



NIEHS PEPH WEBINAR: E-WASTE AND ENVIRONMENTAL HEALTH

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NOVEMBER 9, 2018



CHINA

- Guiyu Town, Shantou City, Guangdong Province
- Rural community, but with concentrated recycling activities in a town surrounded by farming land
- Population ~150,000, and up to ~100,000 migrant workers at its height
- E-waste recycling existed since 1990s, almost the largest on tonnage of e-waste recycled
- Before 2015: mostly home-run business, recycling in front of the house or on the first floor of the 3-4 story home building
- After 2015: still home-run business, recycling became mandatory to occur only in the industrial park with centralized ventilation and waste water treatment



THEN (2010)



POLICY CHANGES IN GUIYU (2015)



“Transportation of electronic waste and plastic prohibited. Violators will be investigated, retained, and materials confiscated.”



“Beginning Dec 1, 2015, any e-waste treating and plastics manufacturing outside of industrial park shall stop, or the electricity will be shut off”

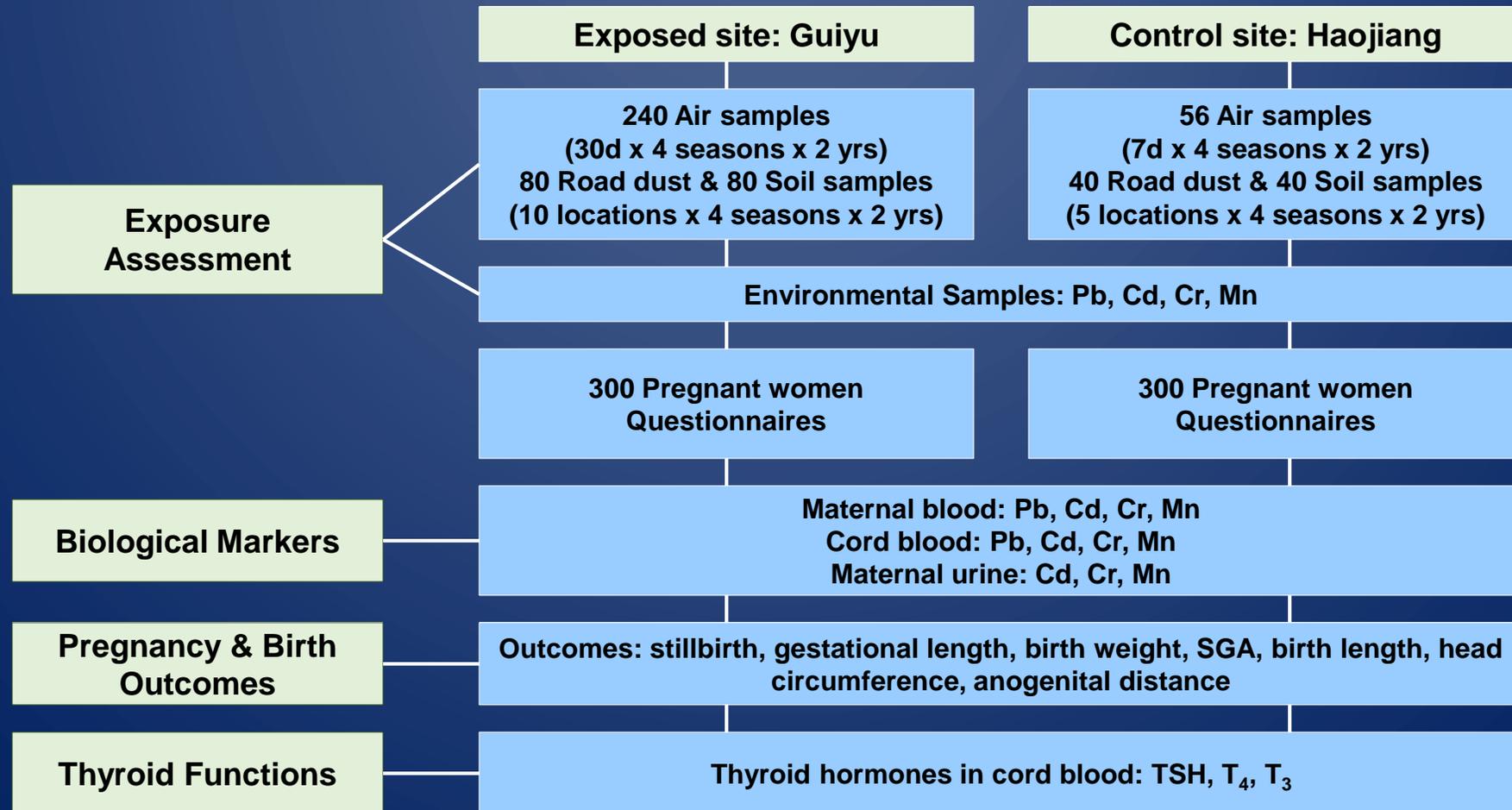
NOW (2018)



E-waste recycling industrial park in Guiyu
Slogan says “Protecting environment is protecting ourselves.”



E-WASTE RECYCLING EXPOSURES AND COMMUNITY HEALTH (E-REACH), 2010-2013



APPROACH

- Collaboration built with Shantou University Medical Center, 25 miles away from Guiyu
- Focusing on community residents rather than recycling workers due to the extent of contamination in the community
- Studying metal exposure in pregnant women and children due to concerns of developmental toxicity

AIR SAMPLES

- Sampled air continuously (every day for a year) in Guiyu
 - Collected air samples in Haojiang for one week per season
 - Air samples: March 2012- May 2013

	Guiyu (n=133)		Haojiang (n=33)		p
	GM	Range	GM	Range	
PM_{2.5} (µg/ m³)	49.91	10.98 – 160.57	37.60	11.37 – 83.10	0.009
Pb (ng/m³)	164.03	9.12 – 1046.9	69.26	9.12 – 293.66	<0.0001
Cd (ng/m³)	5.69	0.40 – 55.71	3.39	0.28 – 22.71	0.002
Cr (ng/m³)	4.51	0.01 – 387.86	3.81	0.01 – 26.43	0.68
Mn (ng/m³)	16.93	0.71 – 143.75	15.64	0.71 – 85.19	0.76

SOIL & ROAD DUST SAMPLES

- Sampled soil & road dust samples each season in community areas
 - 10 scattered locations in Guiyu
 - 5 scattered locations in Haojiang
 - Road dust and soil: 4 seasons in 2012-2013

Matrices	Metal	Geometric Mean of Metal Concentrations		Ratio of Guiyu/Haojiang Area Metal Concentrations		p
		Guiyu (mg/kg, n=44)	Haojiang (mg/kg, n=20)	Estimate	95% CI	
Soil	Pb	213.61	91.92	2.32	1.42, 3.80	0.001
	Cd	0.32	0.07	4.34	2.27, 8.31	<0.0001
	Cr	38.56	31.76	1.21	0.79, 1.87	0.372
	Mn	606.63	614.98	0.99	0.70, 1.39	0.937
Road Dust	Pb	392.58	95.72	4.10	2.74, 6.13	<0.0001
	Cd	1.14	0.36	3.18	2.11, 4.79	<0.0001
	Cr	55.46	64.93	0.85	0.58, 1.25	0.409
	Mn	529.35	493.26	1.07	0.81, 1.42	0.617

METAL CONCENTRATIONS IN BIOLOGICAL SAMPLES

Table 2 Concentrations of Pb, Cd, Cr, and Mn in maternal blood, cord blood, and maternal urine in Guiyu and Haojiang

Metals	LOD ^a	Guiyu <i>n</i> = 314						Haojiang <i>n</i> = 320						Guiyu vs. Haojiang concentration ratio			
		<i>n</i> Missing	<i>n</i> < LOD	GM	Min	Max	CB:MB ratio	<i>n</i> Missing	<i>n</i> < LOD	GM	Min	Max	CB:MB ratio	Unadjusted		Adjusted ^b	
														Ratio	95% CI	Ratio	95% CI
Maternal blood																	
Pb (µg/dL)	0.20	0	0	6.66	1.87	27.09		0	0	3.81	0.86	16.12		1.75	1.64, 1.86*	1.74	1.60, 1.89*
Cd (µg/L)	0.20	0	0	1.72	0.26	4.83		6	6	1.43	0.10	7.03		1.20	1.11, 1.29*	1.21	1.09, 1.34*
Cr (µg/L)	1.67	1	0	13.78	2.35	189.40		0	0	8.90	4.38	175.40		1.55	1.42, 1.69*	1.55	1.37, 1.75*
Mn (µg/L)	1.12	1	0	25.93	8.38	320.50		0	0	28.51	4.41	170.90		0.91	0.86, 0.96*	0.83	0.77, 0.90*
Cord blood																	
Pb (µg/dL)	0.20	20	0	5.03	1.53	26.36	0.84	6	0	3.18	0.59	12.70	0.91	1.58	1.48, 1.70*	1.53	1.38, 1.68*
Cd (µg/L)	0.20	21	171	0.18	0.06	1.96	0.13	16	124	0.23	0.10	2.25	0.18	0.80	0.75, 0.86*	0.78	0.71, 0.87*
Cr (µg/L)	1.67	108	39	4.02	0.10	24.53	0.46	87	60	3.52	0.03	19.94	0.77	1.14	0.93, 1.41	1.32	0.98, 1.78
Mn (µg/L)	1.12	28	0	52.93	20.66	165.90	2.27	29	0	49.69	16.60	131.20	2.00	1.07	1.01, 1.13	1.11	1.03, 1.21*
Maternal urine (µg/g creatinine)^c																	
Cd	0.04	68	2	1.06	0.05	18.71		75	6	0.54	0.03	16.47		1.94	1.65, 2.29*	2.15	1.72, 2.69*
Cr	0.08	107	8	1.66	0.01	114.67		103	18	0.97	0.01	35.12		1.72	1.29, 2.29*	1.63	1.09, 2.45*
Mn	0.06	82	0	7.62	0.84	158.26		54	0	3.14	0.13	40.47		2.43	2.05, 2.88*	2.60	2.04, 3.31*

LOD limit of detection, CB cord blood, MB maternal blood

^aWe used the machine-reading values of those below LOD

^bAdjusted for maternal age, maternal BMI, maternal education, maternal occupation, gravidity, ETS

^cThe unit of limit of detection in maternal urine was µg/L

**p* < 0.05

% ELEVATED BLOOD LEAD AND CADMIUM LEVELS IN PREGNANT WOMEN

Variable	Guiyu <i>n</i> (%)	Haojiang <i>n</i> (%)	Unadjusted RR [RR (95% CI)]	Adjusted RR ^b [RR (95% CI)]
BLL ≥ 5 µg/dL	232 (73.9)	64 (20.0)	3.70 (2.94, 4.64)*	4.03 (3.07, 5.29)*
BLL ≥ 10 µg/dL	50 (15.9)	5 (1.6)	10.19 (4.12, 25.22)*	8.75 (2.85, 26.86)*
BCd ≥ 1.7 µg/L	160 (50.9)	117 (36.6)	1.39 (1.16, 1.67)*	1.49 (1.16, 1.91)*

^aCadmium levels from the CDC Fourth Report 95th percentile of adults in the United States

^bAdjusted for maternal age, maternal BMI, gravidity, and ETS

* $p < 0.01$

THE BASIS OF E-WASTE RECYCLING POLICY CHANGE IN GUIYU, CHINA

- Widespread environmental contaminations to the community
 - Metals, organic compounds including flame retardants, PAHs, and dioxins
- Concerns of developmental toxicity in children and long-term health effects in both children and adults
 - Fetal growth restriction, preterm birth
 - Child lung function development
 - Child neurobehavioral development
 - DNA damage and cancer development
 - Health impact in local and migrant workers: respiratory, cardiovascular, neurological
- Established fortune from e-waste recycling and the prospect of increasing e-waste tonnage in China
- Technological possibility to safely recycle e-waste or at least reduce contaminations

WORKING WITH COMMUNITY

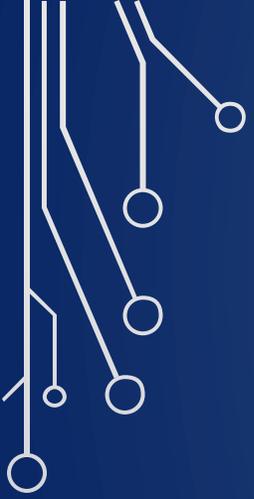
- Need to understand the environmental health problem better
- Overall low awareness of toxicants in e-waste before training
- Inadequate exposure monitoring
- Health effect research lacking
- Local communities not ready accepting of academic research study
 - Recycling is an income stream for the family
 - Resources very limited in the e-waste recycling business
- Over-crowded community and a large amount of children around recycling locations

WORKING WITH COMMUNITY (CONT'D)

- Local dialect different from Mandarin or Cantonese
- Local students and staff are the key to community outreach
- Educated local residents and health care workers share concerns of environmental contamination
- Not intended to disrupt business interest and income stream for local residents and migrant workers

WORKING IN AN INTERNATIONAL SETTING

- Language barrier and translation of study documents
- Time zone difference for conference calls
- Equipment transfer between countries (air samplers)
- Remote data capture with REDCap
- Messenger for policy change at local level more important than international collaborators



LESSONS LEARNED

- Communication, communication, communication!
 - Be as prepared as possible
 - Need to have a Plan B
- 



NEW CHALLENGES WITH CENTRALIZED RECYCLING

- Continued monitoring of environment and biospecimens
- Health effects in residents and workers from cumulative exposures in the past 2-3 decades
- Exposure and health effects in industry park workers
- Clean up of the contaminated environment in Guiyu

FURTHER INTERVENTIONS

- Needed evaluations on a larger scale
- Workers and vulnerable populations are the targets for prevention
- Recycling communities center of the intervention design and implementation

COLLABORATORS & FUNDING

Shantou University Medical College

- Dr. Xia Huo (now at Jinan University School of Environment, Guangzhou, China)
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- Ms. Yuling Zhang
- Mr. Xiangbin Zheng

University of Cincinnati College of Medicine

- Dr. Kim Dietrich
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- Dr. Shuk-mei Ho

Funding from NIH/NIEHS RC4ES019755, P30ES006096