not actually fully, you know, in equilibrium with the air. So there's a -- there's a lot to be understood here of exactly where it's coming from and how it's

getting into air and all that sort of stuff. But we just -- you know, there's been very little work done on it.

CHAIRPERSON SCHWARZMAN: Thank you for that.

Jenny.

PANEL MEMBER QUINTANA: Thank you for a really interesting talk. I was just thinking what a natural experiment might be happening now with a lot of -- especially at workplaces going to increased outside air, because of COVID. So really increasing the outside air ventilation. And so it might be an interesting study to see the effect of this, you know, increased outside air ventilation on people's levels as kind of a -- of a really broad scale natural experiment.

DR. HOFFMAN: Yeah. I mean, I think, boy, you know, one thing about the last two years is it's been a really interesting -- it has definitely sprung so many ideas about thinking about indoor exposure for me, because, you know, it's this one time where we -- where suddenly everyone was spending all of their time at home, right? And so you had one environment that you were spending all your period of time in. And so I think that was a really unique period of time.

And now certainly, we have this idea where we have more ventilation or different ventilation, and

particularly in schools. I know my kids' schools right now are like open all the time, and how that might impact exposure is a really interesting question. I don't know if anyone is doing anything on that. I'm not aware of anybody. I think that's really interesting.

CHAIRPERSON SCHWARZMAN: One thought that occurs to me kind of in concert with that is just the -- you know, we've seen so many disparities or inequities kind of widen in the pandemic. And of course that status of are you at home or are you at work depends a lot on your occupation. When there's a big chunk of people who aren't able to stay home and I don't know of anybody specifically looking at this, but I would be intrigued. It feels like an opportunity to really understand some of the impacts of particular workplaces when there are --

DR. HOFFMAN: Yeah.

CHAIRPERSON SCHWARZMAN: -- places that people have had to go where everyone else who isn't a front-line worker of some sort for a time didn't go into their workplaces.

I want to check in again. I see June-Soo Park with a hand raised. I want to check in and see if Kimiye Touchi is back and invite you to give -- ask your question. If you're back, you are permitted to talk and just need to unmute your -- at your end, if you want to

ask a question.

DR. PARK: Hi. It was a great presentation again. I'm just curious the -- because I see dominant compound, PFAS compound, detected and your dust samples were -- or even number the FTOH 6:2, 8:2. I remember two years ago when publication surveyed municipal landfill leachate, they didn't measure dominant congener some odd number the -- you know, the FTOH. The -- have you looked into the like 5:3 7:3 FTOH or in your sample -- dust samples?

DR. HOFFMAN: Yeah. No, we didn't do that here. And, in fact, in these particular dust samples, we only measured the 6:2 and the 8:2. We also measured some firehouse dust samples at the same time. And those we were -- we measured 10:2 as well, but these were just the 6:2 and the 8:2.

DR. PARK: Got it.

DR. HOFFMAN: It's like a -- it's a very limited -- you know, I say we measured PFAS in these. It's still like a tip of the iceberg list, right, like it's still really small.

DR. PARK: Yeah. Yeah. I totally understand. Yeah. Thank you.

CHAIRPERSON SCHWARZMAN: Thank you. I want to move on to our discussion portion and just make one last

call to see if the participant Kimiye Touchi wants to ask a question, and if not, request that you lower your hand, so we know that that moment has passed.

Okay. I think we will go on and start our discussion now, which I just want to introduce for a moment with some questions that the Biomonitoring Program has posed to us. So the overarching question for this discussion is how Biomonitoring California can support PFAS exposure reduction efforts? Basically, how could -- how could data from the Program be used in that way?

And we can think about what we heard so far today to help inform our advice to the Program on the next steps, both in terms of future study design and the opportunities there for data analysis that Kathleen highlighted.

So I want to show some slides that the Program has put together to just frame this conversation.

I'm working on it. Get the right screen shared.

(Thereupon a slide presentation.)

CHAIRPERSON SCHWARZMAN: I think that should do it. So each of these has a question on it just meant to focus us on guiding the Program. So referring to the opportunities for further analyses of the existing data sets on PFASs that were highlighted by Kathleen Attfield this morning.

The Program's questions are, number one, which are the most promising for illuminating PFAS trends in California? And what type of analyses would you recommend to further understand the sources of the racial disparities that were reported that were observed in those data sets? So what analyses would you prioritize for looking at PFAS trends in the state and how should we better understand what's driving the racial disparities that were observed?

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CHAIRPERSON SCHWARZMAN: The second is when looking at the PFAS data for pregnant women from the MAMAs project, which is based on the blood spots, as a reminder, what potential limitations and confounders should we be concerned with? And specifically, how should these limitations and confounders inform the design of future sample selection from the GDSP, which is the Genetic Disease Screening Program, Biobank that is the repository of these blood spots? So thinking about what are the limitations and confounders of that as a sample source and how to keep that in consideration?

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CHAIRPERSON SCHWARZMAN: With regard to identifying key PFAS exposure sources in biomonitoring studies that are intended to inform exposure reduction

efforts, the questions here are:

What advice do you have on designing questionnaires that are meant to assess PFAS exposure?

What limitations of questionnaires are of concern for evaluating PFAS exposures? And, you know, we saw several -- multiple examples of data provided by questionnaires in the -- in the earlier presentations today, so anything that arose from that.

And what other approaches would you suggest to help evaluate PFAS exposure sources in the studies, that is other than questionnaires I assume is the point of this question?

And for this I just want to flag, and we can return to this in our conversation, the notion that's come up a couple times about looking for co-exposures that might illuminate sources of PFAS exposure. We raised that in the morning around the question of fish exposure -- that is fish consumption and how -- and its association with PFAS exposure, and are there ways like looking at mercury concentrations to evaluate whether that's happening in fish at higher levels of the food web, and then also this afternoon's question about looking more broadly at other kind of co-exposures that might point toward individual sources of PFAS.

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CHAIRPERSON SCHWARZMAN: And then the final question is just a broad one. Any other input on next steps for Biomonitoring California that would support PFAS exposure reduction efforts. So I think I'm going to stop sharing my screen, because otherwise we have to dedicate it to one question or another and I also can't see participants. But let me know if you want to -- me to reiterate any of those questions and we can revisit them, if we run out of things to say to make sure that we responded to all of the Program's questions.

I also want to just mention that in this discussion session, I will call for public comment at some point, but let's start off with folks who have their hands raised.

I have Kathleen and then Nerissa.

MS. HOOVER: Nerissa, maybe you could just go ahead.

DR. WU: Yeah, I'll just -- I just wanted to chime in. One correction is that the samples for the MAMAs are actually a prenatal serum sample taken during the second trimester of pregnancy, not a newborn blood spot. And I think the timing of when that is taken -- one of our questions is related to how you would design or analyze MAMAs data related to things like blood volume and how pregnancy might impact that and their subsequent PFAS

levels.

CHAIRPERSON SCHWARZMAN: Thank you so much, Nerissa. Yes, I missed that. Thank you for clarifying.

Carl Cranor.

PANEL MEMBER CRANOR: Can you hear me?

CHAIRPERSON SCHWARZMAN: Yes.

PANEL MEMBER CRANOR: You raised -- gosh. I'm echoing. You raised a question about minority communities. And I'm wondering have you ruled out where they live? I mean, P -- the PFOAs may or may not be part of a -- living near an industrial area or something like that, but they get a lot of contamination for, you know, things that they live next to, their houses, their sources of air pollution, some studies have been done, things like that. You could rule them out or maybe rule them in. Just a question.

CHAIRPERSON SCHWARZMAN: Kathleen might want to say something about this, but -- or Nerissa. But as I remember from the morning's presentation, it was Asian participants had the highest exposures followed by White and then Black -- Hispanic and then Black, is that right? Do you all mind repeating that?

DR. ATTFIELD: Yeah, that's correct. I did find it interesting that in the new North Carolina studies, they were also saying White is greater than Hispanics. So

the same pattern is happening elsewhere in the country for that.

As far as Carl's comment, it is interesting to try and think about which locations might be of immediate concern. And I might punt that over to Karl Palmer a little bit. But we definitely don't have any large manufacturers of PFAS in California for one.

PANEL MEMBER CRANOR: Um-hmm.

DR. ATTFIELD: And so, yeah, maybe the chrome plating or -- well, then you're -- as Kate Hoffman was talking about, then you're looking at some of the more dispersed source pollutants, which is sort of somewhere in between the very local and a very diffuse pollutant source, such as the wastewater treatment plants feeding into the Santa Ana River.

PANEL MEMBER CRANOR: I just thought it was worth mentioning, because often these communities live in buildings or areas that have been pretty contaminated.

DR. WU: Right. And that's certainly a kind of analysis we could do, similar to what we've done with 1-nitropyrene where we could do some GIS work, if we knew what sources we were looking at and do kind of distance to -- traffic or distance to a facility in this case. It is -- we do have addresses for our non-MAMAs data. And so, yeah, that is -- that is something we could look at

for -- I mean, it's a question of if that is our priority. I think it's one of the dominant exposure sources.

CHAIRPERSON SCHWARZMAN: Tom McKone.

PANEL MEMBER McKONE: Hi. Thank you. So this is a -- I'm kind of struggling with some of the conversations we had earlier about how hard it is to really tease out, you know, what we're seeing, because there are competing pathways and similar substances with the same biomarkers. So it's kind of a chicken and egg, because I think, you know, the only way -- I mean, we're thinking about how to improve biomonitoring to understand how to reduce exposures. And in a way, the only way we're going to understand that is to reduce exposures and see what happens, right, which, you know, we don't -- I don't know how you do that. And so maybe that's what we need to think about.

Are there ways to look at market trends or reductions, you know, things that should reduce exposures and see if they're actually happening? I mean, it's sort of like, you know, in an ideal world, if we could do everything we wanted, we would -- we would, you know, do this differential analysis. We would remove one product from the market totally, and then put it back in the market, right, a case crossover kind of study. And we can't really do that, but maybe it's possible to think

about ways to watch the factors, like consumption patterns, consumer products, or even some very targeted questionnaires to see where theremight be reductions in exposure, and see how that plays out in the biomonitoring data. And then we can go back and say, okay, we kind of confirmed that hypothesis to some extent, so that might be somewhere we want to put resources.

But again, it's very com -- but I struggle with just absolutely at this point saying, oh, given the uncertainties we heard about today, we're supposed to say this is the best thing to do to understand how to reduce exposures, where that's going to be very hard to do until we have a better understanding of these complicated relationships.

CHAIRPERSON SCHWARZMAN: Thank you, Tom. If it's okay, I'll insert my own comment, and then Ulrike, I'll call on you next.

One thing that's been on my mind is something that comes up a lot is sort of treating PFAS as a -- as a group and talking about it -- about as PFAS in general, all PFAS versus the different chemicals that are used in different applications and that seem to change over time. And, of course, with the absence of, you know, required reporting, we don't -- about chemicals that are in products, but that are used in particular applications, we

don't have a general understanding. There's no sort of publicly accessible information about what is used in products and how that might be changing over time, how that chemical profile might be changing over time.

But I'm thinking about some -- so what that says to me is that as much as we can be looking across the board at different types of PFAS compounds, that that might tell us something about exposure sources and what's happening. The example that I'm thinking of is sort of what we've seen in shifting patterns of use of phthalates and how that has been reflected in biomonitoring data, and how you can see action taking place on some phthalates, and then, you know, with a little bit of lag, the concentration of replacement phthalates rises over time. And so we've seen that sort of play out in that switch from one chemical to another within a related class of compounds. But the only way that we're going to see that of course is by looking for a fairly wide range of the compounds, and there's such a long list with PFAS, that that's pretty daunting.

But people who know more about which types of PFAS are used in which types of applications than I do, could probably help inform some hypotheses about, well, if they're being eliminated from food contact materials, these are the chemicals that we might expect to see go

down. And whereas, you know, the legacy compounds that have very long half-lives, yes, those are declining over time, but maybe not as dramatically as when something is pulled from the market and the chemicals have shorter half-lives.

So I don't have the details to fill in the substance of what that recommendation would be, but that's the approach that I would think about is all of the information that you can get on which types of PFASs are used in particular applications that are under scrutiny or that -- or that there's action being taken on like food serviceware. And I know that's all really difficult information to obtain.

Ulrike.

PANEL MEMBER LUDERER: Actually, the last thing that you just said was essentially the direction that I was going in also, which is that this -- you know, the effort to remove PFASs from food contact materials provides an opportunity to see, you know, whether that intervention actually results in reductions in exposure levels over time, but we need to know what are the PFASs that are in food contact materials. And it sounds like from some of the presentations that we heard today, we don't necessarily know that. And so there may need to be two research initiatives happening at the same time to

better understand what's in those -- what's currently being used, and then as they're taken out, you know, to be able to try to follow the trends over time and see if there's a reduction in biomonitored concentrations of those particular PFASs.

CHAIRPERSON SCHWARZMAN: Go ahead, Nerissa.

DR. WU: I was just going to say that, I mean, it's important to have a comparison group as well, just because we have overall downward trends. So maybe there's an opportunity where there's some municipalities that are being more progressive with reduction in food packaging to compare to do surveillance in different communities, just because otherwise you're looking at it in this overall context, and you have lots of different changes happening over time and it's difficult to interpret.

CHAIRPERSON SCHWARZMAN: Yeah, I really hear that and probably the only time to do that is in that kind of liminal space when there are changes being made and there will actually be differences in various markets, because once large areas like the State of California do something to eliminate the use of PFAS in a -- in a whole product category, ultimately that will trickle down to the rest of the market, but at the -- at the beginning of a shift like that, there's going to be differences. And the tricky thing is to be responsive, you know to be able to do

anything either fast enough to capture a change like that or, I mean, that's the point of surveillance, right, is that if you're measuring consistent substances over time, you're already measuring them, and so you can look back and see these changes reflected or try to understand them. But it's hard if you don't have the capacity for that level of surveillance.

DR. WU: And it does take a certain nimbleness to be able to go out and grab the samples, but that is one of the ways MAMAs or the biobank samples are well suited, where you can get retroactive samples. We could go back to the San Francisco area and look over a particular time period in comparison to other places. And I thought of that also when Kate was talking about the Santa Ana area and the interventions in Orange County with their water supply in 2020, going -- we could go back in time and then follow it up prospectively to see how those levels are dropping compared to the other parts of the State.

I know I keep adding stuff to things we could do, which is not the point, but it is -- there are so many questions we're trying to answer.

CHAIRPERSON SCHWARZMAN: I want to just flag that Simona Balan has mentioned in the Q&A that we know -- we do know what's used in food packaging, because the chemicals are listed in FDA's food contact notifications

database, but we don't know all the impurities and the degradants of those PFAS, so to add that to the conversation.

Let me -- I want to turn to Karl Palmer next and just remind folks to lower their hand, if you would, so that I can keep track of who else needs to speak.

MR. PALMER: Thanks, Meg. Yeah, I'll just -- to riff on what Simona pointed out is that I think there are potential strategic opportunities to look at partnering with other regulatory bodies and know what food contact notifications are required. We also know that CalRecycle has implemented certain restrictions on PFAS in food packaging used at State facilities. So there might be an opportunity to find a cohort of people that ostensibly will be having reduced exposure to certain kinds of packaging.

And so those kinds of things -- kudos to the Biomonitoring staff who worked really hard to leverage their limited resources with the other agencies, but I think there's opportunities to expand that and to find potential opportunities there that could perhaps get good data.

CHAIRPERSON SCHWARZMAN: Great.

Veena.

PANEL MEMBER SINGLA: Thank you. Maybe this

doesn't make any sense, but I wondered about looking at the populations that have very low PFAS exposures and seeing if there's information there that could kind of speak to what might be helpful in reducing PFAS exposures. So, you know, do like -- I'm just making this up right, but like -- like maybe a vegan diet or people that don't eat fast food at all, or, you know, use very few personal care products, because I think like both types of information, both, you know, trying to like really understand the sources of exposures for the kind of populations with the highest exposures as well as what might -- what kind of behaviors or actions might prevent exposures, like both kinds of information are useful, so just a thought.

CHAIRPERSON SCHWARZMAN: Go ahead, Kathleen.

DR. ATTFIELD: I love that suggestion, Veena, because we've partly already done it.

(Laughter.)

DR. ATTFIELD: We had -- in addition to asking about people's individual food item frequencies, we try to ask them about different types of diets. And in the ACE study we also asked about dietary changes over time. Not an initial smoking gun, I'm afraid, for sort of vegetarian or vegan in the CARE population though. I had held out hope for it.

(Laughter.)

CHAIRPERSON SCHWARZMAN: So maybe I'll just point us back to some of the other questions. We've sort of been talking about general opportunities or priorities how Biomonitoring California data that exists or that could be gathered would support PFAS exposure reduction efforts. And so just to return to some of the other questions, maybe to highlight one potential for doing additional analyses on the existing data sets. And although we talked for a minute about the sort of racial separation of some of the results with the PFAS data that Kathleen presented this morning. Another question was about potential limitations and confounders with the GDSP biobank data used for the pregnant women and the MAMAS project and what we might recommend to keep in mind with that. Another is questions about designing PFAS exposure questionnaires or other ways of evaluating PFAS exposure sources.

Kathleen, are you still wanting to say something?

No. Okay.

Any feedback from the Panelists on those questions?

José.

PANEL MEMBER SUÁREZ: When it comes to the race/ethnicity piece, in many ways now, that's considered

more of a social construct than really a truly genetic one, when we're looking at differences in just about any health outcome with maybe some rare exceptions, but overall in that sense. But I think the findings that were presented today about very substantial differences -- maybe somebody can remind me how much higher the concentrations were for some of the PFAS for Asians compared to some of the other groups. From what I recall, it was something like 80 percent, is that right, for some of them?

DR. ATTFIELD: It depends on the comparison, but yeah, 144 percent was the highest, you know, when you're going -- you know, comparing the highest group, Asians, down to the lowest group, which were Black participants.

PANEL MEMBER SUÁREZ: Uh-huh. So I mean I see that as a --

DR. ATTFIELD: It was in the slides. I'm happy to pull up any slides anyone would like to see again, if you would like me to.

PANEL MEMBER SUÁREZ: Well, thank you, Kathleen, but I think the -- I think overall there was some -- there were some pretty stark differences for many of the PFAS being substantially higher among Asians compared to most other groups. And so I think that gives this window of opportunity of starting to get a little bit deeper than

that. It's really more of a behavioral or environmental difference there.

And if we're talking about 140 percent difference for some of these, there's something important that one group is doing that the other ones are not when it comes to getting exposures to a lot of these compounds. Of course, PFAS are present in so many -- there's just so many sources that it's hard to even be able to fathom constructing a very thorough or all-encompassing survey for identifying the sources, but I think this is one of those particular settings in which we might be able to get a little more of a straightforward answer, given these stark differences across these constructs, these groups. So that's something worth looking at.

Also, we can't really say Asians and say it's all a homogeneous group, obviously. And so from there, it's parsing it out, right? So do we have -- or do you have any information about the subgroups within the different Asian populations, in which there may be another way to even start getting a little bit closer to what some behavioral or environmental differences there may be.

PANEL MEMBER FIEHN: If I might add directly to this question. You know, I also find these kinds of ethnicities, asking people how they feel, it's a little outdated, because many people say I'm mixed race anyway,

and they feel more and more comfortable to tick that box and it's actually true. So I wonder about that in terms of socioeconomic status, rather than, you know, their cultural and ethnic backgrounds. Do you have information about that?

So it looked to me that these people were just eating more fish and that one of the reasons could be because they are richer. I'm just making it up here as we go, but it could be, right? And that is getting lost in that, you know, adding a label of some kind of ethnic backgrounds.

CHAIRPERSON SCHWARZMAN: I definitely support that, and -- but I also remember that Kathleen showed us that the -- those racial category differences persisted once fish consumption was controlled for. So it may still be what's driving it, not the fish, but it may be a socioeconomic thing that's driving other sources of exposure also. But I completely agree with you that, you know, we all know that race is a social construct not a biological determinant of health. And so the question is what is it connected to? I mean, these are all the same question, right, is like what exposure source is that connected to?

Kathleen, did you want to respond to something there and then -- and then I'll get to Tom.

Oh, no. Hand down.

Okay. Tom, go ahead, please.

DR. ATTFIELD: Oh.

DR. WEBSTER: Do you want me to go ahead?

CHAIRPERSON SCHWARZMAN: Sure. I think I misread Kathleen putting her hand down, but please, you go ahead Tom and then Kathleen.

DR. WEBSTER: So I -- PFASs I think is a pretty interesting group of compounds, at least the legacy ones. It seems to increase with socioeconomic position, contrary to lots of things. And that suggests that it's -- again, it's not the biology of race. This is like where environmental epidemiology and social epidemiology intersect, that people have more income, and so they have different purchasing, and maybe it's you buy carpet, or your diet is different, or you eat more fast food. I don't know. There's all sorts of things going on there.

And, I mean, you know, NHANES does have some pretty nice data on socioeconomic status that they manage to collect that I think makes a pretty good case that that's an important variable for PFAS. So I don't -- again, I don't know what California Biomonitoring has for that, but I'm sure that's part of it.

CHAIRPERSON SCHWARZMAN: Sorry to have skipped over you there, Kathleen. Please, go ahead.

DR. ATTFIELD: I think I hit the lower hand instead of the mute -- or unmute.

Thank you for making the point that, yes, we didn't see the contribution and that's in kind of quotation marks, contribution by race disappear with the addition of fish into our models. So there's still more to this relationship to uncover. And I won't claim that we have plumbed it completely.

One additional piece of information that is good to know about the CARE study is that in relation to law changes, we -- even though I presented these as, you know, very simplistic categories of racial/ethnic identifications, we did allow everybody to identify, as -- in as many categories as they agreed with their background. So, of course, for analysis purposes, you know, sometimes you do have to then take various simplifications, but we do have that underlying information, so that we can look at things in different ways going forward.

And I would say our income data is we had let that be an optional category, so we don't have that for the entire data sets. We do have education. Of course, these aren't completely correlated of course, but give you extra information about socioeconomic status. And at least for education, usually it drops out of the model

once you put age, sex, and race into it for many of the compounds, not for PFNA, but for the others.

CHAIRPERSON SCHWARZMAN: Thanks, Kathleen. José were you wanting to join back in?

PANEL MEMBER SUÁREZ: No. Oh, sorry, my hand was -- should have been lowered, but --

CHAIRPERSON SCHWARZMAN: Okay. Thanks then.

Tom.

DR. WEBSTER: I was just going to say that I think this is where, you know, economic theory can -- sorry, epidemiologic theory can actually help us, because dietary exposure is going to be a poorly measured variable, because it's really -- it's what you've eaten over the last five to 10 years that matters for the persistent PFASs, not what you ate yesterday. So it all depends on, you know, if you use -- so this comes up in NHANES that you use food frequency questionnaires, whether you use dietary surveys, and all that sort of stuff.

But the point is that a poorly measured confounder will not fully control for confounding, right? And it can actually bias things in either direction. So it could be that, you know, we control for fish, but it doesn't fully remove the effect of fish, and so it's still there. So I'm not saying that's not the explanation. It just -- it's -- you know, it's hard. It's hard. Diet is

sort of notoriously hard to measure. And, in fact, I'm kind of -- I'm always surprised that we see any relationship with dietary questionnaires.

CHAIRPERSON SCHWARZMAN: Nerissa.

DR. WU: I just wanted to say that these are all great points about race, and the questions that we still have remaining. And it could be that the ACE data set is one of the places we should be looking for some of these analyses. ACE, of course, the impetus for that was because we did want to understand why Asians were higher in metals as well as PFASs. And it is an opportunity for us to look at, you know, Asians is -- just is a very heterogeneous group. We're able to look at Chinese and Vietnamese and it would be great to get more information with robust numbers to be able to look at these subcategories of Asians in a way.

We did -- we do struggle with the homogeneity of some of the answers, because everyone ate a lot of rice and fish in that group, but it is -- we have sufficient numbers and we have a lot of detail on diet that we just are not able to include in something like the CARE study.

CHAIRPERSON SCHWARZMAN: Thanks.

Kathleen.

DR. ATTFIELD: I just wanted to add on to that point of Nerissa's. So the ACE study looked at

Chinese-Americans in the San Francisco area in one year and the subsequent year was in Vietnamese-Americans in the San Jose area. And back to the point about sort of chemometrics and PFAS profiles. They did have different profiles between the two and we haven't been able to move beyond sort of recognizing that the patterns were different there, but I think it's a good promising arena that we could explore more.

PANEL MEMBER SUÁREZ: Well, in that sense, if I can chime in, so if there was a year difference and location difference from where the two different groups were located, of course, that adds a lot of new variables to that, right? So we're talking about temporal changes and geographical effects to it, maybe not necessarily fully behavioral differences or otherwise across the different groups. Of course, it would have been ideal to have inter-mixed, at the same time ideally somewhere around the same areas where both groups or multiple groups were collected. So, you know, that's just adding additional levels of complexity to disentangling, I guess, the differences.

CHAIRPERSON SCHWARZMAN: Maybe I will take this moment to do our sort of formal call for public comment. I think it's been understood that participants and anyone in the audience can raise a question or provide a comment,

but I want to remind you that you can use the raise-hand feature in the Zoom webinar or send an email to biomonitoring@oehha.ca.gov, or type a question into the Q&A function on Zoom.

So I just want to check in with staff and see if there's any public comment that we haven't tended to.

DR. HOLZMEYER: There's no emails.

CHAIRPERSON SCHWARZMAN: Okay.

DR. IYER: And no hands raised.

CHAIRPERSON SCHWARZMAN: Thank you, Cheryl and Shoba.

Kathleen.

DR. ATTFIELD: Apologize, I keep not tending to it.

CHAIRPERSON SCHWARZMAN: Maybe there's a sort of call to folks for other kind of nominations for other potential sources of exposure around which we might see differential exposure that would help us understand exposure sources, like we've already talked about, the elimination of PFAS from food contact materials or food serviceware, and to flag any other ideas like that for the Program.

Jenny.

PANEL MEMBER QUINTANA: Hi. We have such experts among us, I'm hoping that we could hear -- especially I'm

interested in occupational exposures. It seems like this is an exposure that might be very prevalent, firefighters, military bases or people that live on military bases, you know, airports. I'm just wondering if you have any comments on occupations, which would be important to study?

CHAIRPERSON SCHWARZMAN: If I understand you, right, Jenny, you're asking for comments from any of our expert speakers who have contributed today?

PANEL MEMBER QUINTANA: Yes, I just thought what a great opportunity to get advice about what we should do from them.

CHAIRPERSON SCHWARZMAN: Yes, absolutely.

DR. WEBSTER: Well, I have to say my experience with PFAS and occupational exposure is really chemical workers, you know, chloropolymer facilities. So, I mean, I would expect that there might be some difference with firefighters and maybe the -- you know, I don't know, these chrome plating things, I've never done any work on that, but that sounds like that would be worth looking at.

There are a lot of them and I -- actually, off the top of my head, I don't know if anyone has actually looked at that.

DR. HOFFMAN: Maybe I'll just throw on to add on to what Tom said there. We also looked at firefighter

dust in the same study that I referenced looking at the household dust. And there, we did find higher levels of a lot of those compounds in dust in fire stations, indicating some occupational -- or potential for occupational exposure there. I know it's dust and I showed you that maybe dust isn't the most important exposure, but I think you might expect a similar pattern there. And certainly, you know, just given the use of these compounds and AFFF were also like firefighting gear, you might expect that exposure there. So I think there are studies looking into that now, so you might expect that as well. Like Tom, I don't know about anything with the plating industry, although that's an interesting question too.

PANEL MEMBER QUINTANA: I actually -- sorry, go ahead.

CHAIRPERSON SCHWARZMAN: No go ahead.

PANEL MEMBER QUINTANA: Well, I was kind of unfairly going to ask another question. Is that okay?

CHAIRPERSON SCHWARZMAN: That's okay. Carry on. While you -- yep. Go ahead.

DR. WEBSTER: You know, it made me think, like I don't know if anyone has looked at food workers, people who work in fast food restaurants or in pat -- the food processing industry. I don't know if anyone has actually

ever looked at that. So I don't know how much exposure there would be, because I think a lot of the food contact materials are actually polymer based. And so you might have residuals and so it's going to be complicated and there's lots of them and they're hard to measure, right, so...

MR. PALMER: I just might add that, you know, this is one of the challenges that we have when we're looking at certain consumer products that contain the materials. Once you know that they're there, then you can start breaking down how they get there and the process that they're manufacturing.

Food packaging is a good example. Food packaging is generally a combination of a lot of different materials, sometimes with multiple people in the supply chain. And so, for example, some of the fiber based food packaging uses mold releasers that contain PFAS. I'm not sure if those are sprayed on and there's someone there spraying it or if it's automated and what workers -- but that's one of the challenges, not only where are these chemicals in the products, but how are they actually manufactured, which would speak to the role of workers, but certainly platers are a good example of someone who there's probably a good chance they're exposed.

DR. WEBSTER: Another one that might be worth

looking at would be, you know, people who work in places that sell carpet, if the carpet is treated. Karl, do you know if anyone is -- has done that. I mean, I know this has been done with things like flame retardants in the past, but I --

MR. PALMER: Well, I don't know and Simona might have a better idea. She led our PFAS team. But we did, when we were looking at these treatment products for example --

DR WEBSTER: Yeah.

MR. PALMER: -- you can purchase a piece of furniture that is not treated and then when you buy it, they say would you like other treatment. And so we don't know if there's some poor guy on the back loading dock who's spraying it or if it's done in a factory on order and things like that, so those are certainly good questions.

PANEL MEMBER QUINTANA: My second somewhat unrelated question, but you brought up the dust issue again, Dr. Hoffman, and I'm just wondering that even though dust might not be as correlated to the air -- the body burden as air levels, I'm wondering if it could still be serving as a reservoir, and that the variability in air levels could be, you know, the reservoir partitioning into air, plus ventilation in the home leading to air levels or

something like that. I was just kind of curious if there's any thought that dust could be a reservoir, because it certainly has a lot of stuff in it.

DR. HOFFMAN: Yeah, definitely. And, I mean, I just -- you know, I want to make really clear too that, you know, we looked at a limited set, right? And so dust might be really important for some other things. And that's part of the hard part about understanding these compounds. We're going to get some that are going to be really important in air and some that are going to be more important in dust. So I think that's an important point.

And you're right, you're going to get this kind of equilibrium and partitioning between the two and you may see that sort of as a reservoir for what's coming into air as well.

CHAIRPERSON SCHWARZMAN: Thanks.

Ulrike and then I have a question from the Q&A from a participant.

PANEL MEMBER LUDERER: Thanks. Yeah. I just had a couple of comments. One, apropos of firefighters. I know one of the questions of the Program was asking us was whether there are additional measurements that would -- potentially could be made in some of the archived samples from prior Biomonitoring California studies. And I know in the FOX study, which is the Firefighter Occupational

Health -- Occupational Exposures study, the smaller original kind of group of 12 PFAS was measured. And I think it might be worth looking at the expanded set of PFAS in that -- in those samples, because dust was in a subset of the fire stations in that study. I know that PFAS were also measured in dust as I recall. So that might be -- I mean, it would be a while ago, so you are going to be talking more about historical exposures in firefighters, but that might an opportunity to use existing samples from the Program's archives.

And the other thing apropos of, I noticed -- I recall that there was a study that was done by the Program where people were replacing their upholstery and it was looking at flame retardant biomonitoring levels, but I wonder whether that study might be an opportunity to look at the effects of that on PFAS. Now, I don't remember how long -- you know, what the time interval was with these longer lived compounds that might be too short. But that it might be another thing to think about and -- you know, an intervention study that was done that might be informative.

CHAIRPERSON SCHWARZMAN: Thank you, Ulrike.

While we're on the topic of occupational categories, I'll just add two comments from the question and answers. Simona Balan says that, "There were some

studies of air monitoring in carpet stores, but not in California".

And I'll also add that I just know of a doctoral student who was trying to measure exposure to carpet recycling workers in California, because we have a mandate for carpet recycling and wasn't able to gain access to the facility. So that's a potentially highly exposed occupational category. I just want to say that's my own comment.

And Anna Reade comments that, "Some other occupational exposures that may be of interest include ski areas..." -- I assume that's like people who aredoing ski waxes -- "...car washes and cleaners who are..." -- like janitors, I assume here, because of floor waxes.

And I'll add to that maybe just that it's so tricky, because all of those uses of PFAS-intensive materials also involve environmental contamination with those products. And so teasing out what gets into the environment and what gets into the workers, it can be tricky.

Tom, did you have something to add?

DR. WEBSTER: Oh, yea. There's definitely been work on ski waxers in Scandinavia. There's been several very good studies. They have very high exposure.

CHAIRPERSON SCHWARZMAN: Presumably because

they're applying it with heat --

DR. WEBSTER: Absolutely.

CHAIRPERSON SCHWARZMAN: -- and there's volatilization.

DR. WEBSTER: Little tiny, not very well ventilated rooms, and -- you know.

CHAIRPERSON SCHWARZMAN: Right.

DR. WEBSTER: Although, I think that stuff is -- they're taking it out of the wax for professional competitions now, I believe.

CHAIRPERSON SCHWARZMAN: I have got a question from Summer-Solstice Thomas from Silent Spring Institute. "Has it been considered..." -- so this is sort of getting to the point of questionnaires. "Has it been considered the importance of asking individuals the date of their most recent menstrual cycle when taking blood samples for PFAS biomonitoring? Has Biomonitoring California looked at PFAS levels in breast milk"?

So that's two questions, one specifically for the Program about breast milk and another more generally about the role of asking for date of last menstrual cycle.

DR. ATTFIELD: This is Kathleen Attfield.

As far as breast milk, at least four of these studies that the design of the study is conducted by Biomonitoring California, we haven't measured any breast

milk, I believe. I can't speak for our lab collaborations. And no, we have not asked about most recent menstrual cycle. What we have -- the relevant information is mostly about -- related to age and to parity that we have for various studies.

DR. WEBSTER: Parity is huge.

CHAIRPERSON SCHWARZMAN: And, Tom, you're saying that because levels decline with increasing parity?

DR. WEBSTER: Absolutely. I mean, I think that's very well established in the literature now.

CHAIRPERSON SCHWARZMAN: Is that independent of breast feeding?

DR. WEBSTER: It's connected to breast feeding, but I believe it's independent. Although, I can't swear by that and I'd have to look.

DR. ATTFIELD: And I should add we have months of breast feeding as well for the CARE studies at least.

CHAIRPERSON SCHWARZMAN: I have June-Soo and then Sara.

DR. PARK: Yeah. Just a quick comment, because you guys talked about the ski wax. Actually, Anna Kärrman was the one -- her group and her former advisor did a lot of work a lot of work on the ski wax, ski -- the worker for the PFAS exposure.

I just want to comment that since I opened my

microphone, I also would like to make -- keep comment toward José's earlier concern about the background. To our experience, by far, PFAS background, you know, came mainly from our instrument, when we purchased it and installed -- purchased a new instrument and installed it, it took us long time to get the background levels down, even after we replaced all the teflon liners. That's what -- what's happening to our new instrument just installed.

We had a 6:2 fluorotelomer sulfonate background, which is gradually coming down, but it just takes time, like our old instrument. But, you know, the old test tubes we tested has a little background was because I just realized we published the paper. You know, the reserve we tested the serum separation too, compared to the red-top tube we historically used for the blood collection analysis. So I think I can forward that publication to you, that's the 2014 one.

Thank you.

MS. HOOVER: So, Meg, I just wanted to chime in and say it's almost 4:05, which means we have very little time left in the discussion. However, I can tell you that the plan for the 2022 SGP meetings is extremely short, so you could consider, you know, that we cover that and then you come back and close up this discussion. So think

about if that feels right, because I don't think we're going to have time to close up this discussion very well or address some of the other questions.

And actually, I was raising my hand to answer the other question that Simona had posed, which is, "Is Biomonitoring California considering updating its PFAS definition to match the revised definition from OECD"? We have not at this point. And that would actually be an SGP decision. Now, you all may recall that I did raise potentially expanding and looking at more fluorinated compounds as a past possible chemical selection item, and that was not of interest to the SGP. But if the Panel is interested in reconsidering the definition, that's something that we could bring for your consideration at a future meeting.

CHAIRPERSON SCHWARZMAN: Nerissa.

DR. WU: Thanks. I just wanted to address Ulrike's comment about using archived samples to go back and look historically at PFASs. A reminder that when we do any analyses on old samples, we are obligated to then return the results to participants. And so that triggers another concern, which is that people have signed up for a study maybe years ago, and so returning results to them may be coming to them out of a little context. And so it's something that we always consider when going back.

We have done that with the FOX participants going back to look another class of flame retardants. And so there's some precedence for it.

But the MAMAS also does offer the same kind of benefit in terms of being able to do historical profiles of PFASs. And then that way also we can -- we can get more of a surveillance type of data, rather than a particular cohort that we would have recruited to the study.

And because we are coming to the end of the time, I just want to put in a plug again. We've talked a little bit about collaborations. We've talked about more types of analyses than the Program can do on our own. And so inviting all of you to think about students who might be interested in doing this kind of work. We have lots of data sets. And I think Cheryl or Sara will also post the links to our positions available in Biomonitoring California, because if there are people listening, who would like to come work on some of these questions, we are looking for good epis.

CHAIRPERSON SCHWARZMAN: I have a question about that, Nerissa, of how to better matchmake between the needs for data analysis that the Program has and the rich data sources that are here. And, you know, the very spread out, diffuse sort of placement of doctoral students

and working with researchers in different universities all around. And I -- is -- I've been kind of mulling it over all day, but I wonder if there's any -- if we could think through some kind of format that is not too burdensome for the Program, like putting together a short slide deck that would illustrate some of the opportunities that there are that could be circulated or if there could be one webinar held that everybody could tune into, so it wouldn't have to be outreach to individual schools of public health or like that, that -- I have a sense that we could do more to proactively kind of, I think, speed up that matchmaking.

DR. WU: I think that's a great idea. We have started down that road kind of coalescing all of this data of like, you know, who's in the study, what panels do we measure, what are the kinds of questions we've asked. And we do have that in a database. I think there's another step to that we have -- which we have done for CARE, where we've started to just do a quick analysis of, you know, who answered this question and what kind of variability are we seeing? So these are the questions that will be useful for some kind of analyses.

So it's quite an effort to go back and do that, but I think we have -- it's one of those things on our to-do list that we want to come out with this menu, so

that we can say, you know, here what's available to you, researchers, and what are questions that you might want to be interrogating our data for.

CHAIRPERSON SCHWARZMAN: Great. Thank you.

At this point, I want to pass it over to Sara. And as she mentioned, if we move through the next part of the meeting quickly and there's still -- I'll check in at the end of Sara's presentation, if there are un -- if there's sort of unfinished business from this discussion that we can reopen before we close the meeting.

So I want to pass it over to Sara for the plan for the 2022's Scientific Guidance Panel meetings. Sara Hoover is Chief of the Safer Alternative's Assessment and Biomonitoring Section in OEHHA, and she'll provide a brief overview of that plan.

(Thereupon a slide presentation.)

MS. HOOVER: Thank you, Meg. And I will also add that after I finish my brief presentation, we could also call for open public comment. And then you could clear both the items and turn back to this discussion, if that seems reasonable.

Okay. I'm going to give this a shot. My first try in -- let's see now. This is interesting. I have it open. Okay. I'm just going to share my screen and navigate to my PowerPoint.

Let's see, slide show from beginning. Okay. Can everyone see this?

DR. MARDER: We're still seeing your I think Teams screen.

MS. HOOVER: Okay. This is why we practice ahead. Okay. Let me stop sharing, and -- so, Elizabeth, when I pick the share screen, it did not give me -- okay. Now it's giving me the PowerPoint option. All right. Let's try that. Okay.

DR. MARDER: And now we see your PowerPoint.

MS. HOOVER: There you see it. Fantastic.

It wasn't -- that window was not coming up.

Okay. Really briefly. Normally, every November, we talk about possible topics for the next year's meetings. And in conferring with my team, with Nerissa's team, with other Program leads, with our management, we realized that we want to take a simpler approach in 2022 for a number of reasons. And those reasons are, number one, my team and at OEHHA we're spending our time on AB 617 biomonitoring. We're launching the Stockton project this week and we're also going to be working on another project in the coming year.

Meanwhile, at CDPH and DTSC, they're busy working on implementing the new budget augmentation and hiring people. So we just realized we have to go to a simpler

model. So to start with, thank you to the Panel members for responding to a couple surveys. We pinned down our three dates for next year. They're all going to be half-day meetings from one to four p.m. on March 25th, July 22nd, and November 18th. And those are all Fridays.

Fortunately, even though the Bagley-Keene exemption of not having to meet in person is going to expire. At this moment, it's slated to expire in January. However, given the nature of the meetings we're having, we're still going to be able to join -- have attendees and Panel members join via Zoom webinar. We will set up a meeting room for each meeting in case the public wants to come to a meeting room, where they will then watch the webinar.

--o0o--

MS. HOOVER: So we're just planning to have a very simple standing agenda for all three meetings, where Nerissa would give her Program update. Susan Hurley would give the AB 617 biomonitoring update, and then we'd really just have an open discussion with Panel members, Program staff, and the audience about whatever issues we're confronting in our work at that time. Then we'd also make sure to have some dedicated time for specific Panel input as well as public comment. And that's the plan for 2022.

I also want to remind everybody on this call and

in general that it's always possible to submit public comment on any topic to the Program to our Program email.

So I'll just stop there, and see if before I close the slides, if anybody has any questions about this plan for me, either from the Panel or the audience?

And any comments about the plan or if it seems reasonable. I should add -- I'm sorry. I should add one other thing which is that if there were a specific topic that came up, we could always consider scheduling that. So this is the standing agenda, but, you know, we're not banning the possibility of talking about other things. There might -- something might come up that we all feel is important to address.

CHAIRPERSON SCHWARZMAN: Tom, you had a question or a comment.

PANEL MEMBER McKONE: A brief question. So it sounds like these are going to be a hybrid meeting where there will be a room?

MS. HOOVER: Exactly. It's a hybrid.

PANEL MEMBER McKONE: And then so are the --

MS. HOOVER: I'm calling it the hybrid model.

PANEL MEMBER McKONE: And the Panel members do have the option? I mean, if I'm -- if it's easy to get there, if it's local, like over in Richmond.

MS. HOOVER: Sure. Yeah. I think what we

probably would do is set up a room in the Oakland building of OEHHA. And, yeah, absolutely, Panel members will be welcome to join there.

PANEL MEMBER McKONE: Okay.

CHAIRPERSON SCHWARZMAN: Would -- as results continue to kind of come out from analysis of CARE and things like that, is that what would be included in the Program update? Would that be a chance to sort of see some snapshots into that?

MS. HOOVER: Yeah. Definitely.

Okay. Well, I don't see any other questions. Cheryl or Shoba, are there any public questions or comments on this?

DR. IYER: I'm not seeing any attendee hands up, no.

DR. HOLZMEYER: And I don't see any new emails.

MS. HOOVER: Okay. Great. So again, if anybody does think of something later, feel free to email us. And that is the end of that presentation. Thank you very much.

CHAIRPERSON SCHWARZMAN: Great. Thank you, Sara. And I just want to -- it's sort of like a good moment to note the tremendous amount of effort that goes into preparing these really rich and informative meetings from -- on the part of the staff of Biomonitoring

California, and all of our guest presenters, and discussants. And I think we've all benefited enormously from that, but that it's also important to recognize how much work they are, and that we'll -- it will be interesting to try on for size this new format that hopefully will reduce the burden a bit on staff, and -- and let's see how it -- what kinds of meetings it produces and we can go from there.

Carl Cranor, did you have a question or a comment?

Carl, were you going to make a comment or no?

PANEL MEMBER CRANOR: Yes, I was muted. These were great presentations and efficient. Thank you.

CHAIRPERSON SCHWARZMAN: Great.

Tom. Webster, that is.

DR. WEBSTER: Hi. Yeah, I was -- I wanted to comment a little bit on expanding the definition. So like I said before, I have one of my PhD students is looking at the different definitions, and in particular, with the implications they have for organofluorine, pharmaceuticals, and pesticides. And I'm not saying it's a good or a bad thing. But one of the consequences of going to the OECD def -- the new OECD definition is you would pull in a large number of high-volume fluorinated pharmaceuticals. And that's going to cause IRB problems,

so just be aware. You know, if you do it, have your eyes open.

CHAIRPERSON SCHWARZMAN: So I want to say something about the rest of the meeting. We have 15 minutes, if we need it, and there's a few things that we need to do during that time. One is I want to open public comment. We have 10 minutes allotted for the public comment period and this is an opportunity to comment on any topic related to Biomonitoring California. It doesn't have to be constrained to the topic of today's meeting.

And a reminder that if you're attending via webinar, you can submit written comments or questions in the Q&A function or by email to biomonitoring@oehha.ca.gov. You can raise your hand via the Zoom function and we'll call on you to speak your comment.

There's two comments that I want to flag that were posted on -- or links to which are available on the November meeting page under the open public comment section, and those are both by Dr. Ahimsa Porter Sumchai of the Hunters Point Community Biomonitoring Program. And that commenter submitted two links, one is called "Unraveling the Breast Cancer Conundrum in San Francisco", and the other is, "Biomonitoring Saves a Life". And so both of those public comments are available via links from

the website.

And then a third comment that was emailed to the Program is just following up. It's from Sharyle Patton and just following up on a comment dropped in the Q&A about the two pesticides that contain PFAS. And the details -- the comments includes the details on those two pesticides and Biomonitoring California has information now. So rather than share all the content, I just want to refer to it.

So that's to acknowledge the three public comments that have come in. And I want to pause for a moment to see if there are any public comments submitted by email. I don't see any attendees with hands raised or anything in the Q&A.

DR. HOLZMEYER: There are no new emails.

CHAIRPERSON SCHWARZMAN: Okay.

So aside from -- assuming that we don't have to wait. There's no lag in submitting public comments, the only remaining thing that we have is if there's additional comment and discussion from our -- from our discussion period that we didn't get to before the time came for Sara's presentation about meetings in 2022.

So I want to leave a moment here for any Panelists or attendees to raise hands or drop a comment or question in the Q&A before we adjourn the meeting?

Any thoughts that that discussion triggered around the topic of PFAS and how Biomonitoring California can contribute to understanding sources of PFAS and how to reduce exposures?

Sara.

MS. HOOVER: Yeah, I'll just chime in briefly, since no one else is. I am curious about the Panel's take on the possibility of expanding the definition. As I said, I've raised the issue of considering other fluorinated compounds. I have not been an advocate for expanding the definition in part, because of the cautions that Tom Webster raised, but I would be interested to hear the Panel's thoughts on that particular question.

CHAIRPERSON SCHWARZMAN: Anyone have contributions to that at this moment? Jenny, did you have something?

PANEL MEMBER QUINTANA: Just to say I agree with Dr. Webster.

CHAIRPERSON SCHWARZMAN: And that's about the complication of --

PANEL MEMBER QUINTANA: About the complications and maybe getting too diffuse as well.

CHAIRPERSON SCHWARZMAN: It's reminiscent to me of the difficulties that arise around non-targeted screening and how to handle illicit substances and/or

prescription substances, pharmaceuticals, and all of that. It's a little bit reminiscent of that.

Veena.

PANEL MEMBER SINGLA: I -- my thoughts are that I think that we'd just want to make sure that the current definition does capture all of the PFAS that could be of interest related to the kind of exposure types and sources we're interested in, you know, including some of the components that go into fluoropolymers. And I think it would be worthwhile to just take a little bit of a closer look at that question in terms of the definition, and that certainly the listing could be written in a way to exclude pharmaceuticals, if that's not of interest, similar to how halogenated organic chemicals used as flame retardants is very specific to chemicals used as flame retardants.

CHAIRPERSON SCHWARZMAN: Yeah. That's something I've appreciated about the Program's class definitions is that they're not -- they haven't been like strictly -- they've managed to span that distance between like is it strictly a sort of molecular definition or is it -- or is it also a use definition. And I've appreciated how the Program has kind of spanned that divide in the past.

Maybe it's just a vote of confidence for the Program's capacity to do that.

Sara, did you have a comment?

MS. HOOVER: Yeah, if I can just chime in to say that I will take note of that suggestion, and I'm actually really interested in this question. I've been looking at it a lot. I know Tom has been looking at it a lot. So I'll plan to take a closer look and see, you know, because I agree there are some things that are missed through the Buck et al. definition, but there might be another way to handle that rather than changing -- I've resisted changing that definition, because that is the definition that established the class of PFASs. So my idea would be to instead, well, is there another group of fluorinated compounds that we want to bring in, and how would be -- what would be the best way to do that. So why don't -- why don't I go back to that to, you know, look at that. I'll confer with Tom and others about it and we'll just at some point report back on what we found. Does that sound good? Is that okay?

CHAIRPERSON SCHWARZMAN: That's great.

MS. HOOVER: Okay. Great.

CHAIRPERSON SCHWARZMAN: Tom Webster, did you have a comment?

DR. WEBSTER: Yeah. I was going to say that I actually really like what she just said, that I don't think the Buck definition is really comprehensive enough for what you want. But you need to think hard about what

is it that your organization wants to get out. That's the point about a definition is what's the purpose of it? And I -- you probably don't want to include fluorinated pharmaceuticals. I don't think that makes a lot of sense for you, but you might want to include, you know, liquid crystal monomers, for example, if people might be exposed. I don't know. I think it's worth sort of thinking about fairly seriously.

CHAIRPERSON SCHWARZMAN: Thank you.

Jenny.

PANEL MEMBER QUINTANA: Was Sara ahead of me to make a comment?

CHAIRPERSON SCHWARZMAN: I think Sara made her comment.

PANEL MEMBER QUINTANA: Oh. Okay. I was hoping I could make a really quick open public comment, and then for something for maybe another session to discuss this so that --

CHAIRPERSON SCHWARZMAN: Sure. And -- but you can make a comment at any time.

PANEL MEMBER QUINTANA: Okay. Well, I can hold it if you want to wrap-up the meeting.

CHAIRPERSON SCHWARZMAN: No, that's good. Now is good.

PANEL MEMBER QUINTANA: Okay. I just want to

make a -- throw out for a future discussion for our Guidance Panel that we think about if we want to stick with pure biomarkers of exposure because of a recent study in our updates where we might be looking at biomarkers of early genetic damage, for example, which is kind of a departure for the study for our Program to look at anything but biomarkers of pure exposure. So I just want to throw that out there that we might want to have a discussion about it.

MS. HOOVER: Can I chime in on that, Meg?

CHAIRPERSON SCHWARZMAN: Yeah.

MS. HOOVER: So just to clarify, Jenny, if you're referring to the AB 617 study, remember that that study spans -- it goes beyond just Biomonitoring California, so we're funded to support the AB 617 mandate. The biomonitoring -- the exposure biomonitoring is run under Biomonitoring California, but we have other funding, so I wouldn't say that we're actually expanding in Biomonitoring California beyond what we've traditionally done. I don't know if that's helpful.

I will also note that technically, in terms of our purview, we can choose whatever biomarkers we think are reasonable as indicators of exposures to chemicals on the designated list, for example, so that's another way to look at it.

PANEL MEMBER QUINTANA: I don't want to take up too much time. Just for another -- for another meeting perhaps.

CHAIRPERSON SCHWARZMAN: Great. And Jenny, did you have an additional comment?

PANEL MEMBER QUINTANA: Me? No. Sorry, my dog is barking.

CHAIRPERSON SCHWARZMAN: It's okay. I thought you said you had had two. No worries.

Okay. I don't see any other hands raised. But now is the moment if anyone has any last contributions before we wrap-up the meeting?

In that case, I will do the final announcement that the transcript of this meeting will be posted as usual on the Biomonitoring California website when it's available. Our next meeting, as Sara mentioned, will be on March 25th, 2022 from one to four p.m. and attendees will be able to join via Zoom webinar or at a meeting room that will be announced.

I want to thank Biomonitoring California staff for putting together this meeting. I want to thank all the presenters who brought such rich content to the discussion, and all of the audience members who participated, and, of course, to the Panel with a especially hearty thank you to Veena for everything that

you have contributed to our conversations over the past few years, more than that, while you've been a member of the Panel. And I understand you'll still be involved, but I'll just be sorry not to have you as a -- as a fellow Panelist here. But thank you so much for everything you brought to the Program.

And with that, I'll adjourn the meeting and we'll see you in March.

(Thereupon the California Environmental Contaminant Biomonitoring Program, Scientific Guidance Panel meeting adjourned at 4:27 p.m.)

CERTIFICATE OF REPORTER

I, JAMES F. PETERS, a Certified Shorthand Reporter of the State of California, do hereby certify:

That I am a disinterested person herein; that the foregoing California Environmental Contamination Biomonitoring Program Scientific Guidance Panel meeting was reported in shorthand by me, James F. Peters, a Certified Shorthand Reporter of the State of California, and thereafter transcribed under my direction, by computer-assisted transcription.

I further certify that I am not of counsel or attorney for any of the parties to said meeting nor in any way interested in the outcome of said meeting.

IN WITNESS WHEREOF, I have hereunto set my hand this 29th day of November, 2021.

JAMES F. PETERS, CSR
Certified Shorthand Reporter
License No. 10063