Assessing PAH exposures with multiple approaches including silicone wristbands

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BACKGROUND

To assess human exposure to environmental chemicals, researchers rely on a variety of methods including:

Questionnaires

- Insight into participant background, behavior, activities Participant may not know which chemicals s/he is exposed to



Active Sampling – Air Monitoring Backpack

- Well-recognized for monitoring chemicals in air
- Pump noise and carrying backpack can be burdensome



- **Biological Samples**
- Integrates all chemical exposure routes
- Hard to control for some confounding factors influencing metabolic capacity



- Passive Sampling
- Does not incorporate a battery or pump
- Only accounts for chemicals in the external environment does not account for dietary exposure

Recent applications of passive sampling include the use of <u>silicone</u> wristbands, which can sequester a wide variety of target compounds:

- **Pesticides**¹
- Flame Retardants^{2,3}
- **PAHs⁴** (Polycyclic Aromatic Hydrocarbons)



METHODS

- Paired study at the Columbia Center for Children's Environmental Health (CCCEH) in New York with 22 women in their 3rd trimester of pregnancy
- The CCCEH has associated PAH exposure with allergies, asthma, impaired neurodevelopment, and obesity in young children since 1998 ⁵⁻⁷



OBJECTIVES

- Wristbands 62 PAHs at Oregon State University using
- PUFs & Filters 20 PAHs at Southwest Research Institute
- Urine 8 PAH metabolites (OH-PAHs) at the CDC using

- Demonstrate that PAHs are captured and recovered from silicone wristbands in 48 hour deployments
- Compare and characterize PAHs in wristbands and backpacks
- III. Compare and characterize PAHs in wristbands and PAH metabolites in urine samples

- 84% of the PAHs were detected in at least 1 wristband 32 PAHs were detected in over 50% of the wristbands
- Of the 62 PAHs analyzed in wristbands:



Figure 1. PAH frequency of detection and concentration in 22 wristbands (A), backpack PUFs (B), and backpack PUFs and filters combined (C). The 20 PAHs analyzed in both the wristband and backpack samples are represented.

AIM I Conclusions:

- \checkmark PAHs are captured and recovered in wristbands in a 48 hour nonoccupational exposure period
- Wristbands recovered PAHs in similar frequencies of detection and concentrations as PUFs and filters

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Naphthalenes

Acenaphthene

Phenanthrene:

Fluoranthene

• MW ≥ 228 g mol-1

• Pyrene

Table 2. Spearman's correlation table for creatinine corrected OH-PAHs in urine samples and PAHs in backpacks (PUFs and filters) and wristbands.

		Urine PAH PUF Bac	Metabolite & kpack PAH	Urine PAH PUF + Filter I	Metabolite & Backpack PAH	Urine PAH Wristb	Metabolite & and PAH
PAH	PAH Metabolite	۲s	p-value	ľs	p-value	ſs	p-value
naphthalene	1-OH-naphthalene	0.53	0.01*	0.53	0.01*	0.48	0.02*
naphthalene	2-OH-naphthalene	0.27	0.23	0.27	0.23	0.44	0.04*
fluorene	2-OH-fluorene	0.44	0.04*	0.44	0.04*	0.33	0.13
fluorene	3-OH-fluorene	0.08	0.72	0.08	0.72	0.14	0.52
phenanthrene	1-OH-phenanthrene	0.18	0.41	0.18	0.41	0.76	<0.0001 [,]
phenanthrene	2- & 3-OH-phenanthrene	0.22	0.33	0.22	0.33	0.37	0.09
phenanthrene	4-OH-phenanthrene	0.23	0.30	0.23	0.30	0.18	0.42
pyrene	1-OH-pyrene	0.11	0.63	0.12	0.59	0.66	0.0009*

AIM II and III Conclusions:

- ✓ Wristbands may be more predictive of PAH metabolites in urine than PUF + filter traditional methods
- \checkmark Correlation patterns could be the result of wristbands incorporating both **dermal** and vapor phase PAH exposure and/or wristbands more selectively capturing the **bioavailable PAH fraction**





Table 1. Spearman's correlation table for 20 PAHs analyzed in air monitoring backpacks (PUFs and filters) and wristbands.

VF Back & Wristb	kpack PAH and PAH	PUF + Filter Backpack PAH & Wristband PAH		
r _s	p-value	rs	p-value	
0.71	0.0002*	0.71	0.0002*	
0.47	0.03*	0.47	0.03*	
0.49	0.02*	0.49	0.02*	
а	а	а	а	
0.69	0.0004*	0.69	0.0004*	
0.71	0.0002*	0.71	0.0002*	
0.54	0.009*	0.54	0.009*	
b	b	b	b	
0.15	0.50	0.14	0.53	
0.41	0.06	0.43	0.05*	
0.56	0.007*	0.54	0.009*	
0.26	0.20	0.28	0.20	
-0.03	0.9	0.03	0.89	
а	а	0.09	0.69	
а	а	0.23	0.29	
а	а	0.18	0.43	
а	а	0.15	0.52	
С	С	b	b	
С	С	с	С	
а	а	0.33	0.14	

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- PUF and wristband comparisons indicate moderate to strong correlations for 7 of 11 PAHs
- Including filter concentrations does not greatly change correlation trends

PAHs in PUFs + Filters & OH-PAHs are correlated for **2 of 8 comparisons** • PAHs in wristbands & OH-PAHs are correlated for 4 of 8 comparisons • 1-OH-phenanthrene and 1-OH-pyrene are strongly correlated with associated PAHs in the wristbands

SUMMARY

Wristbands appear to be a candidate technology for inclusion in exposure science and epidemiology studies