

Decentralized longitudinal transcriptomic studies using homeRNA:

*A framework for studying the effects of the exposome
and wildfire smoke*



2021 Cub Creek Fire. Source: [Photography By Carolyn](#)

Ashleigh Theberge

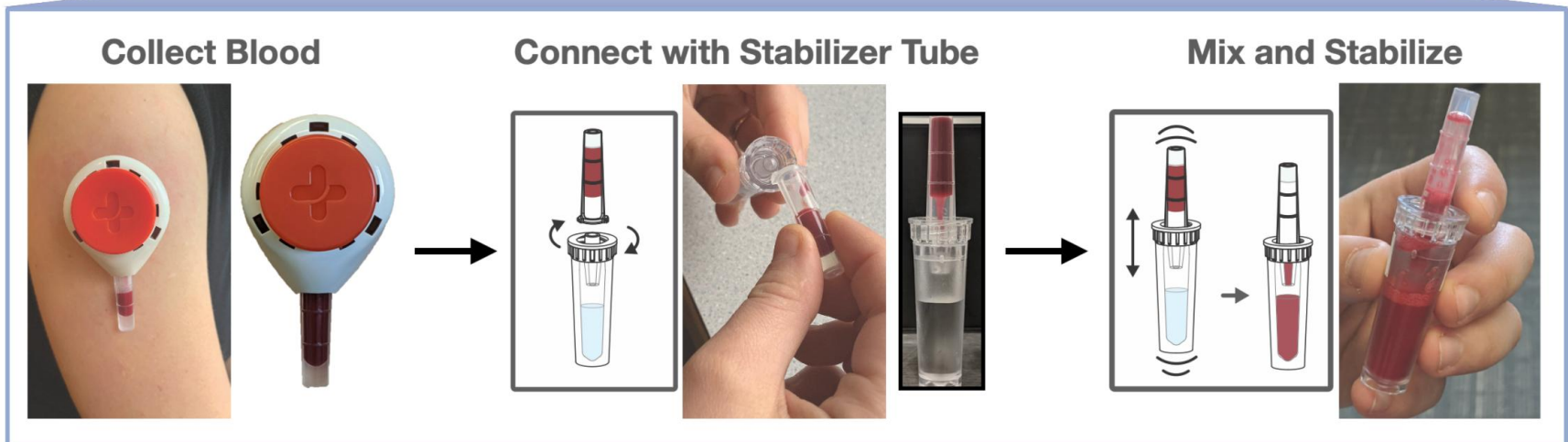
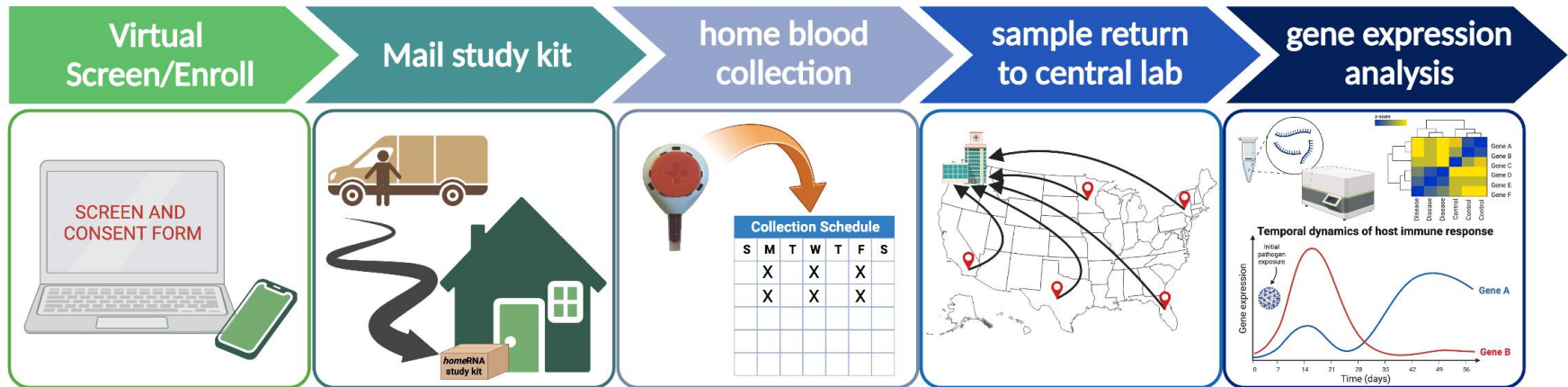
Professor, Department of Chemistry
Adjunct Professor, Department of Urology

W UNIVERSITY of WASHINGTON

Disclosures

- Ashleigh Theberge, Erwin Berthier (Affiliate Professor & Co-PI of our lab), and Sanitta Thongpang (Research Scientist) cofounded and have ownership in Seabright, LLC.
 - Sanitta and Erwin are partially employed by Seabright, LLC
 - Seabright will advance new tools for diagnostics and clinical research, including the homeRNA, homeAir, and CandyCollect platforms.
- Erwin Berthier and Sanitta Thongpang also have ownership in Salus Discovery, LLC and Tasso, Inc. Erwin is a cofounder and employed by Tasso, Inc.
 - The at-home blood sampling device shown in this presentation is from Tasso, Inc.
- The terms of this arrangement have been reviewed and approved by the University of Washington in accordance with its policies governing outside work and financial conflicts of interest in research.

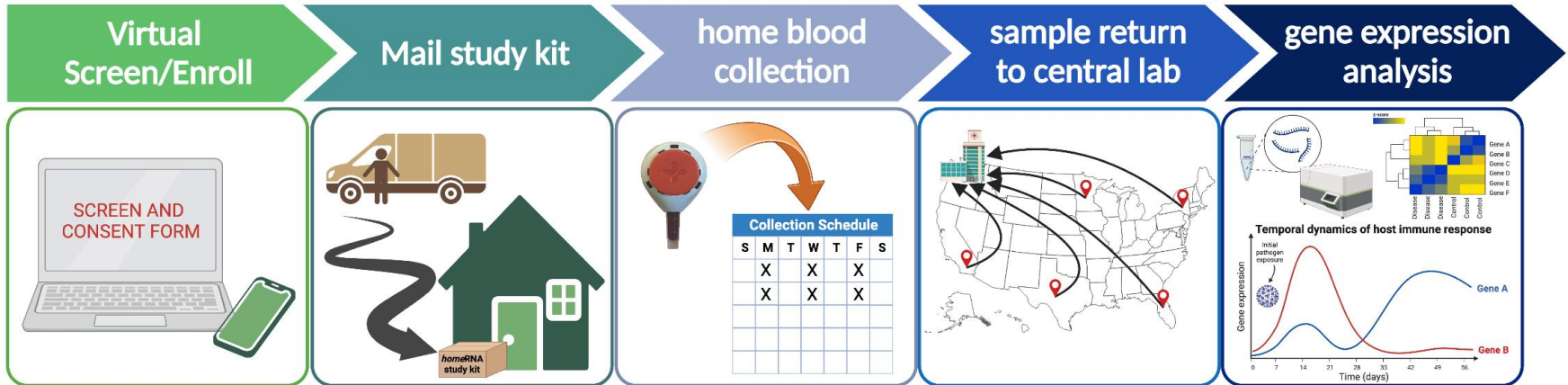
Decentralized clinical study design



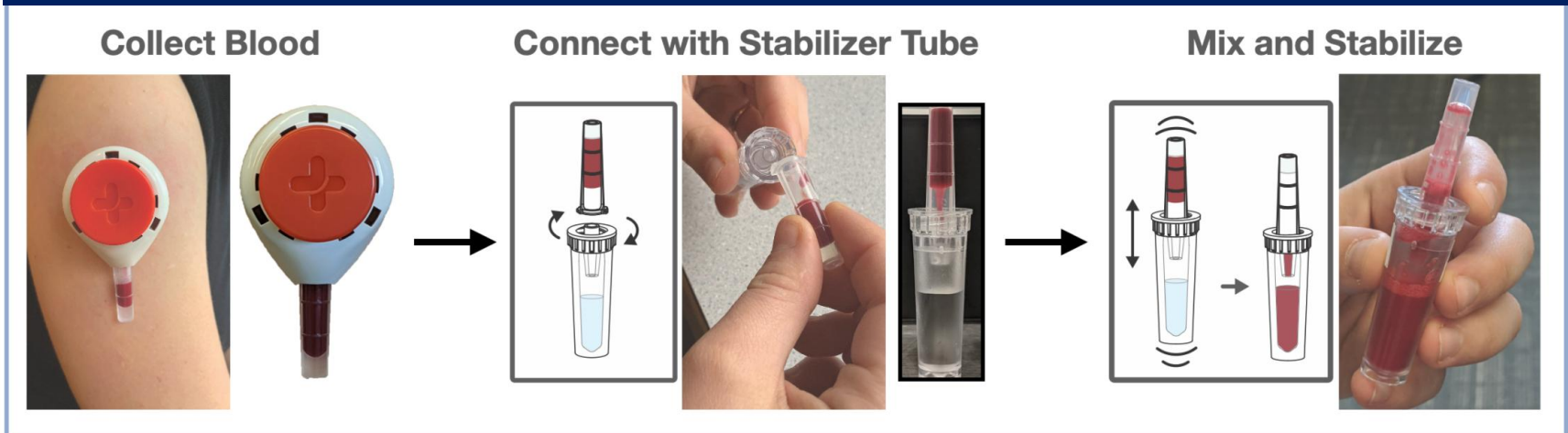
Haack*, Lim*, Kennedy, Day, Adams, Lee, Berthier, Theberge. *Anal. Chem.* **2021**. 93, 13196.

Lim, Lea, Dostie, Kim, van Neel, Hassan, Takezawa, Starita, Adams, Boeckh, Schiffer, Hyrien, Waghmare[§], Berthier[§], Theberge[§]. *eBioMedicine* (Lancet). **2025**, 112, 105531.

Decentralized clinical study design



Our initial goal: Stabilize cellular RNA for downstream analysis.

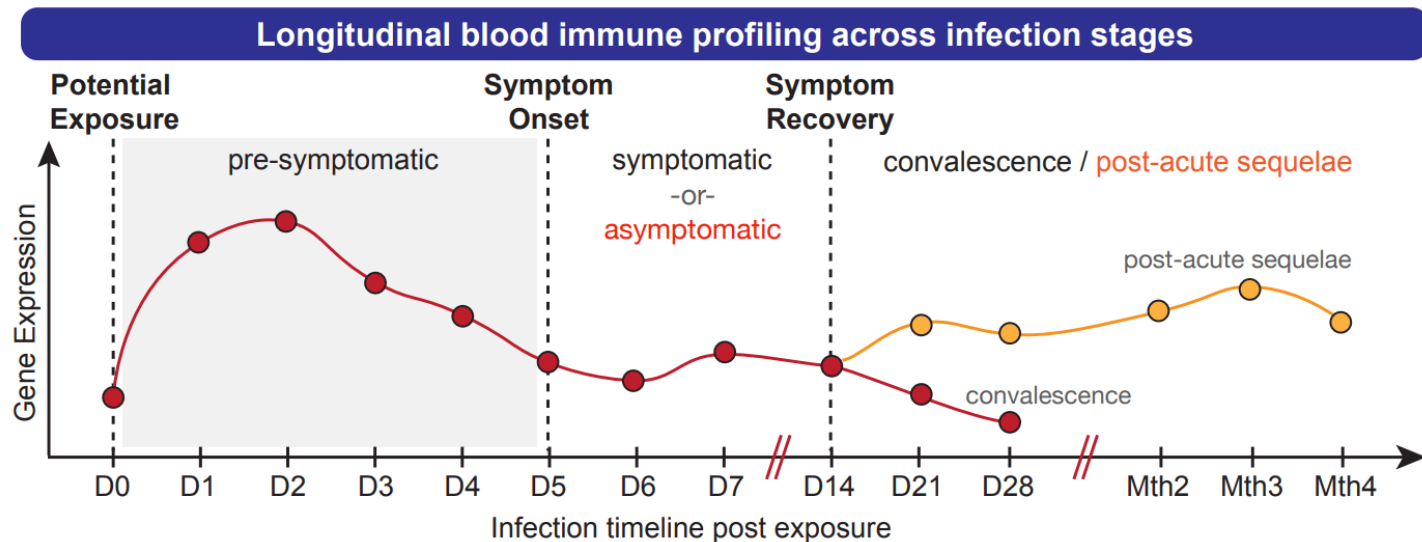


Haack*, Lim*, Kennedy, Day, Adams, Lee, Berthier, Theberge. *Anal. Chem.* **2021**. 93, 13196.

Lim, Lea, Dostie, Kim, van Neel, Hassan, Takezawa, Starita, Adams, Boeckh, Schiffer, Hyrien, Waghmare[§], Berthier[§], Theberge[§]. *eBioMedicine* (Lancet). **2025**, 112, 105531.

Vision for at-home blood transcriptomics

- At-home longitudinal sampling will enable
 - Monitoring responses to environmental/pathogen exposures
 - Maintaining wellness: predicting disease before symptoms
 - Studying effects of intervention(s)
 - Decentralized clinical trials
 - Personalized drug dosing
 - Behavioral and lifestyle interventions → *relevant for exposome!*



Wildfire smoke exposure study



National Institute of
Environmental Health Sciences

UW EDGE Pilot Grant

Rapid Response R21

UW EDGE: Community
Engagement &
Biostatistics Cores



2021 Cub Creek Fire. Source: [Photography By Carolyn](#)

Photograph from <https://twispwa.com/fire/>

Amanda Haack, PhD Lauren Brown, PhD



Yuting Zeng, PhD



Ingrid Robertson

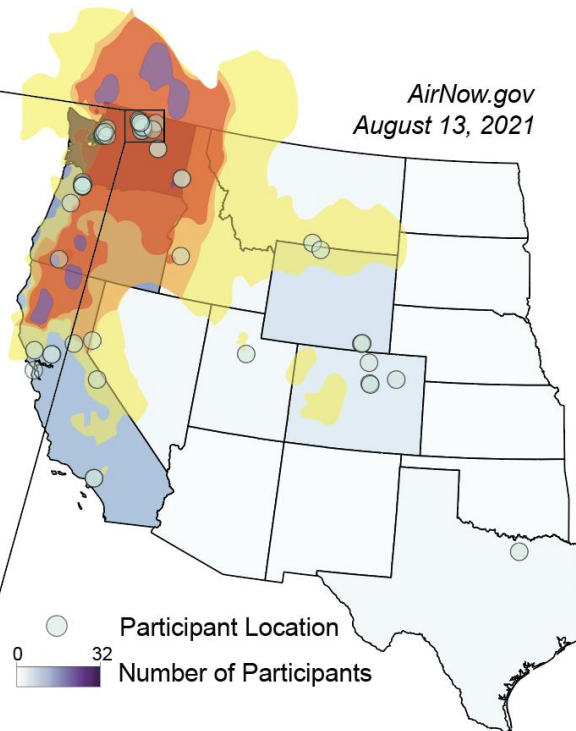
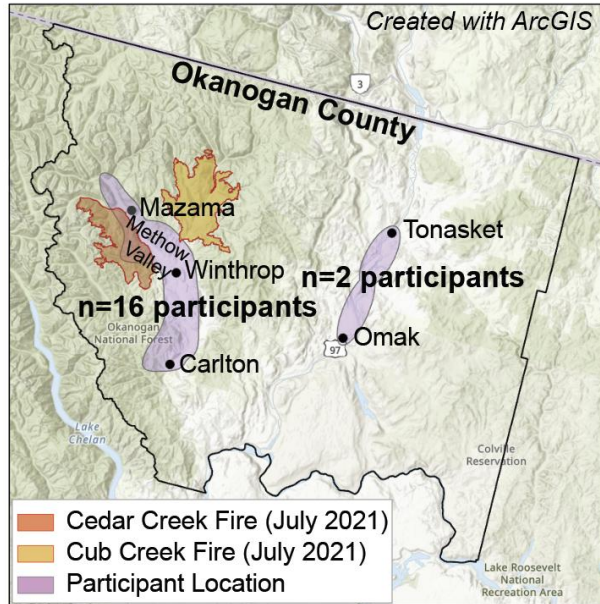


With Erwin Berthier, Karen Adams,
Nicole Errett, Elizabeth Walker,
Tania Busch Isaksen, Theo
Bammler, James Macdonald, Taushif
Khan, Damien Chaussabel

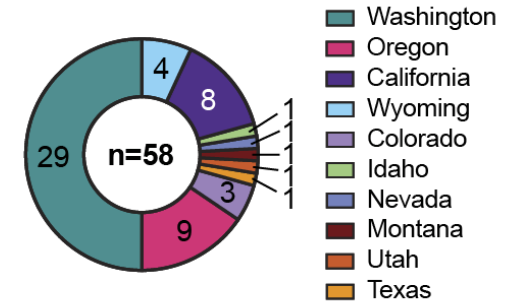
Haack*, Brown*, ...Berthier[§], Theberge[§], medRxiv, **2025**.

Wildfire smoke exposure study

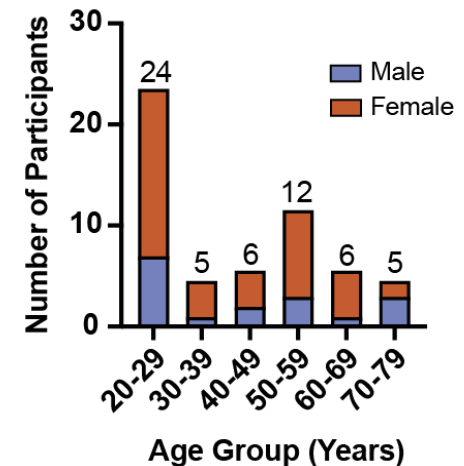
Goal: Understand how wildfire smoke exposure affects inflammation



U.S. State Location



Gender and Age

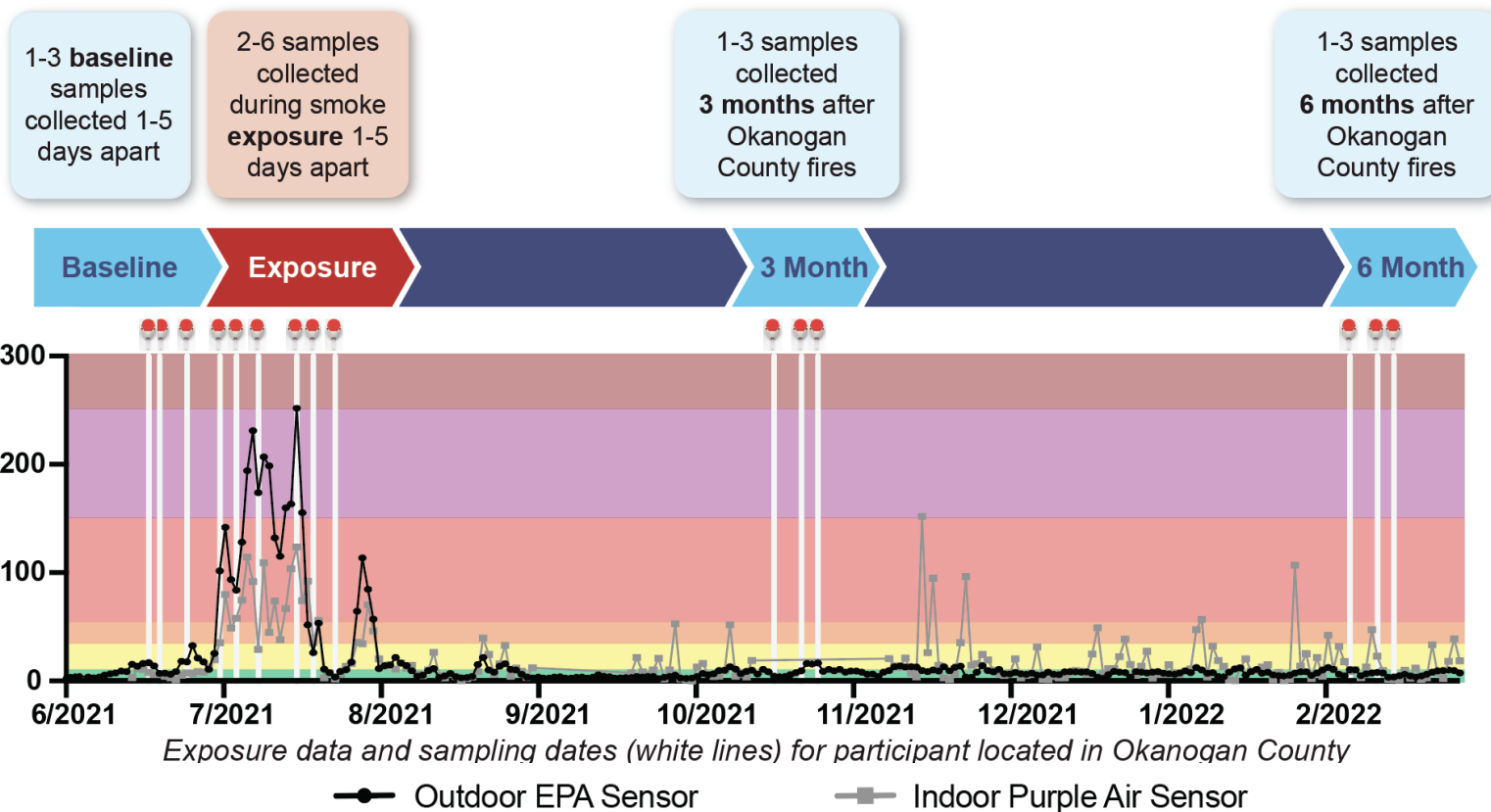


- Community engaged research (Okanogan County, Washington, USA)
- 58 participants completed the study for 2021 wildfire season
- Second cohort summer 2022

Wildfire smoke exposure study

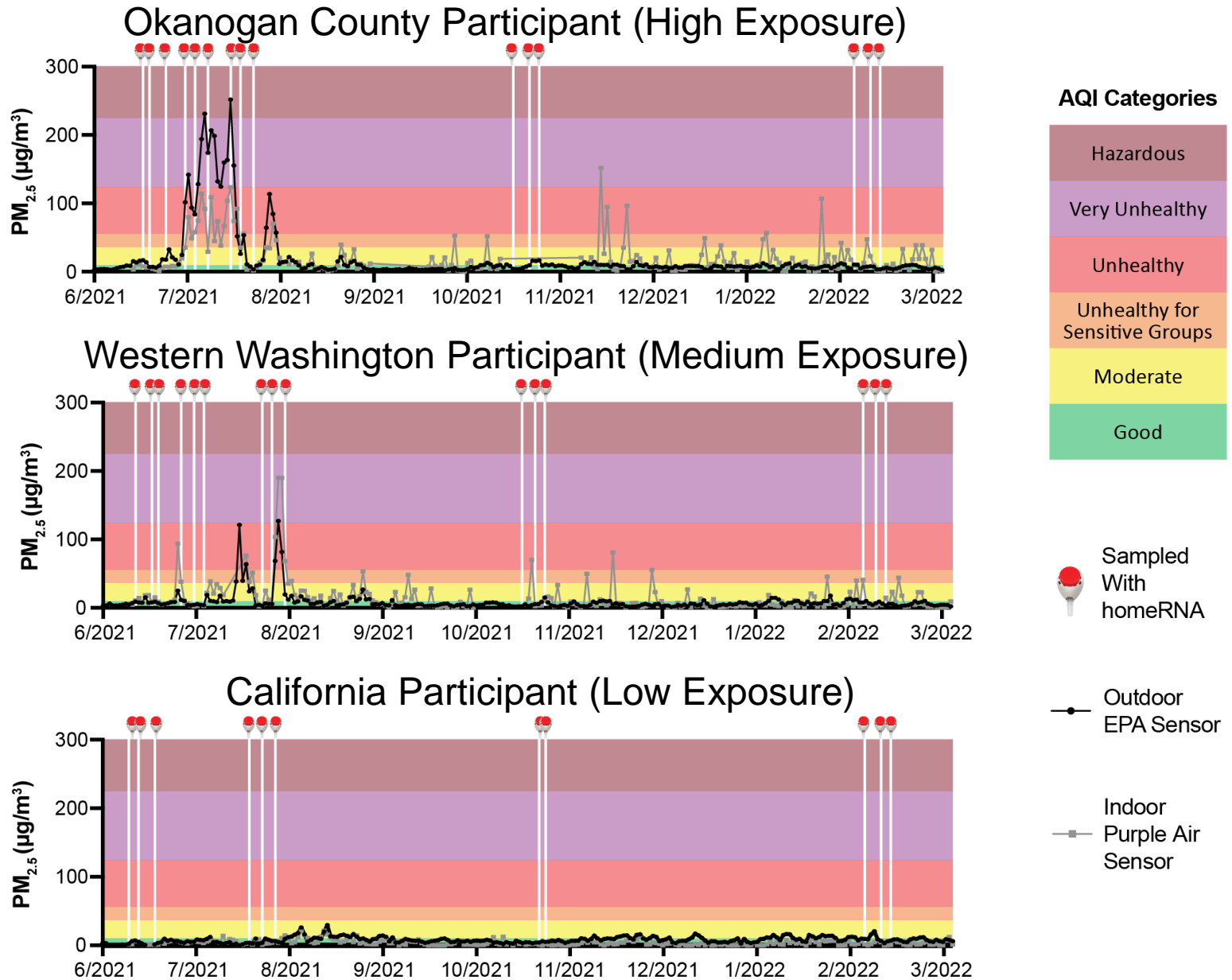
Example sampling timeline

Key feature: the ability to collect baseline and post-exposure samples to compare an individual back to their own baseline.



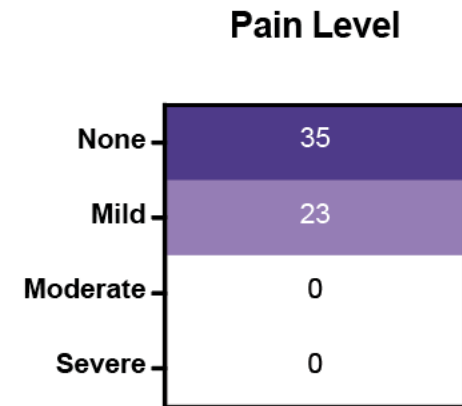
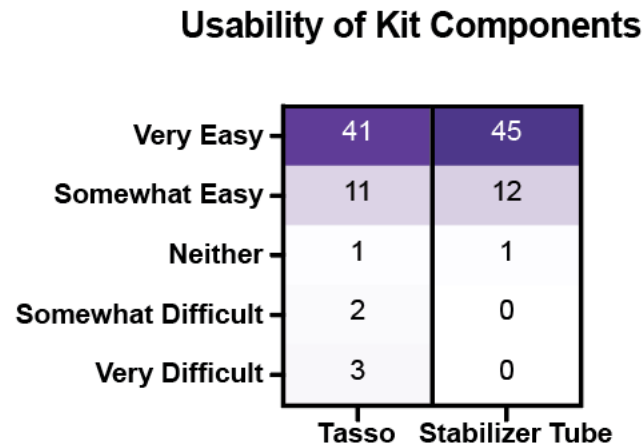
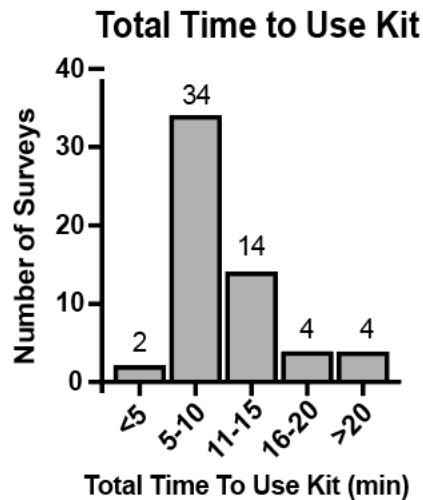
- Includes exposure surveys, questions on health and mental health, etc. (survey questions standardized with PhenX and DR2 when possible)

homeRNA captured participants with varying exposures

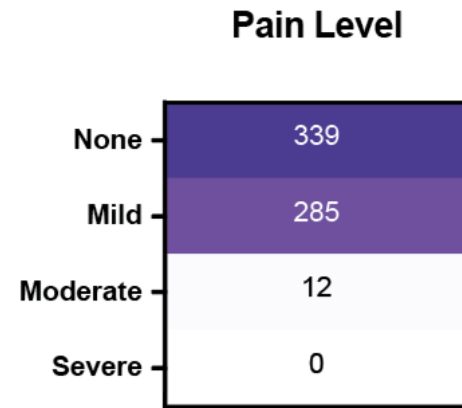
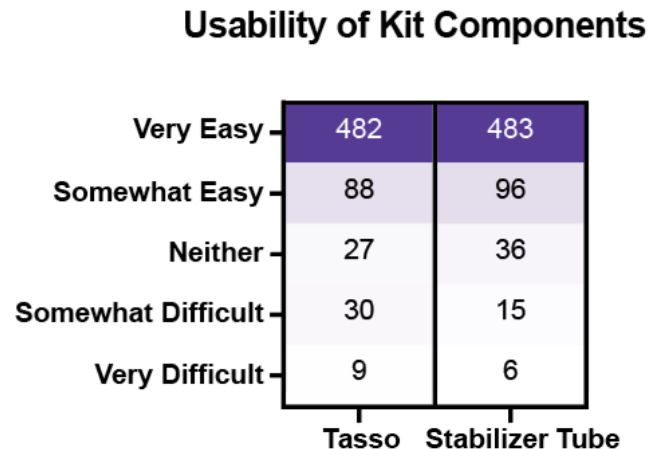
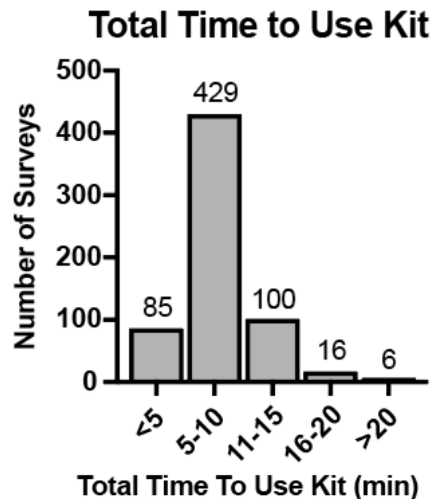


Usability of homeRNA throughout study timeline

First Collected Sample (n=58 surveys)

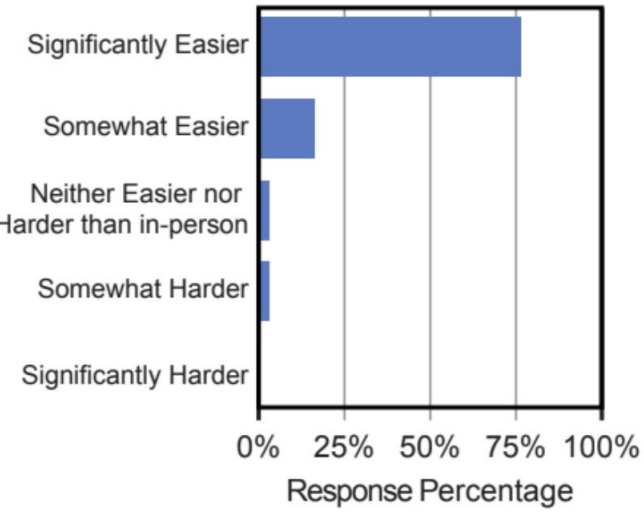


All Collected Samples (n=636 surveys)

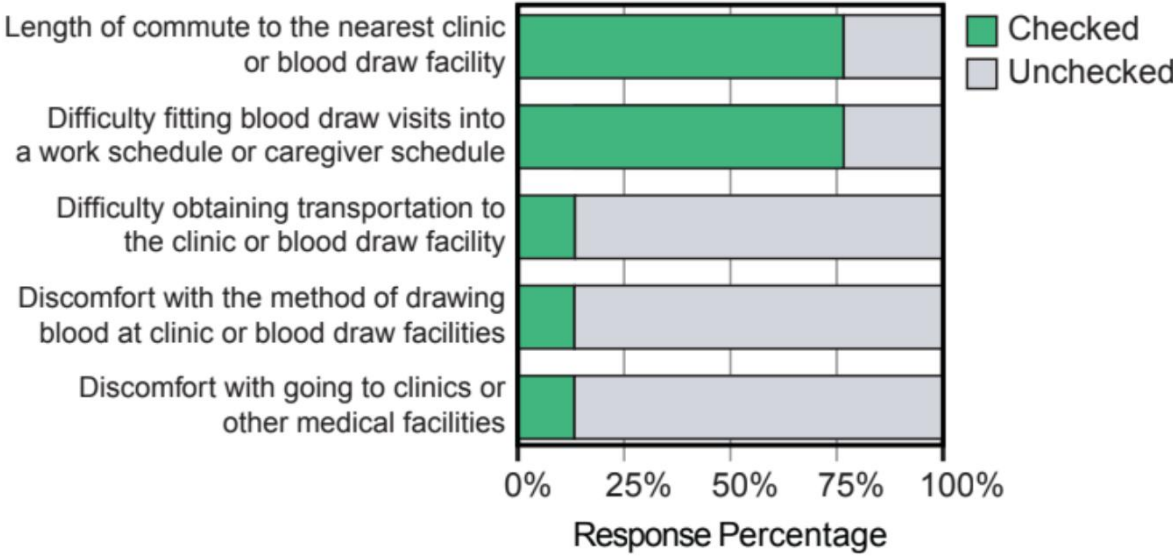


Remote sampling overcomes some barriers of in-person research

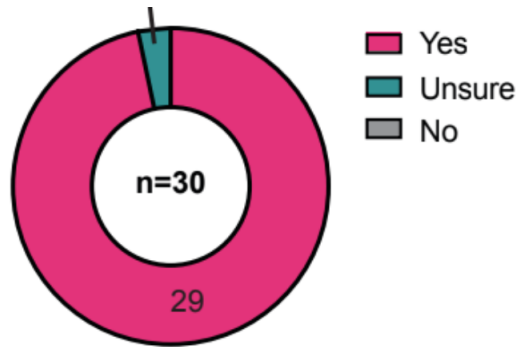
Please rate the ease of participating in a study with remote blood sampling compared to participating in a study with in-person blood sampling



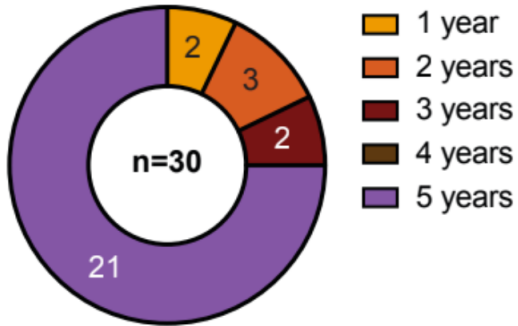
Would any of the following prevent you from participating in an in-person blood sampling study? (please check all that apply)



Would you be willing to participate in this study or a similar study again?



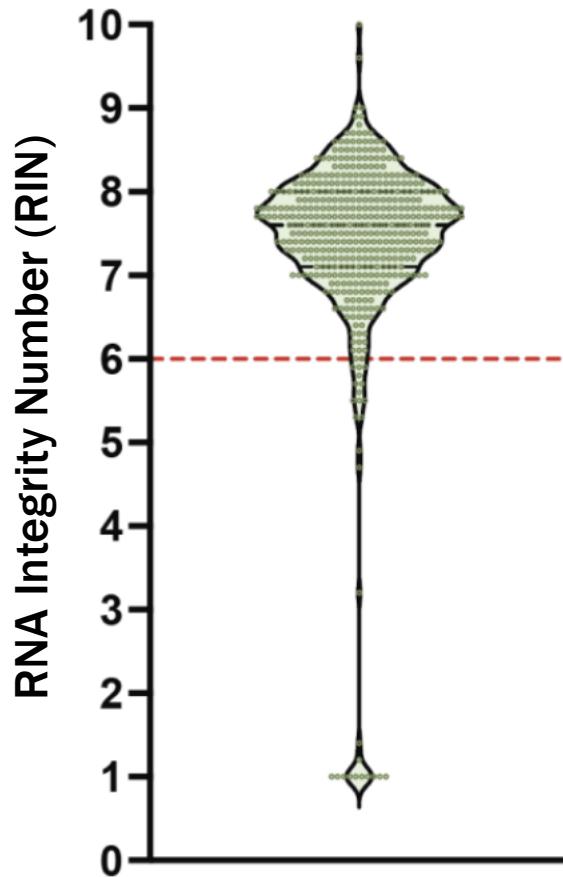
Please indicate the maximum number of years that you would be willing to participate in this study or a similar remote blood sampling study



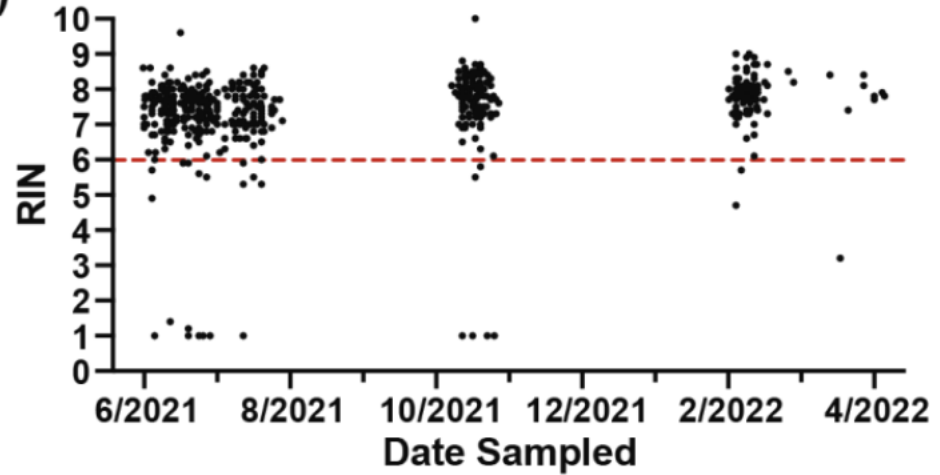
Implementation science survey instrument developed with:
 - Dr. Nicole Errett
 - Kathleen Moloney

Sufficient RNA integrity regardless of time of year

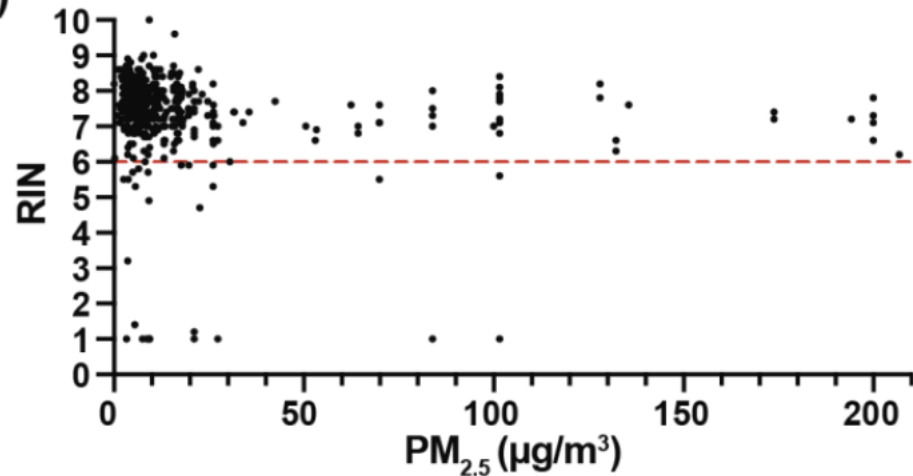
A) All Extracted Samples
(n=455 samples)



B)

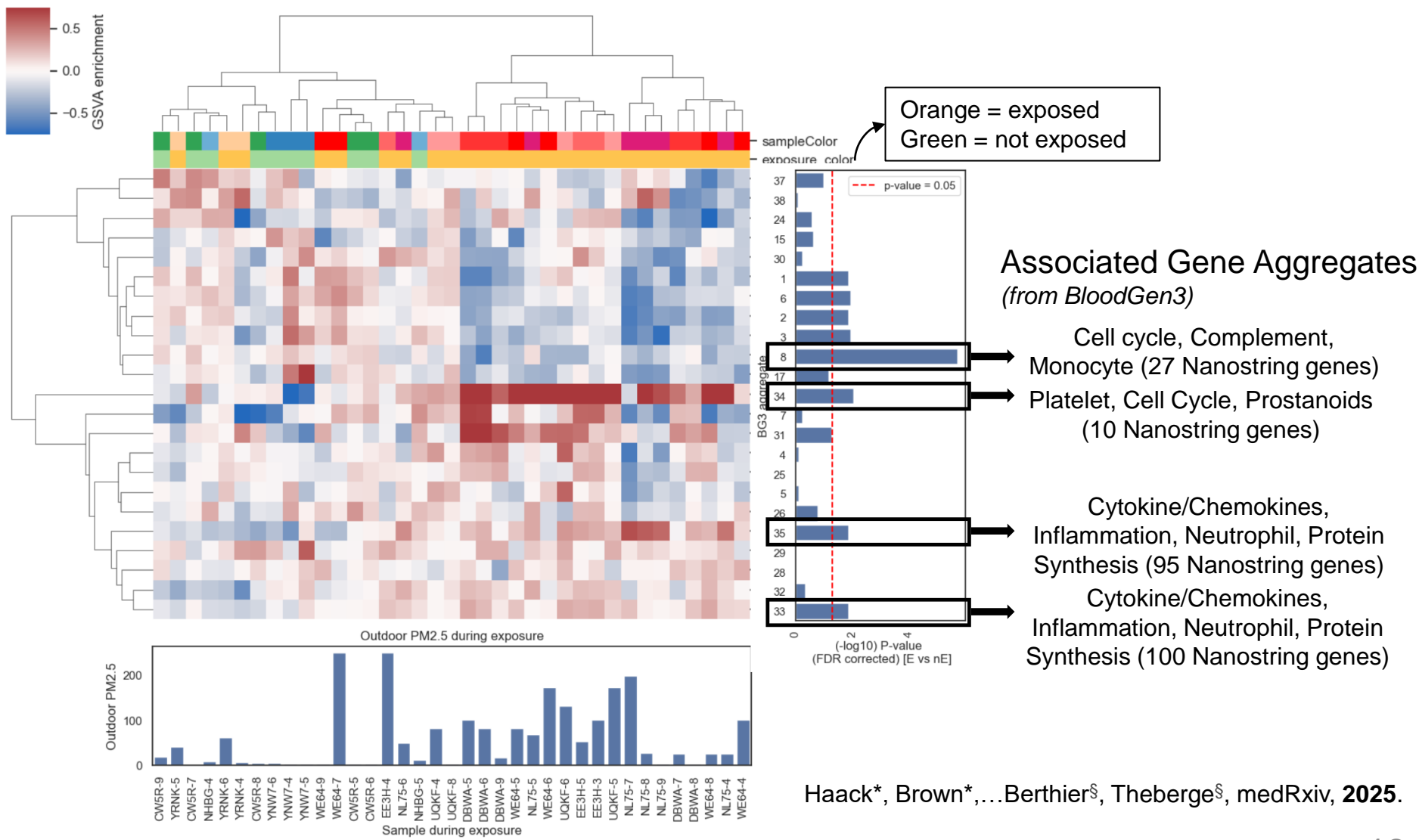


C)



Preliminary analysis: Analyzing RNA expression

During Exposure (Normalized to Baseline)

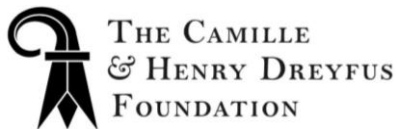


*Statistical test used was a two-sample Welch's t-test (also known as unequal variance t-test) with post-hoc Benjamini-Hochberg Multiple Testing Correction to control the false discovery rate

Conclusions and future work

- homeRNA enables participant-centric longitudinal studies for exposome research
- Ongoing work to analyze bulk transcriptomics data from ~500 samples collected across 2021-2022 wildfire seasons
- Ongoing and future work led by Tristan Nicholson, MD, PhD, combining homeRNA, exposure sampling, and homeSperm to study male fertility → *2026 EDGE Pilot Grant*
- *Special thanks to the UW EDGE Center!*
 - Dr. Nicole Errett, Dr. Elizabeth Walker, Lisa Hayward, and the Community Engagement Core
 - Dr. Theo Bammler and James McDonald
 - Drs. Joel Kaufman and Terry Kavanagh
 - Nancy Judd and Oma McLaughlin
 - Other EDGE collaborators across many other projects!

Schmidt Sciences
2024 Polymaths Award



National Institute of
General Medical Sciences
Maximizing Investigators'
Research Award (MIRA)



National Center
for Advancing
Translational Sciences

Beckman Young Investigator Award



Eunice Kennedy Shriver
National Institute of
Child Health and
Human Development



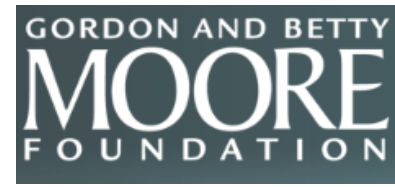
National Institute of
Diabetes and Digestive
and Kidney Diseases



National Institute of
Allergy and
Infectious Diseases



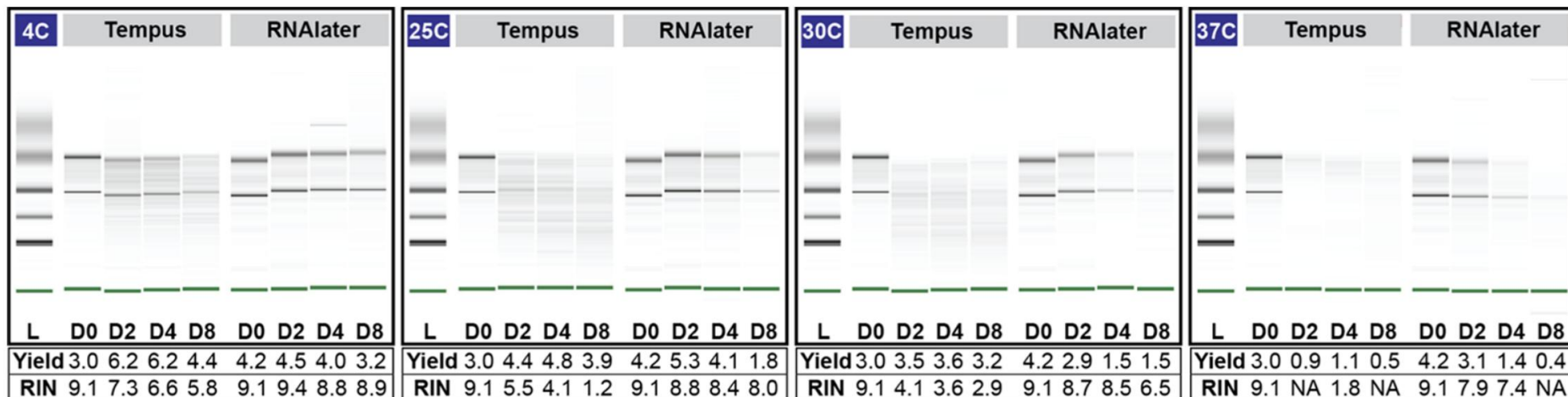
UW Men's Health
Grant Program



W UNIVERSITY of WASHINGTON

- Extra slides

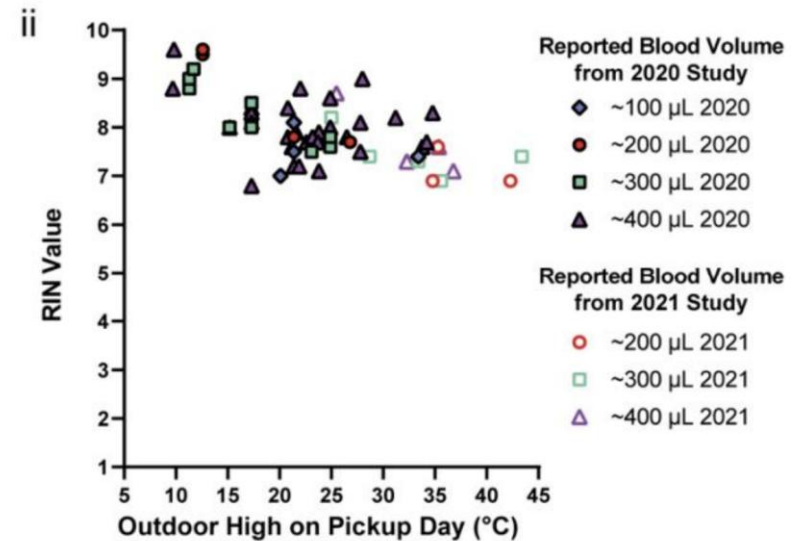
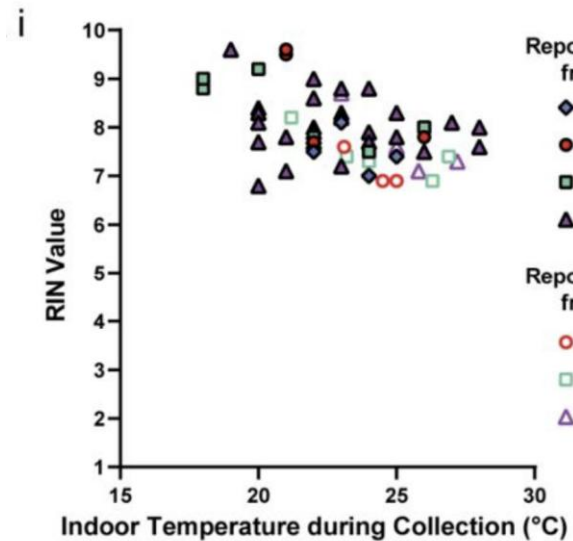
RNAlater reagent stabilizes RNA at elevated temperatures



- RNAlater provides superior RNA stabilization at high temperatures compared to Tempus and PAXgene (common stabilization reagents)
- The *homeRNA* kit uses RNAlater

homeRNA stabilizes RNA across a range of temperatures

- homeRNA kit enables high RNA integrity (RIN typically >7) across a range of temperatures
 - Note: a few samples have a RIN between 6 and 7 and would need to be assessed before further analysis



Brown*, Haack*, Kennedy, Adams, Stolarczuk, Takezawa, Berthier, Thongpang, Lim, Chaussabel§, Garand§, Theberge§. *Frontiers in Digital Health*. **2022**. 4, 903153.

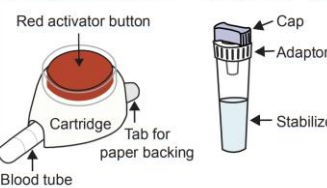
At-home blood transcriptomics: usability study

Home Blood Collection Kit

INSTRUCTIONS FOR USE

KIT CONTENTS

Make sure your kit contains all components listed below

- 1) Tasso-SST device
 - 2) Stabilizer tube
 - 3) Alcohol wipes
 - 4) Hot pack
 - 5) Bandage
 - 6) Specimen bag
 - 7) Sample Holder
 - 8) Mail return bag
- 

If you need assistance or have questions regarding the use of this kit, contact us at [REDACTED] or call us at [REDACTED]

Thank you for participating in our study!

Instructions for Use (IFU) available in English, Spanish & Thai

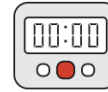
PREPARE DEVICES AND APPLICATION SITE

FIRST TIME USERS

Point your phone's camera here to watch an instructional video:



or go to depts.washington.edu/bcme/lab/pilotstudy/



1. Wash hands and get a timer. You will use a timer in Steps 2 and 10.



2. Apply hot pack to upper arm for 2 minutes. Warming helps your blood flow better.



3. Clean arm with alcohol wipe.



4. Open the stabilizer tube by twisting off the purple cap.



5. Open Tasso pouch by pulling apart white and clear layers. Discard cap in pouch.

COLLECT BLOOD USING TASSO-SST



6. Remove clear plastic cover over the red button.



7. Peel paper tab behind the red button. Keep the tube pointing down.



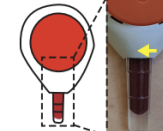
8. Stick device to shoulder. Do not remove once it is on.



9. Press button quickly and firmly until it can't go any farther. Wait 2 seconds then let go.



10. Start a 5 minute timer. Keep arm at your side. You won't see blood right away. It can take up to a minute for blood to flow.



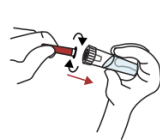
11. After 5 minutes or when the tube fills, whichever comes first, peel off the device.

It is important to do steps 12-14 as quickly as possible.

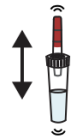


12. Remove tube by firmly twisting a quarter turn and pulling down. This may take a bit of finger strength.

MIX AND PACKAGE



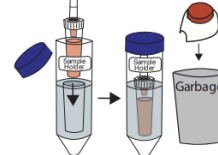
13. Bring together the blood tube and stabilizer tube and screw these together tightly.



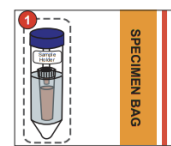
14. With the stabilizer tube on the bottom, shake hard up and down to mix. Stop when mixed. Some fluid may remain in blood tube. When mixed, the color is the same. See insert for details.

DO NOT DISCONNECT TUBES.

FULLY MIXED



15. Place sample in sample holder. Throw away used Tasso device.



16. Place blood sample in the specimen bag. Leave the absorbent pad in the bag.



17. Place specimen bag in box and fill out collection date and time on the box. Do not put box in mailer bag until you fill out the online survey (step 18).

BCME Pilot 1
[unique code]

18. Fill out the online survey following the link that was emailed to you. You will need unique code and temperature reading located on the box. **After** filling out survey, place box in mailer bag and return.

Your Blood is Out for Delivery: Considerations of Shipping Time and Temperature on Degradation of RNA from Stabilized Whole Blood

Filip Stefanovic,[▽] Lauren G. Brown,[▽] James MacDonald, Theo Bammler, Darawan Rinchai, Serena Nguyen, Yuting Zeng, Victoria Shinkawa, Karen Adams, Damien Chaussabel, Erwin Berthier, Amanda J. Haack,* and Ashleigh B. Theberge*

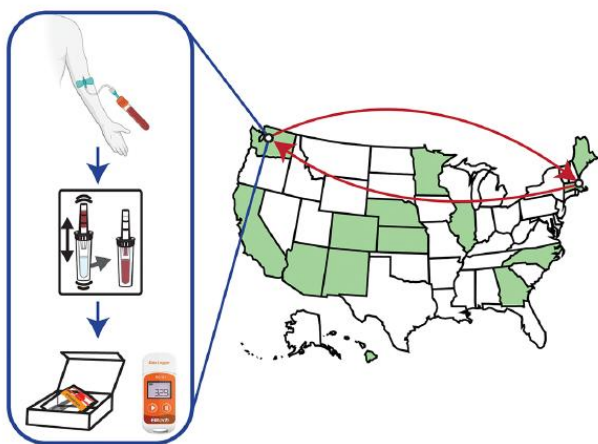


Cite This: *Anal. Chem.* 2025, 97, 1635–1644

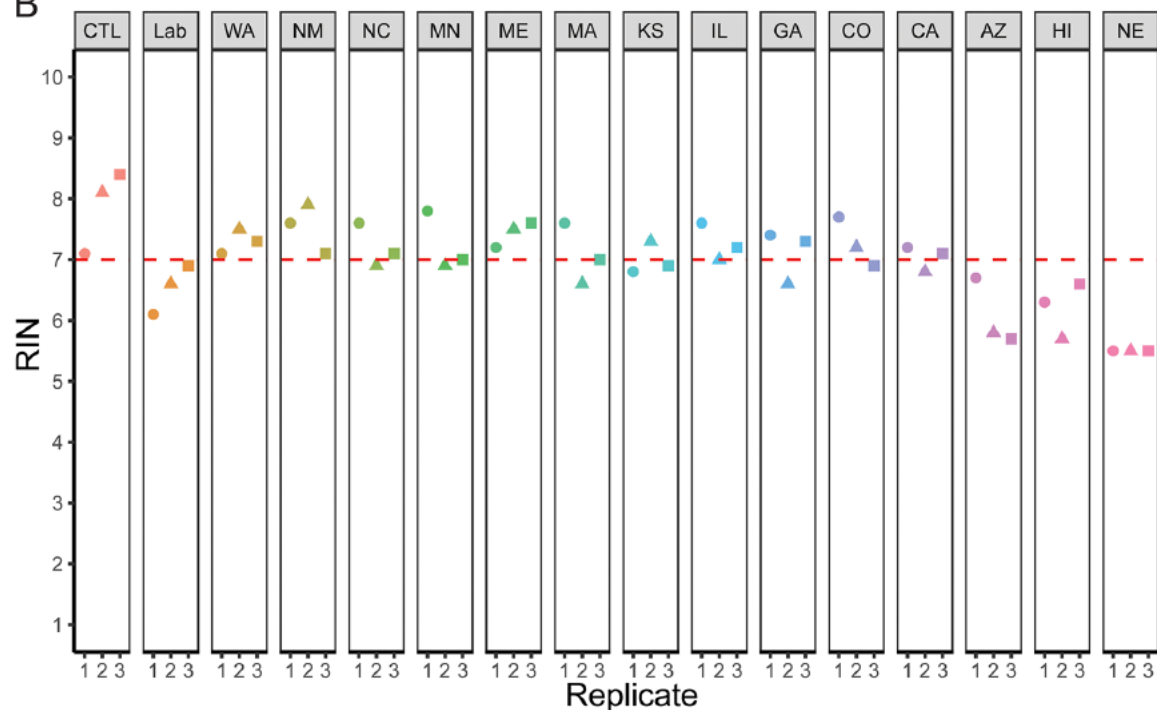


Read Online

A

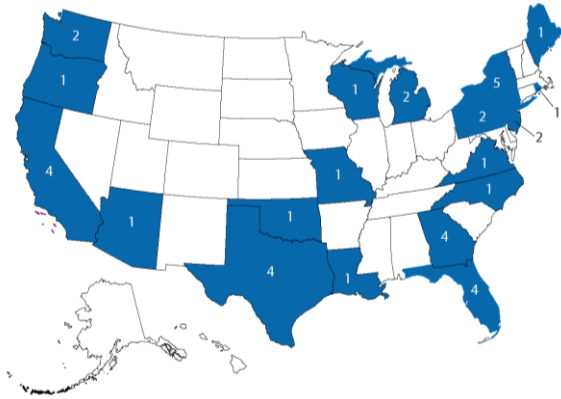


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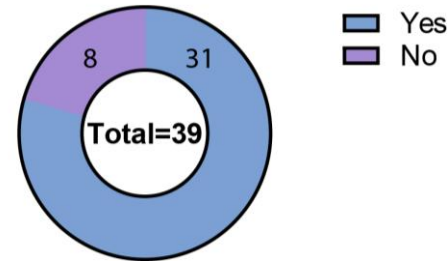


Remote studies enable diverse demographics

- 40 participants enrolled, 39 completed the study
- 5-10 *homeRNA* blood samples and nasal swabs collected over 1-2 months



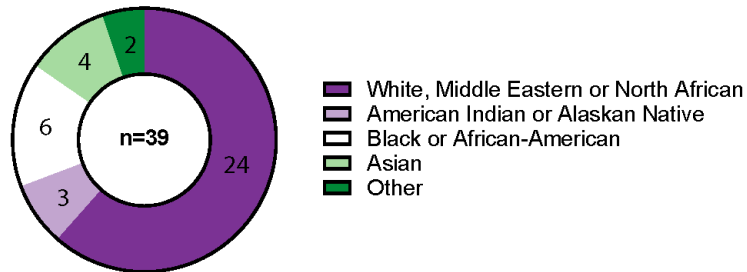
Socioeconomically disadvantaged



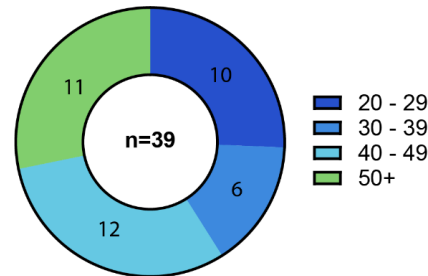
U3 criteria (from NIH):

- Socioeconomically disadvantaged
- Underserved rural
- Underrepresented racial and ethnic populations
- Sexual and gender minority

Race



Age



Filip Stefanovic & many other team members

(Unpublished)

with Prof. Erwin Berthier & Dr. Fang Yun Lim

Remote studies enable diverse demographics

Responses from
n=39 U3 women

Implementation science
survey instrument
developed with:

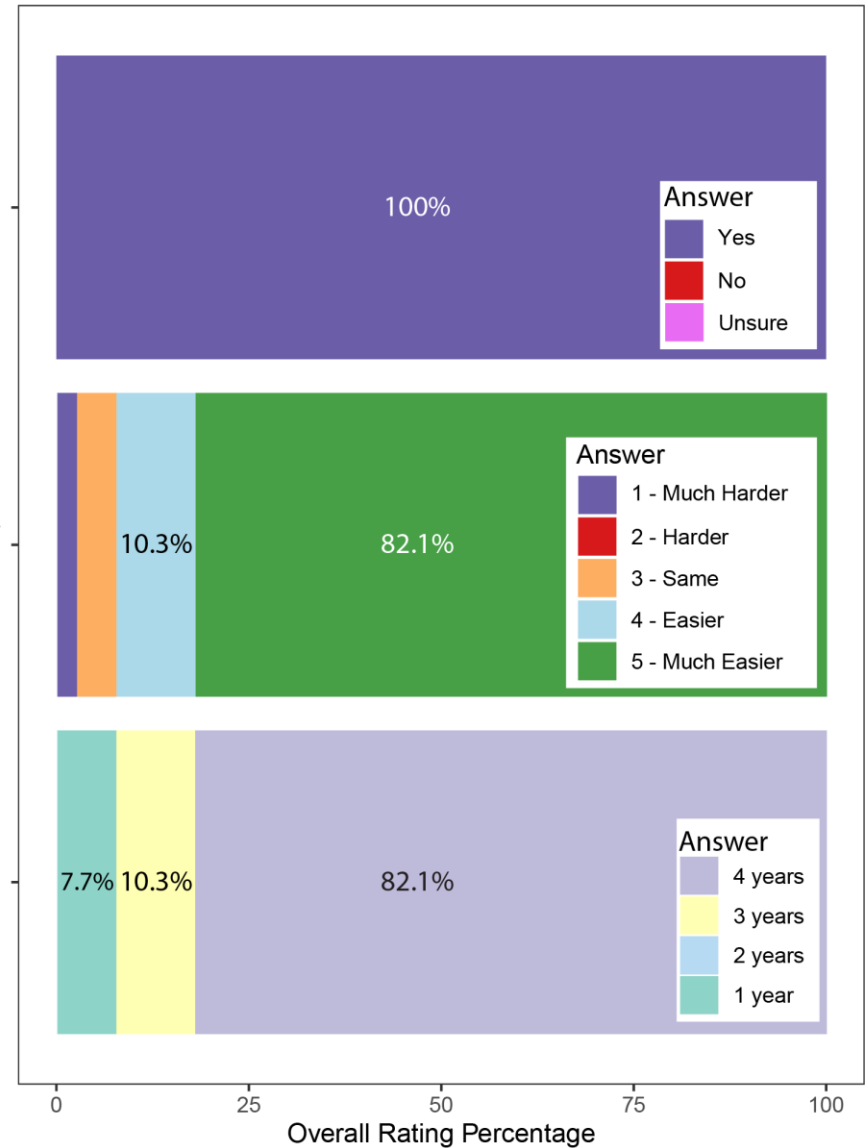
- Prof. Nicole Errett
- Kathleen Moloney

Would you be willing to participate
in this study or a similar study again?

Compared to participating in a study
that requires in person visits, how easy
would it be to participate in a remote
study with multiple samples?

Please indicate the maximum number of
years that you would be willing to
participate in a similar remote blood
sampling study assuming you were
collecting ~15 samples per year

Future Participation



Remote studies enable diverse demographics

Responses from
n=39 U3 women

Implementation science
survey instrument
developed with:

- Prof. Nicole Errett
- Kathleen Moloney

Barriers to participation in traditional in-person studies

