NOVEL APPROACH TO ASSESS PERSONAL CHEMICAL EXPOSURE

COLLABORATIVE ON HEALTH AND THE ENVIRONMENTAL

JUNE 19, 2019
WEBINAR

Kim A. Anderson, PhD
Professor, Environmental & Molecular Toxicology
Director, Food Safety & Environmental Stewardship Program
Oregon State University

Stationary Monitors *May* Be a Poor Estimate of Personal Chemical Exposure

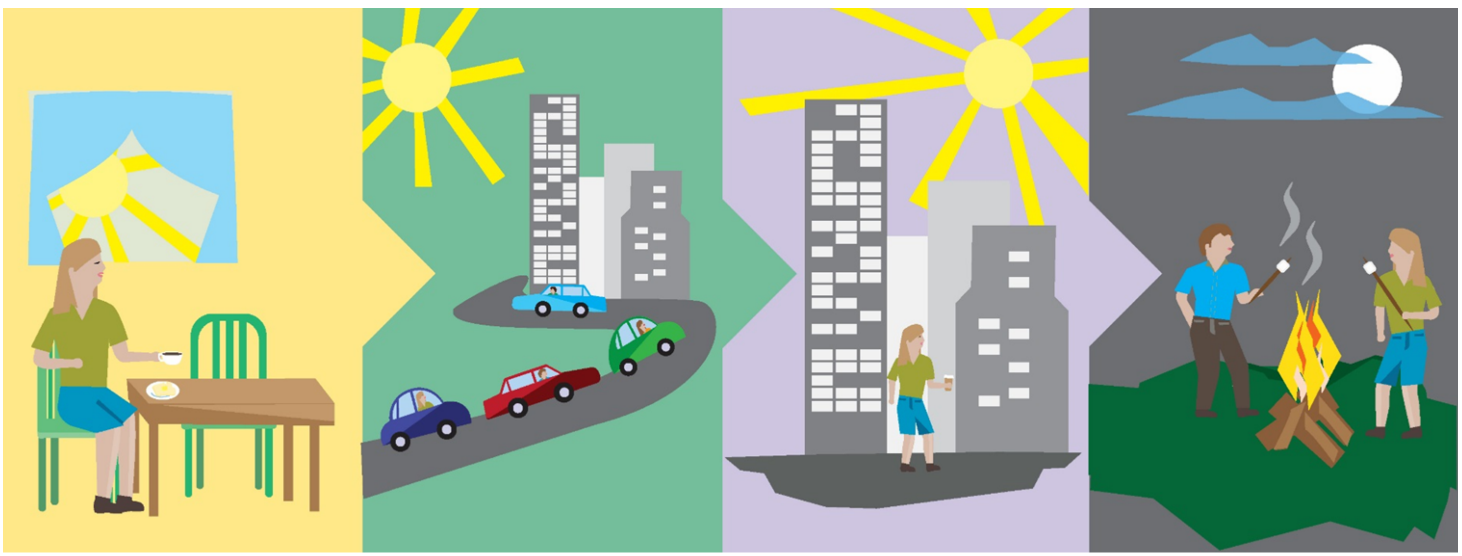

Assessing the Exposome with External Measures: Commentary on the State of the Science and Research Recommendations

Michelle C. Turner,[1,2,3,4] Mark Nieuwenhuijsen,[1,2,3] Kim Anderson,[5] David Balshaw,[6] Yuxia Cui,[6] Genevieve Dunton,[7] Jane A. Hoppin,[8] Petros Koutrakis,[9] and Michael Jerrett[10,11]

Annu. Rev. Public Health 2017. 38:215–39

The Lancet, Vol. 391, No. 10119

Tidwell et al. 2017, Donald et al. 2017, Minick et al. 2017



Paulik & Anderson et al. 2018, Turner et al. 2017

dx.doi.org/10.1021/es405022f | Environ. Sci. Technol. 2014, 48, 3327−3335

Environmental Science & Technology

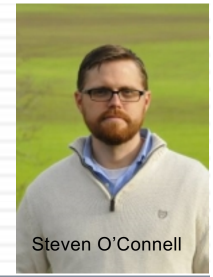
Article

pubs.acs.org/est

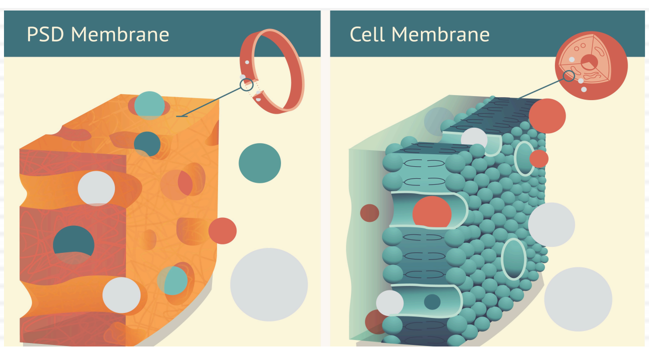
Silicone Wristbands as Personal Passive Samplers

Steven G. O'Connell, Laurel D. Kincl, and Kim A. Anderson*

Department of Environmental and Molecular Toxicology and [‡]College of Public Health and Human Sciences, Oregon State University, Corvallis, Oregon 97331, United States



Your exposures. . . *Fit for Purpose*



SCIENTIFIC AMERICAN™

Chemistry » Environmental Health News

Bracelets Can Detect Chemical Exposures

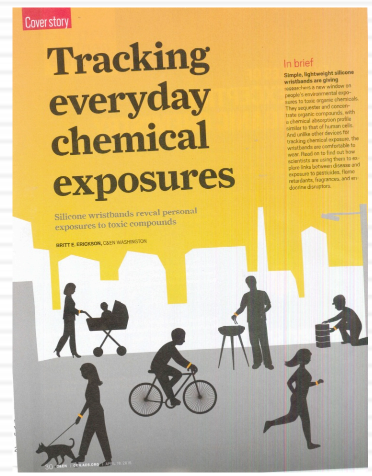
The next wave of wrist wear might act as a fashionable archive of your exposure to everything from caffeine to pesticides

Mar 7, 2014 | By Brian Bienkowski and Environmental Health News

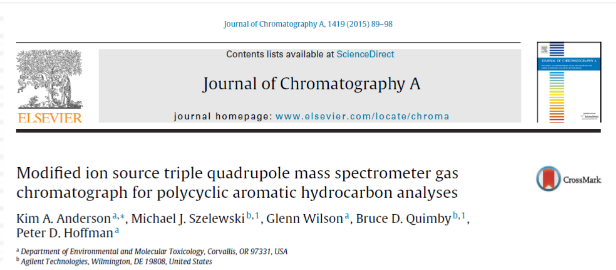
Wristbands are the accessory of choice for people promoting a cause. And the next wave of wrist wear might act as a fashionable archive of your chemical exposure.

Researchers at Oregon State University outfitted volunteers with slightly modified silicone bracelets and then tested them for 1,200 substances. They detected several dozen compounds – everything from caffeine and cigarette smoke to flame retardants and pesticides.

Silicone in wristbands absorbs chemicals. Researchers used modified ones to test people's exposure to 1,200 substances, such as flame retardants and cigarette smoke. Credit: *LexnGer/Flickr*



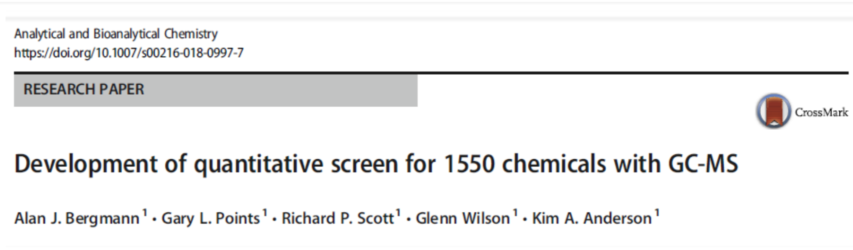
Wristband FAQs at: http://fses.oregonstate.edu/



Journal of Chromatography A, 1419 (2015) 89–98
Contents lists available at ScienceDirect
Journal of Chromatography A
journal homepage: www.elsevier.com/locate/chroma

Modified ion source triple quadrupole mass spectrometer gas chromatograph for polycyclic aromatic hydrocarbon analyses

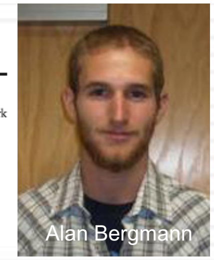
Kim A. Anderson[a,*], Michael J. Szelewski[b,1], Glenn Wilson[a], Bruce D. Quimby[b,1], Peter D. Hoffman[a]
[a] Department of Environmental and Molecular Toxicology, Corvallis, OR 97331, USA
[b] Agilent Technologies, Wilmington, DE 19808, United States

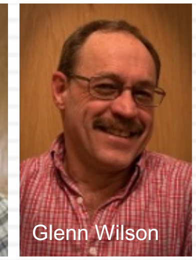


Analytical and Bioanalytical Chemistry
https://doi.org/10.1007/s00216-018-0997-7
RESEARCH PAPER

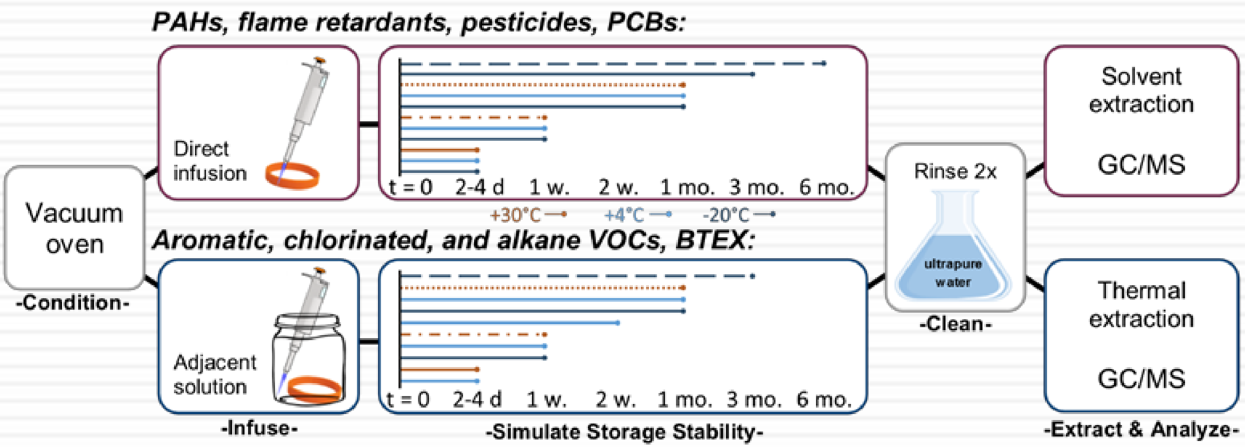
Development of quantitative screen for 1550 chemicals with GC-MS

Alan J. Bergmann[1] · Gary L. Points[1] · Richard P. Scott[1] · Glenn Wilson[1] · Kim A. Anderson[1]





Methods



- **OPAHs** (oxygenated polycyclic aromatic hydrocarbons, eg. ketones and quinones) method were performed on an Agilent 7890A gas chromatograph coupled to a 5975C mass spectrometer under electron ionization (70 eV).
  - Layshock et al, ET&C, 2010
  - O'Connell, Haigh, Wilson and Anderson Anal Bioanal Chem 2013
- **Pesticides** Agilent 6890N gas chromatograph (GC) with dual 7683 injectors, dual columns and dual electron capture detectors (ECD). The GC was configured with Agilent DB-XLB and Agilent DB-17MS columns.
  - Anderson *et al* Philosophical Trans B, The Royal Society Biological Science. 2014
- **Flame Retardants** Agilent 6890A GC coupled to a 5975C MS
  - Kile, Scott, O'Connell, et al and Anderson, Envir. Res 2016
- **PAHs (62) quantitatively** analyzed using an Agilent 7890A gas chromatograph interfaced with an Agilent 7000 GC/MS-MS, Agilent Select PAH column, with correlations ≥0.99
  - hydrogen self-cleaning ion source and modified 9mm extractor lens
  - GC-EI/MS/MS large linear range of 1-10,000 pg μl^{-1} and
  - instrument detection limits of < 2 pg/μl
  - Anderson *et al*, J. Chrom A, 2015.
- Screened for **1530 target compounds** using GC-MS (***1 injection***) in full-scan with retention time locking, automated mass spectrum deconvolution information system (AMDIS) and deconvolution reporting software (DRS)
  - A complete list of compounds is available at our website (http://fses.oregonstate.edu/methods)
  - 50 minutes per sample instrument time
  - 15 minutes chemist q-edit review time
  - Bergmann, A.J. *et al*, Analytical and Bioanal Chem, 2018

https://www.youtube.com/watch?v=ktuaHKdEJSE&feature=youtu.be

OPEN

Journal of Exposure Science and Environmental Epidemiology (2017) 27, 551–559
www.nature.com/jes

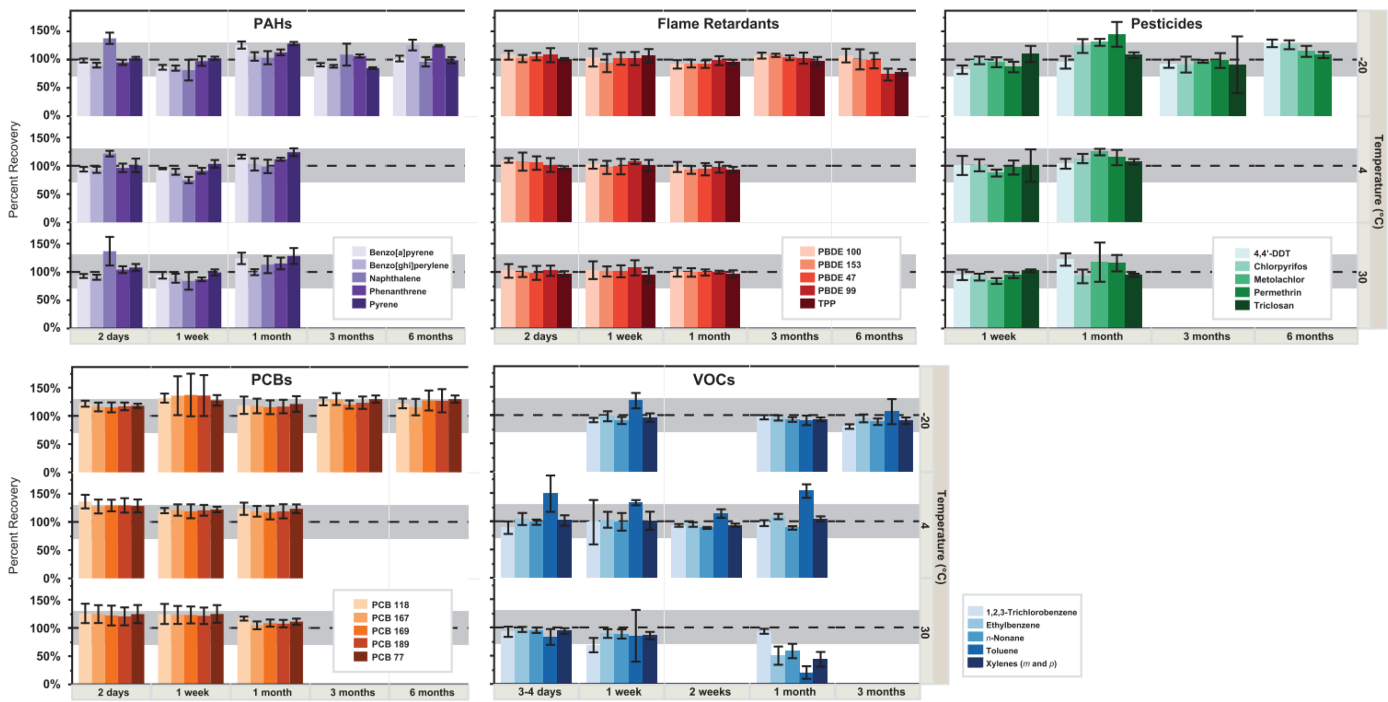
ORIGINAL ARTICLE

Preparation and performance features of wristband samplers and considerations for chemical exposure assessment

Kim A. Anderson[1], Gary L. Points III[1], Carey E. Donald[1], Holly M. Dixon[1], Richard P. Scott[1], Glenn Wilson[1], Lane G. Tidwell[1], Peter D. Hoffman[1], Julie B. Herbstman[2] and Steven G. O'Connell[1]

Transport and storage stability

n=4 for each experiment, 148 chemicals all 102%, SVOCs 104%, VOCs 99%



Captures and Recovers Chemicals

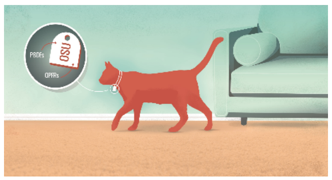
0°C	5000°C	15,000,000°C
Water freezes	sun surface	**sun center**
log 0	log 3.7	log 7

Wide applicability of types of chemicals that can be sequestered

(octanol water partitioning coefficient) log K_{ow} -0.7 to 9.5

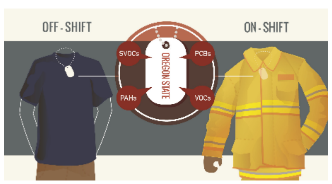
(octanol air partitioning coefficient) log K_{oa} 5.5 to 13

Testing in the field – a peak at a few on-going studies



Measuring Flame Retardant Exposure in Cats

Measuring PAH Exposure and Lung Function

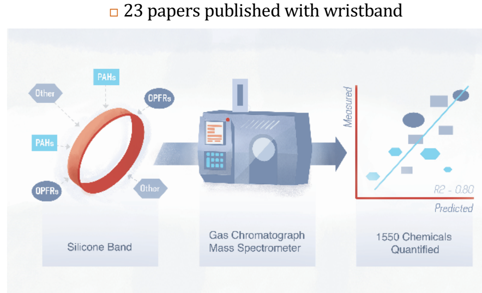


Measuring Firefighter Chemical Exposure

Global Assessment of Human Chemical Exposure

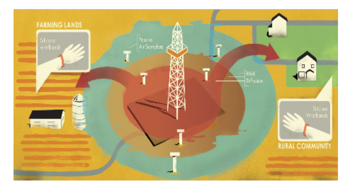
Technology Highlights

- Over 2,000 wristbands analyzed
- Wristbands deployed in 6 continents
- Over 500 different chemicals detected
- 23 papers published with wristband



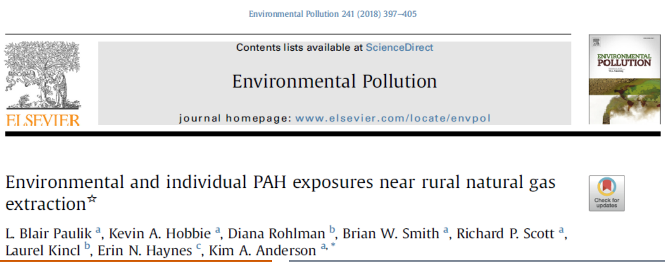
Measuring PAH Exposure in Pregnant Women

Multi-class Chemical Exposure in Peru



Measuring PAH Exposure Related to Fracking

Measuring Pesticide Exposure in Senegal


Environmental Pollution 241 (2018) 397–405

Contents lists available at ScienceDirect

Environmental Pollution

journal homepage: www.elsevier.com/locate/envpol

Environmental and individual PAH exposures near rural natural gas extraction☆

L. Blair Paulik [a], Kevin A. Hobbie [a], Diana Rohlman [b], Brian W. Smith [a], Richard P. Scott [a], Laurel Kincl [b], Erin N. Haynes [c], Kim A. Anderson [a, *]

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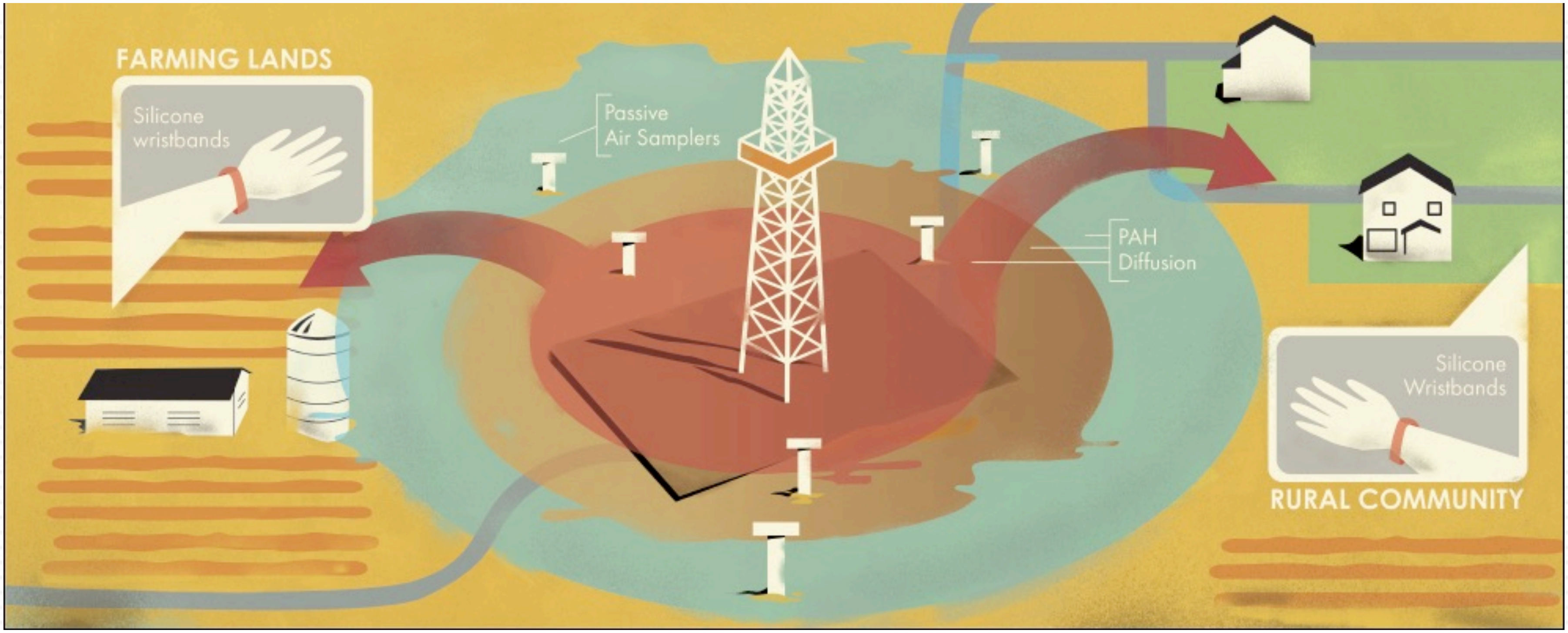
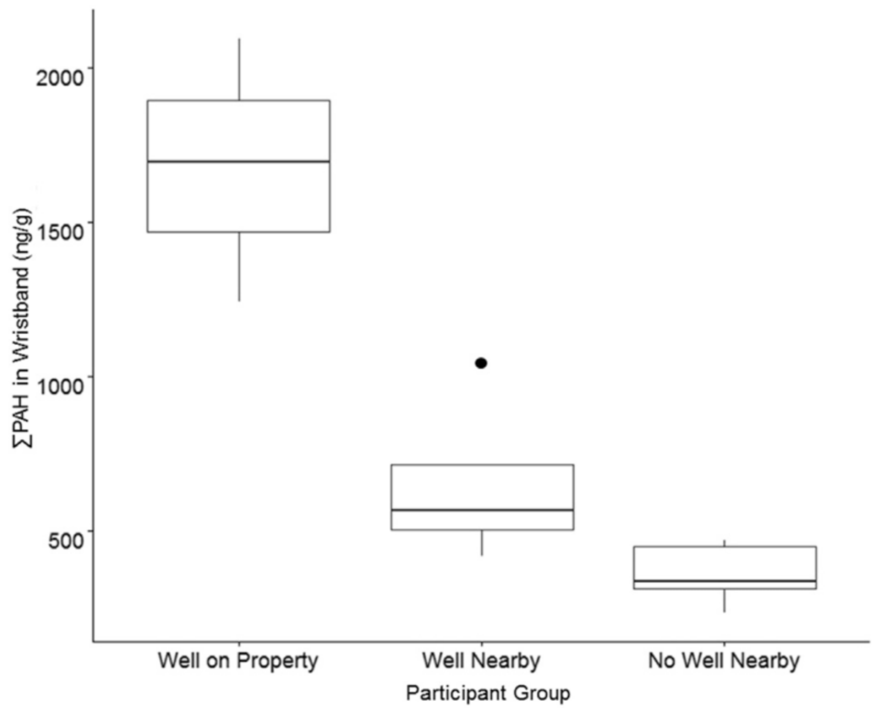
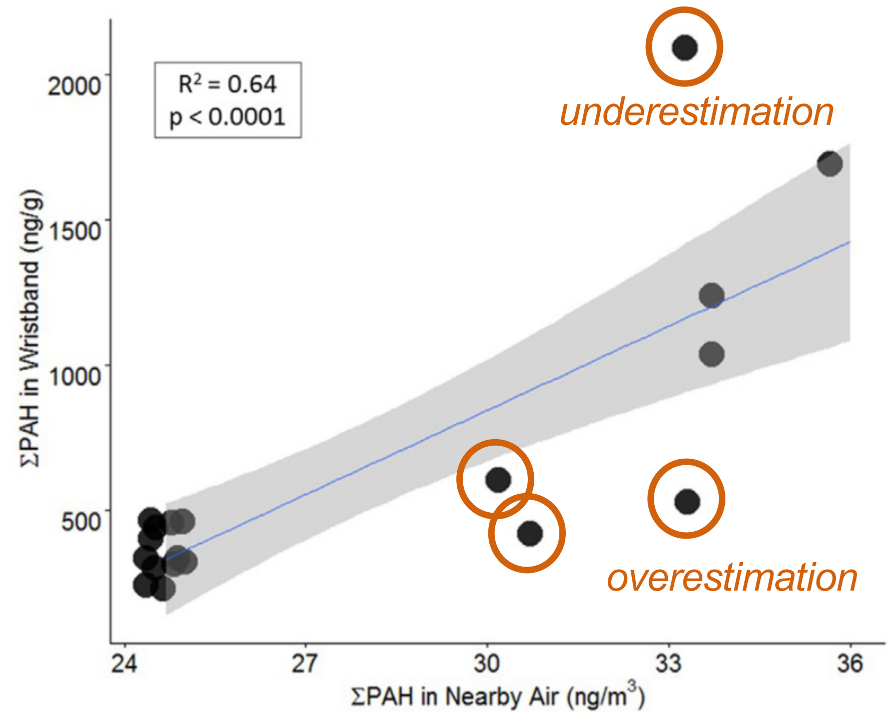
Connecting PAHs in air and the personal environment near rural natural gas extraction



ΣPAH significantly higher in wristbands worn by participants closer to active natural gas extraction



Significant positive correlation between **ΣPAH** in wristbands and **ΣPAH** in air near participants homes or workplaces



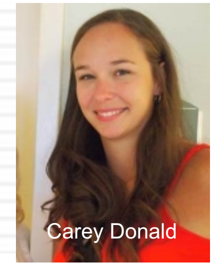
ROYAL SOCIETY OF CHEMISTRY

Silicone wristbands detect individuals' pesticide exposures in West Africa

Carey E. Donald, Richard P. Scott, Kathy L. Blaustein, Mary L. Halbleib, Makhfousse Sarr, Paul C. Jepson, Kim A. Anderson

Published 17 August 2016. DOI: 10.1098/rsos.160433

Published in collaboration with the Royal Society of Chemistry



Africa *adaptable to many audiences, include many training formats*

Farming community

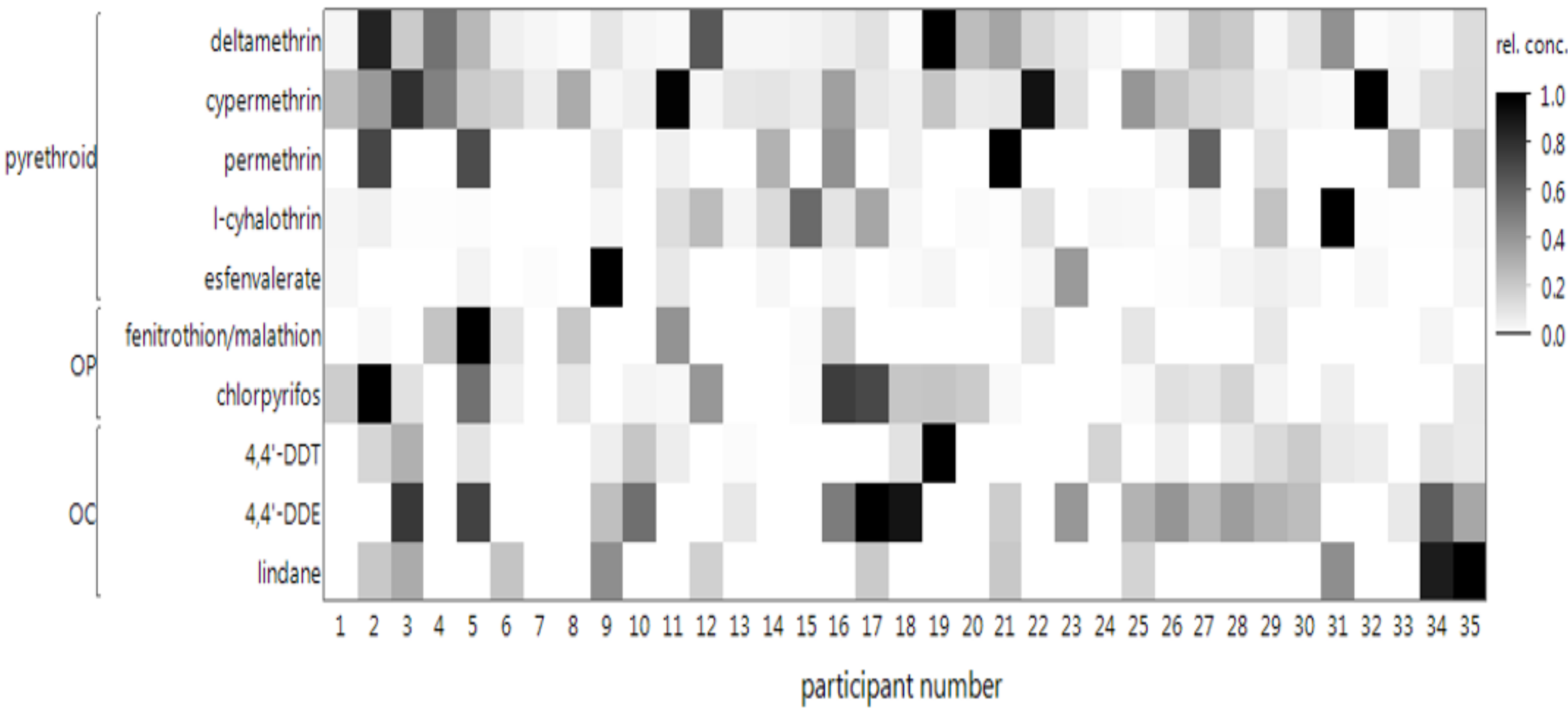
Thirty-five men, women, and children from farming families in Diender, Senegal were recruited in November 2015 (n=70)

Given two wristbands **to wear for two separate** periods of up to 5 days

acknowledging limitations of small sample size in studies

Intra-individual differences **large**

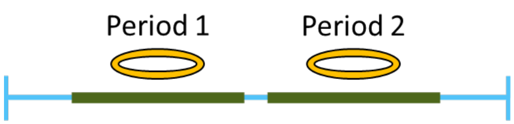
Frequency of detected pesticides by concentration

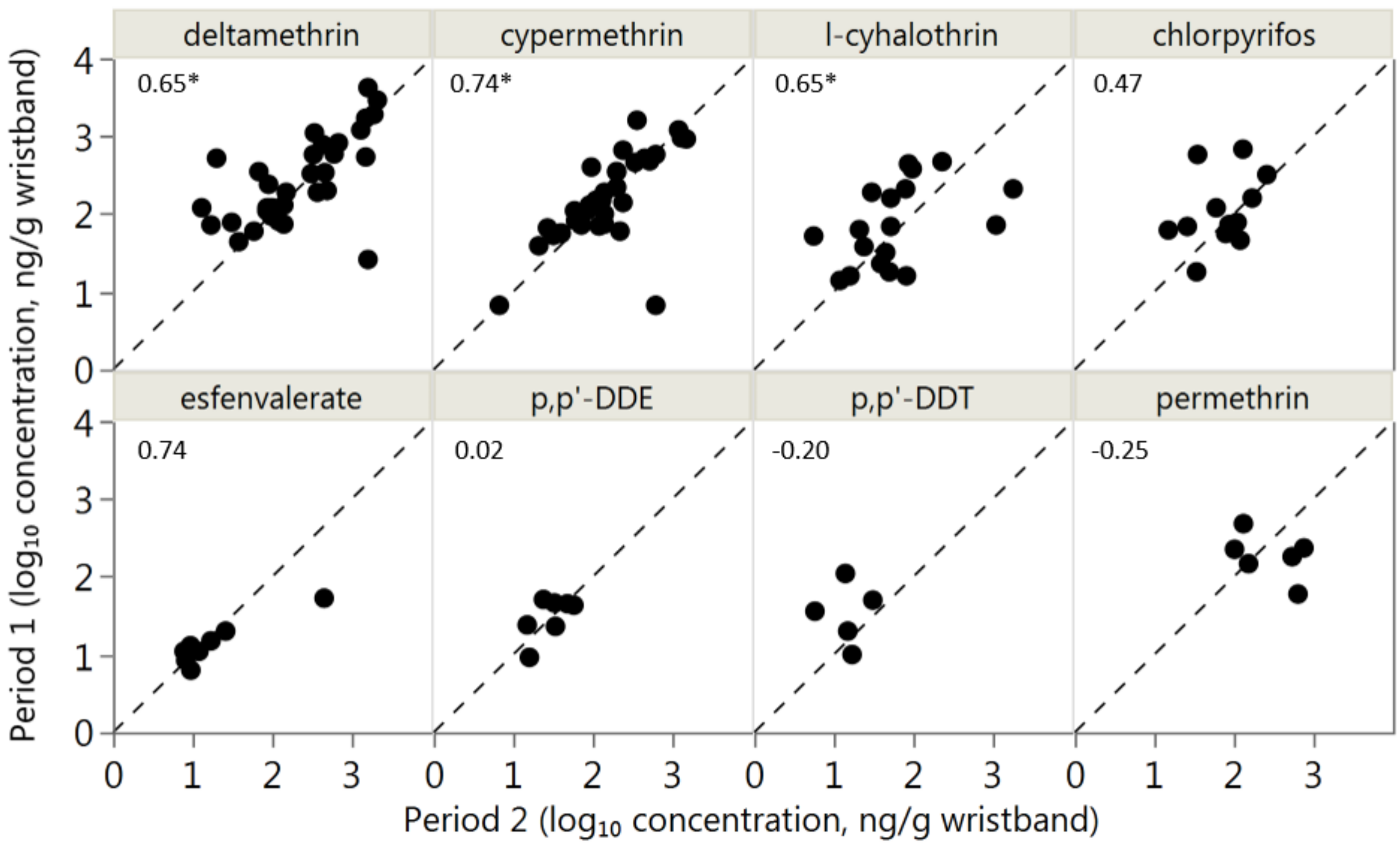


Inter-individual differences small

Neither the number of positive detected nor the concentrations of individual pesticides sequestered in a participant's wristband were different between the two periods

(signed-rank test, no significant p-values after Bonferroni adjustment < 0.003)



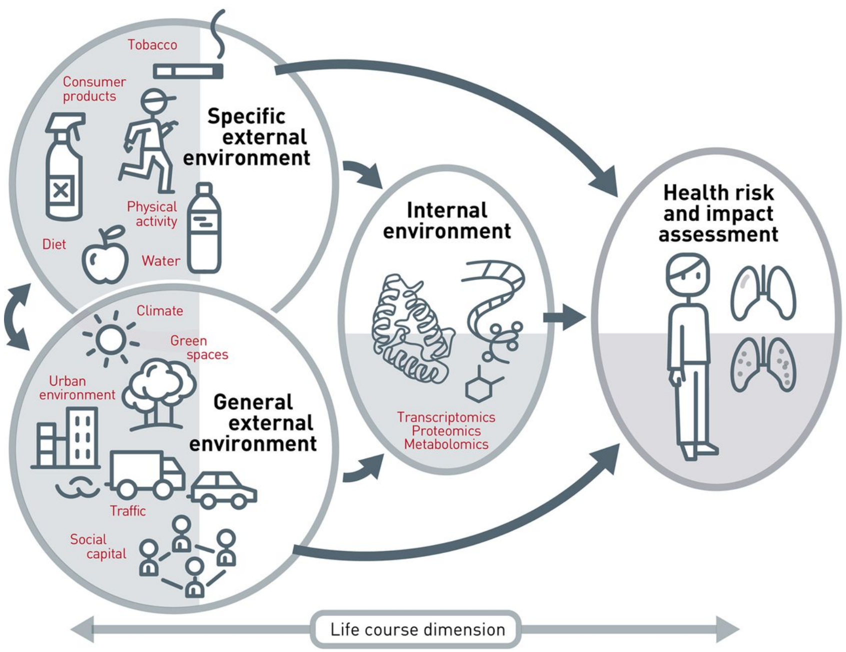


Africa

- 50% of samples analyzed some type of QC
- 63 pesticides quantified
- 26 were detected in at least one wristband
  - Log K_{oa} ranged from 5.8 (chloroneb) to 12.5 (bifenthrin)
  - Log K_{ow} ranged from 0.8 (dimethoate) to 8.2 (bifenthrin)
- Wristbands had between 2 and 10 pesticides from our quantitative method
- All pesticides reported by participants found
- 19 pesticides detected beyond those reported

Carey E. Donald[a], Richard P. Scott[a], Kathy Blaustein[b], Mary L. Halbleib[b], Makhfousse Sarr[c], Paul C. Jepson[b], and Kim A. Anderson[a]*, Silicone wristbands detect individuals' pesticide exposures in West Africa, Royal Society Open Science, 3, 160433, **2016**.

Chemical exposures & adverse health effects

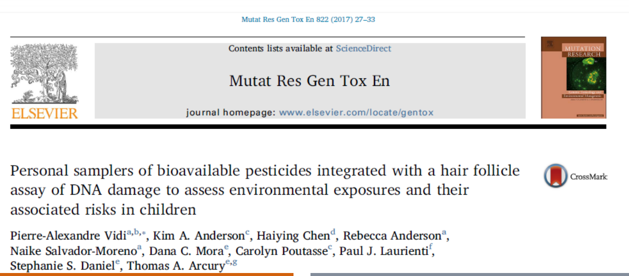


Vrijheid 2014

- **Interventions**
  - To change behaviors and built environments to reduce exposure to chemical stressors, the external personal chemical environment needs to be studied
  - All chemicals do not have a clear link to an internal biomarker
  - External measurement of chemicals in some cases can provide quicker link to an intervention (some chemicals bioaccumulate)

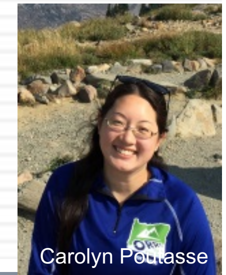
- **Regulations and Policy**
  - Policy on organic chemical exposures will be based on the external chemical exposure level
  - Due to variability in metabolism, lifestyle, and other personal variables, organic chemical regulations will not be based on biomarker concentrations

Chemical ?= DNA Damage / DNA Methylation ?= Mutation ?= Tumor ?= Cancer


Mutat Res Gen Tox En 822 (2017) 27–33
Contents lists available at ScienceDirect
Mutat Res Gen Tox En
journal homepage: www.elsevier.com/locate/gentox

Personal samplers of bioavailable pesticides integrated with a hair follicle assay of DNA damage to assess environmental exposures and their associated risks in children

Pierre-Alexandre Vidi[a,b,*], Kim A. Anderson[c], Haiying Chen[d], Rebecca Anderson[a], Naike Salvador-Moreno[a], Dana C. Mora[e], Carolyn Poutasse[c], Paul J. Laurienti[f], Stephanie S. Daniel[e], Thomas A. Arcury[e,g]



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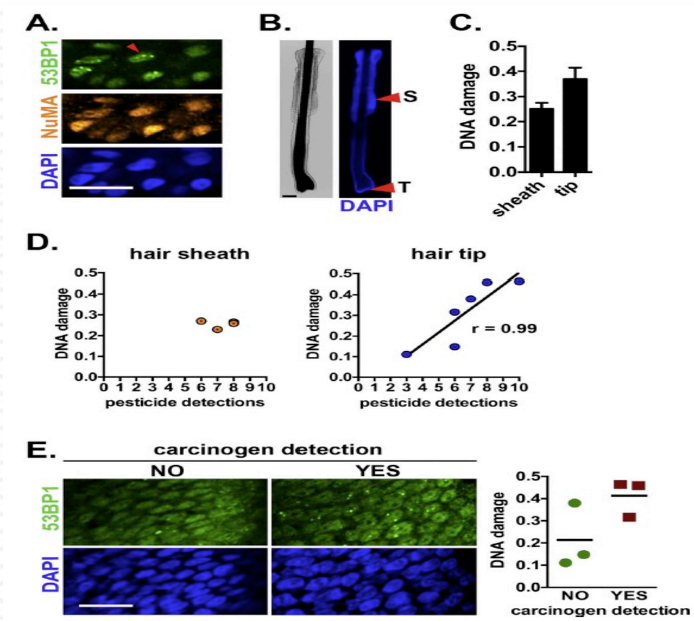
Significant association found between number of pesticides in wristbands and DNA damage in hair follicles

- 7-9 yr olds, n=10
- North Carolina
- Farmwork families
- Kruskal-Wallis testing,
- P<0.05 considered significant



(A) Staining of a child participant hair with antibodies against 53BP1 (DNA damage) and NuMA (staining control). The arrowhead points to a nucleus with DNA repair foci. Nuclei were counterstained with DAPI.

(B) Illustration of the sheath (S) and tip (T) regions of a scalp hair follicle plucked from a participant.

(C) DNA damage (average number of 53BP1 foci/nucleus cross section± SEM) in the sheath and tip regions

(D) DNA damage in hair sheaths or at hair tips, plotted against the number of pesticides detected with wristbands in each participant.

(E) Confocal images of 53BP1 staining (left) and DNA damage quantification (right) in participants with or without detection of pesticides described as carcinogenic by Cal/EPA. Individual values are plotted and means are indicated. Scale bars, 20 µm.

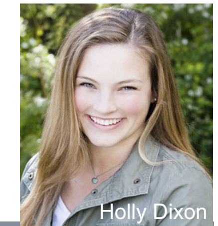
Analytical and Bioanalytical Chemistry (2018) 410:3059–3071
https://doi.org/10.1007/s00216-018-0992-z

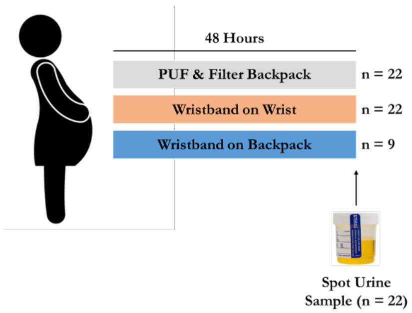
PAPER IN FOREFRONT

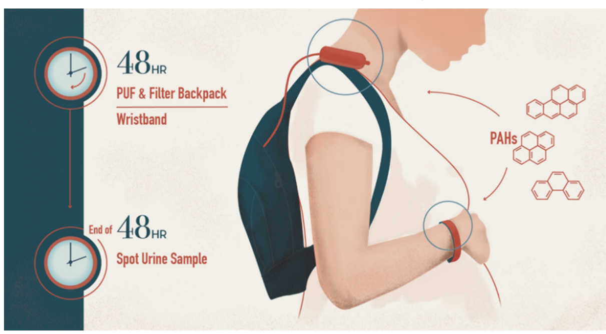
Silicone wristbands compared with traditional polycyclic aromatic hydrocarbon exposure assessment methods

Holly M. Dixon[1] · Richard P. Scott[1] · Darrell Holmes[2] · Lehyla Calero[2] · Laurel D. Kind[3] · Katrina M. Waters[4] · David E. Camann[5] · Antonia M. Calafat[6] · Julie B. Herbstman[2] · Kim A. Anderson[1]

Three times more positive, significant correlations between PAH and OH-PAH pairs in wristbands and urine samples than there were between PUFs-filters and urine samples







Continuation:

- 150 women
- Paired wristbands, backpacks, and urine
- Respiratory health of children compared to mother's chemical exposures

Table 4 Correlation table for creatinine-corrected OH-PAHs in urine and PAHs in backpacks (PUFs and filters) and wristbands

PAH	PAH metabolite	Urine PAH metabolite and PUF PAH		Urine PAH metabolite & PUF-filter PAH		Urine PAH metabolite & wristband PAH	
		r_s	*p*-value	r_s	*p*-value	r_s	*p*-value
Naphthalene	1-OH-naphthalene	**0.53**	**0.01***	**0.53**	**0.01***	**0.48**	**0.02***
	2-OH-naphthalene	0.27	0.23	0.27	0.23	**0.44**	**0.04***
	ΣOH-naphthalene[a]	0.35	0.11	0.35	0.11	**0.47**	**0.03***
Fluorene	2-OH-fluorene	**0.44**	**0.04***	**0.44**	**0.04***	0.33	0.13
	3-OH-fluorene	0.08	0.72	0.08	0.72	0.14	0.52
	ΣOH-fluorene[b]	0.33	0.13	0.33	0.13	0.27	0.22
Phenanthrene	1-OH-phenanthrene	0.18	0.41	0.18	0.41	**0.76**	**<0.0001***
	2- and 3-OH-phenanthrene	0.22	0.33	0.22	0.33	0.37	0.09
	4-OH-phenanthrene	0.23	0.30	0.23	0.30	0.18	0.42
	ΣOH-phenanthrene[c]	0.20	0.38	0.20	0.38	**0.64**	**0.002***
Pyrene	1-OH-pyrene	0.11	0.63	0.12	0.59	**0.66**	**0.0009***

[a] Sum of 1-OH-naphthalene and 2-OH-naphthalene concentrations

[b] Sum of 2-OH-fluorene and 3-OH-fluorene concentrations

[c] Sum of 1-OH-phenanthrene, 2- and 3-phenanthrene, and 4-OH-phenanthrene concentrations

* and **bold type** indicates $\alpha < 0.05$

Environmental Research 147 (2016) 365–372
Contents lists available at ScienceDirect
Environmental Research
journal homepage: www.elsevier.com/locate/envres

Using silicone wristbands to evaluate preschool children's exposure to flame retardants

Molly L. Kile [a], Richard P. Scott [c], Steven G. O'Connell [c], Shannon Lipscomb [a,b], Megan MacDonald [a], Megan McClelland [a], Kim A. Anderson [c,*]

Lipscomb et al. Environmental Health (2017) 16:23
DOI 10.1186/s12940-017-0224-6
Environmental Health
RESEARCH Open Access

Cross-sectional study of social behaviors in preschool children and exposure to flame retardants

Shannon T. Lipscomb[1], Megan M. McClelland[2], Megan MacDonald[2], Andres Cardenas[3], Kim A. Anderson[4] and Molly L. Kile[2*]

Environmental Science & Technology
Article
pubs.acs.org/est

Measuring Personal Exposure to Organophosphate Flame Retardants Using Silicone Wristbands and Hand Wipes

Stephanie C. Hammel,[†] Kate Hoffman,[†] Thomas F. Webster,[‡] Kim A. Anderson,[§] and Heather M. Stapleton[*,†]

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Built Environment: **Flame retardants in wristbands associated with children's social skills**

Children with higher flame retardant exposures exhibited poorer social skills in three domains that play an important role in a child's ability to succeed academically and socially

1. **Higher organophosphate** flame retardant exposure were rated by their preschool teachers to show less responsible behavior and more externalizing behavior problems
2. Children with higher exposure to **brominated** flame retardants were rated by their preschool teachers as less assertive

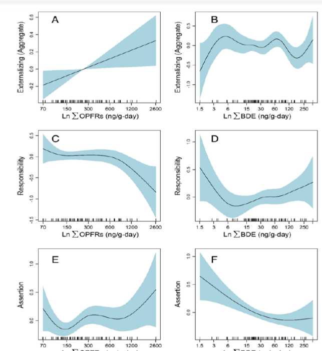
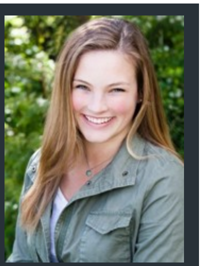


Fig. 1 Exposure-response relationship between ln ΣOPFR ng/g-day and ln ΣBDE ng/g-day and externalizing behavior (**a**, **b**), responsibility (**c**, **d**), and assertion (**e**, **f**). All generalized additive models are adjusted for gender, age, family context, and child's exposure to adverse experience($n = 69$)

Table 3 Multiple regression analyzes that examined the relationship between two classes of flame retardants and social behavior subscales ($n = 69$) adjusted for gender, age, family context, and child's exposure to adverse experiences

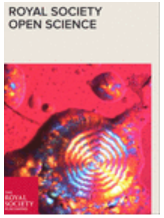
	Assertion	Responsibility	Externalizing
	B (SE)®	*B (SE)*®	*B (SE)*®
Covariates			
Gender[a]	0.21 (0.10) 0.21*	0.44 (0.10) 0.43**	−0.29 (0.10) −0.30**
Age	0.32 (0.07) 0.44**	0.24 (0.07) 0.33**	−0.12 (0.10) −0.18
Family Context	0.13 (0.08) 0.18[†]	0.21 (0.08) 0.27**	−0.21 (0.11) −0.32[†]
Adverse Experiences	0.04 (0.07) 0.06	−0.04 (0.07) −0.05	0.31 (0.10) 0.42**
Flame Retardants			
Ln ΣPBDE	−0.13 (0.04) −0.31**	0.03 (0.04) 0.07	−0.05 (0.10) −0.04
Ln ΣOPFR	0.09 (0.06) 0.15	−0.16 (0.06) −0.25**	0.24 (0.10) 0.31*
R square	0.41	0.44	0.35
R square for model without Flame Retardant variables	0.28	0.29	0.19

[a]0 = male, 1 = female
B = Unstandardized Estimate. *SE* standard error. ® = Standardized Estimate
[†]$p < .10$. *$p < .05$. **$p < .01$



DISCOVERY OF COMMON CHEMICAL EXPOSURES ACROSS THREE CONTINENTS USING SILICONE WRISTBANDS

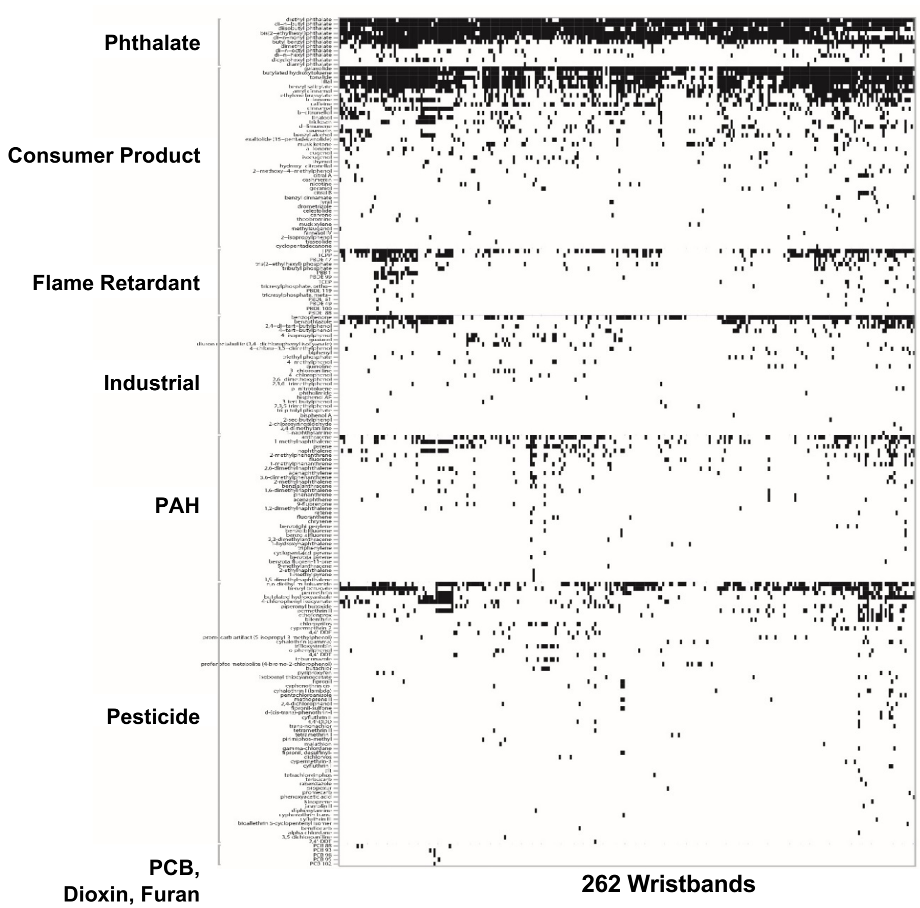
Two hundred and forty-seven volunteers from fifteen distinct communities in the U.S.A., Senegal, South Africa, and Peru



Discovery of common chemical exposures across three continents using silicone wristbands

Published:06 February 2019https://doi.org/10.1098/rsos.181836

No Two Wristbands Have Same Chemical Detection Profile



400,860 chemical data points

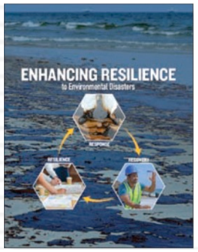
Patterns Emerge

14 chemicals in over 50% of the wristbands

Chemical	Frequency of Detection out of 262 Wristbands (%)	Potential Endocrine Disruptor Chemical
diethyl phthalate	94	Yes
galaxolide	93	Yes
di-n-butyl phthalate	92	Yes
diisobutyl phthalate	85	Yes
bis(2-ethylhexyl)phthalate	84	Yes
di-n-nonyl phthalate	82	Yes
butylated hydroxytoluene	78	Yes
tonalide	76	Yes
lilial	75	Yes
benzyl salicylate	73	Yes
butyl benzyl phthalate	66	Yes
benzophenone	64	Yes
triphenyl phosphate	52	Yes
N,N-diethyl-m-toluamide	52	No

U.S. in 2008 banned these in conc. >0.1% in children toys and articles

DEET, insect repellent



Response, Recovery, and Resilience to Oil Spills and Environmental Disasters: Exploration and Use of Novel Approaches to Enhance Community Resilience

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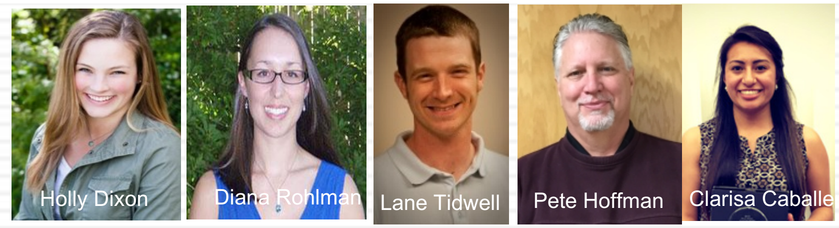


Unpublished data

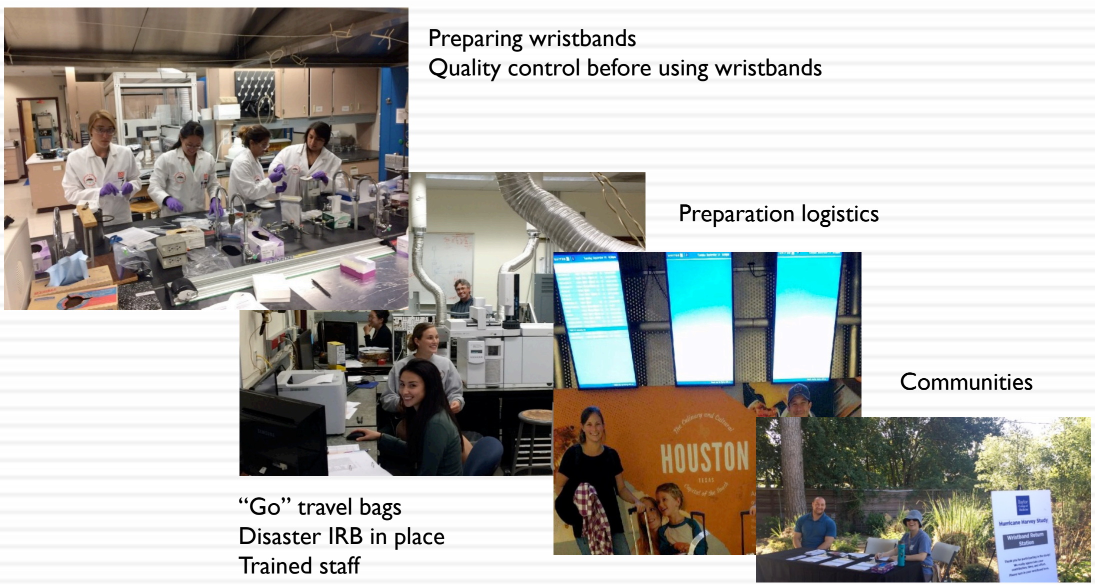
Data already given to community and participants

Rapid Response Hurricane Harvey

chemicals exposures can not be known *a priori*, lots of unknowns….

The Houston Health Dept stated that "millions of contaminants" were present in floodwaters.

Hiroko Tabuchi & Shelia Kaplan, A Sea of Health and Environmental Hazards in Houston's Floodwaters, *New York Times* (August 31, 2017)

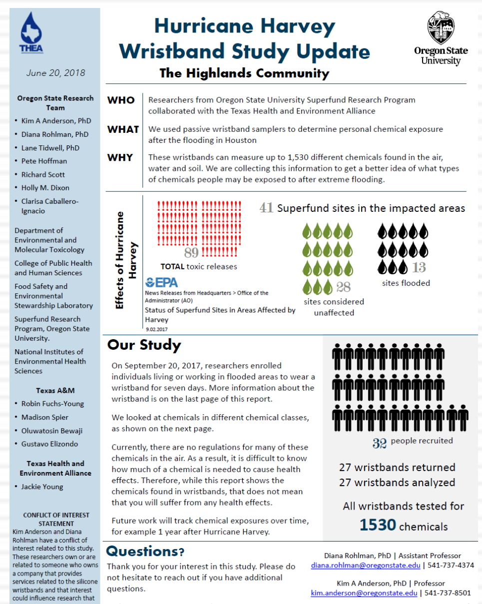


Preparing wristbands
Quality control before using wristbands

Preparation logistics

Communities

"Go" travel bags
Disaster IRB in place
Trained staff



THEA

June 20, 2018

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CONFLICT OF INTEREST STATEMENT
Kim Anderson and Diana Rohlman have a conflict of interest related to this study. These researchers own or are related to someone who owns a company that provides services related to the silicone wristbands and that interest could influence research that you are participating in.

Hurricane Harvey Wristband Study Update
The Highlands Community

Oregon State University

WHO Researchers from Oregon State University Superfund Research Program collaborated with the Texas Health and Environment Alliance

WHAT We used passive wristband samplers to determine personal chemical exposure after the flooding in Houston

WHY These wristbands can measure up to 1,530 different chemicals found in the air, water and soil. We are collecting this information to get a better idea of what types of chemicals people may be exposed to after extreme flooding.

Effects of Hurricane Harvey

89 TOTAL toxic releases

41 Superfund sites in the impacted areas

28 sites considered unaffected

13 sites flooded

EPA
News Releases from Headquarters > Office of the Administrator (AO)
Status of Superfund Sites in Areas Affected by Harvey
9.02.2017

Our Study

On September 20, 2017, researchers enrolled individuals living or working in flooded areas to wear a wristband for seven days. More information about the wristband is on the last page of this report.

We looked at chemicals in different chemical classes, as shown on the next page.

Currently, there are no regulations for many of these chemicals in the air. As a result, it is difficult to know how much of a chemical is needed to cause health effects. Therefore, while this report shows the chemicals found in wristbands, that does not mean that you will suffer from any health effects.

Future work will track chemical exposures over time, for example 1 year after Hurricane Harvey.

32 people recruited

27 wristbands returned
27 wristbands analyzed

All wristbands tested for
1530 chemicals

Questions?

Thank you for your interest in this study. Please do not hesitate to reach out if you have additional questions.

~ *The Oregon State Research Team*

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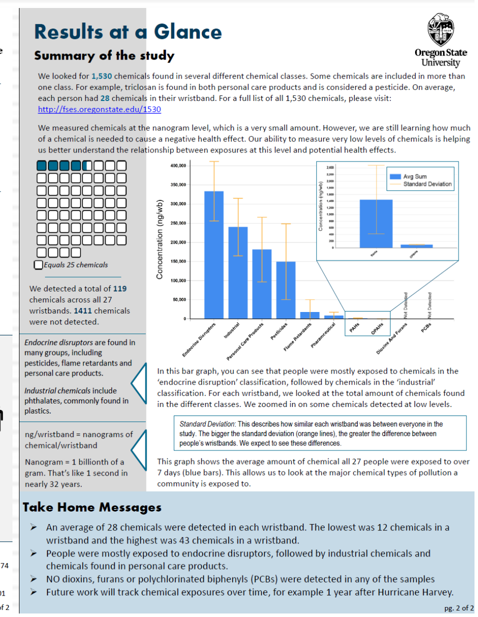
pg. 1 of 2



Results at a Glance
Summary of the study

Oregon State University

We looked for **1,530** chemicals found in several different chemical classes. Some chemicals are included in more than one class. For example, triclosan is found in both personal care products and is considered a pesticide. On average, each person had **28** chemicals in their wristband. For a full list of all 1,530 chemicals, please visit: http://fses.oregonstate.edu/1530

We measured chemicals at the nanogram level, which is a very small amount. However, we are still learning how much of a chemical is needed to cause a negative health effect. Our ability to measure very low levels of chemicals is helping us better understand the relationship between exposures at this level and potential health effects.

Equals 25 chemicals

We detected a total of **119** chemicals across all 27 wristbands. **1411** chemicals were not detected.

Endocrine disruptors are found in many groups, including pesticides, flame retardants and personal care products.

Industrial chemicals include phthalates, commonly found in plastics.

ng/wristband = nanograms of chemical/wristband

Nanogram = 1 billionth of a gram. That's like 1 second in nearly 32 years.

In this bar graph, you can see that people were mostly exposed to chemicals in the 'endocrine disruption' classification, followed by chemicals in the 'industrial' classification. For each wristband, we looked at the total amount of chemicals found in the different classes. We zoomed in on some chemicals detected at low levels.

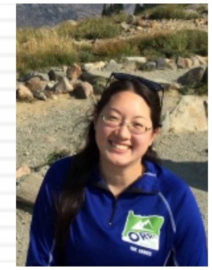
Standard Deviation: This describes how similar each wristband was between everyone in the study. The bigger the standard deviation (orange lines), the greater the difference between people's wristbands. We expect to see these differences.

This graph shows the average amount of chemical all 27 people were exposed to over 7 days (blue bars). This allows us to look at the major chemical types of pollution a community is exposed to.

Take Home Messages

- An average of 28 chemicals were detected in each wristband. The lowest was 12 chemicals in a wristband and the highest was 43 chemicals in a wristband.
- People were mostly exposed to endocrine disruptors, followed by industrial chemicals and chemicals found in personal care products.
- NO dioxins, furans or polychlorinated biphenyls (PCBs) were detected in any of the samples
- Future work will track chemical exposures over time, for example 1 year after Hurricane Harvey.

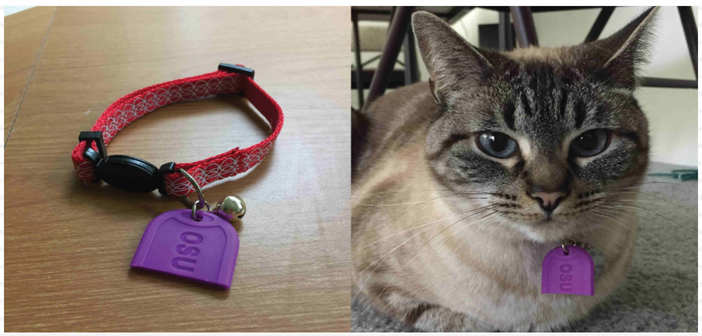
pg. 2 of 2

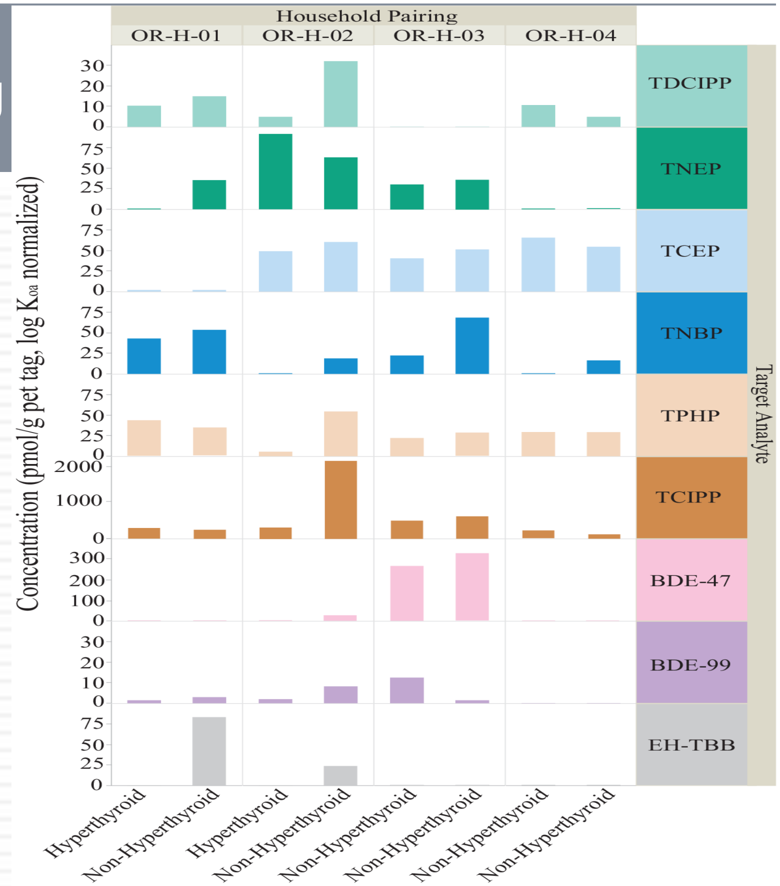


In press

ES&T 2019

Hyperthyroid Case-Control Cat Tag

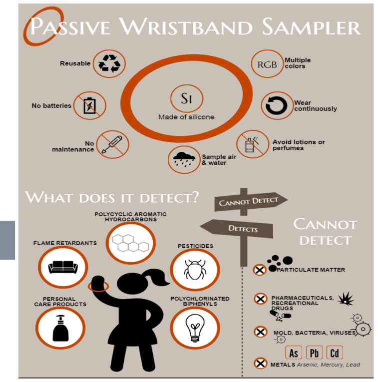




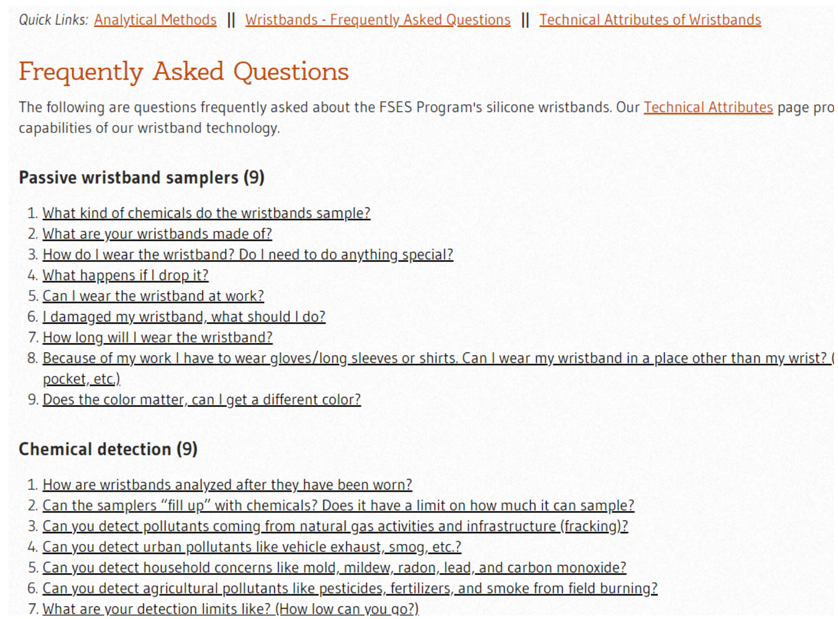
- Tris(1,3-dichloro-2-isopropyl) phosphate (TDCIPP) concentrations were higher in hyperthyroid than non-hyperthyroid pet tags (adjusted odds ratio, $p<0.07$; Mantel-Cox, $p<0.02$).

- Higher TDCIPP concentrations were associated with higher fT_4 and TT_4 concentrations ($p<0.05$).

Wristband Limitations & Considerations



- Time integrated
- Not real time
- Must be worn for a few hours
- External environmental exposures can include dermal
- Independent measure
- Our webpage:
  - **http://fses.oregonstate.edu/faq-page**



Quick Links: Analytical Methods || Wristbands - Frequently Asked Questions || Technical Attributes of Wristbands

Frequently Asked Questions

The following are questions frequently asked about the FSES Program's silicone wristbands. Our Technical Attributes page pro
capabilities of our wristband technology.

Passive wristband samplers (9)

1. What kind of chemicals do the wristbands sample?
2. What are your wristbands made of?
3. How do I wear the wristband? Do I need to do anything special?
4. What happens if I drop it?
5. Can I wear the wristband at work?
6. I damaged my wristband, what should I do?
7. How long will I wear the wristband?
8. Because of my work I have to wear gloves/long sleeves or shirts. Can I wear my wristband in a place other than my wrist? (pocket, etc.)
9. Does the color matter, can I get a different color?

Chemical detection (9)

1. How are wristbands analyzed after they have been worn?
2. Can the samplers "fill up" with chemicals? Does it have a limit on how much it can sample?
3. Can you detect pollutants coming from natural gas activities and infrastructure (fracking)?
4. Can you detect urban pollutants like vehicle exhaust, smog, etc.?
5. Can you detect household concerns like mold, mildew, radon, lead, and carbon monoxide?
6. Can you detect agricultural pollutants like pesticides, fertilizers, and smoke from field burning?
7. What are your detection limits like? (How low can you go?)

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Oregon Taxpayers

In accordance with her management plan, Dr. Kim Anderson, **discloses** a financial interest in MyExposome, Inc.

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Collaborators:
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Confederated Tribes of the Umatilla Indian Reservation

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Questions?

http://cen.acs.org/articles/94/i16/simple-way-track-everyday-exposure.html

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