Environmental exposures due to informal level e-waste recycling activities and human health

Julius Fobil, John Arko-Mensah, Stuart Batterman, Niladri Basu & Thomas Robins
E-waste: global production

E-WASTE GENERATED BY COUNTRY (2012 total, in millions of tons)

- USA: 10.317
- EU: 10.933
- Mexico: 1.138
- Brazil: 1.530
- China: 7.995
- India: 3.033
- Russia: 1.556
- Japan: 3.022

Source: Step-Initiative.org
E-waste: global movement

Export of e-waste

Source: Greenpeace, Basel Action Network
E-waste: global destinations
Recycling Methods

- Recycling activities take place in a highly concentrated area and include:
  - Open burning
  - Manual dismantling
    - Chisels and hammers
- Fabrication/moulding into local cookstoves
Recycling Methods
Multiple Toxic Exposures
Multiple Toxic Exposures
Scientific goals include:

1) characterize work-related, time-varying, job-specific exposures of electronic waste recycling activities at the Agbogbloshie site, and assess biological markers of dose, to metals, organic compounds, and markers of combustion products;

2) provide estimates of potentially increased lifetime, work-exposure-associated cancer risks; and,

3) evaluate associations of exposures with measures of acute and chronic respiratory morbidity in workers.

Scientific goals are fully integrated with strengthening EOH capacity in West Africa.
Specific Aims

- **Specific Aim 1.** To enroll 207 study participants over a 12-month period: 142 Agbogbloshie waste recycling workers...as well as a group of 65 'controls' residing in Madina Zongo...

- **Specific Aim 2.** To collect and analyze, at 0-, 6-, 12-, and 16-months for each participant,
  1. biological samples (blood and urine) for a) metals, b) organic compounds including flame retardants, polycyclic aromatic hydrocarbons (PAHs), dioxin-related compounds, and,
  2. personal air monitoring, through a combination of real-time measurements and analysis of size-specific samples collected on filters
  3. estimate life-time cancer risks
Specific Aims 2/2

- Specific Aim 3. To collect respiratory health data (symptom reports; spirometry) at 0-, 6-, 12-, and 16-months for each participant.
  - Specific Aim 3a. To evaluate whether working on the Agbogbloshie site, ...and whether quantified exposures ...(PM 2.5, elemental carbon, PAHs) are associated with differences in respiratory health status.
  - Specific Aim 3b. To investigate interactions between occupational exposures ...and 1) ....biomass fuels for cooking in domiciles, 2) tobacco use, 3) pre-employment history of ... asthma or tuberculosis, in producing adverse respiratory health effects.
Depending on the metal's half-life, blood and urine biomarkers will give an indication of recent cumulative exposure.

<table>
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<tr>
<th>METALS</th>
<th>Whole Blood</th>
<th>Urine</th>
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<tbody>
<tr>
<td>Cadmium</td>
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<tr>
<td>Lead</td>
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<td>Chromium</td>
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<td>Zinc</td>
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Assessment of Confounders

With little background data on prior exposures and health conditions among informal e-waste workers, our questionnaire is comprehensive.
Ambient and Personal Level Assessments

- Agbogbloshie worker study includes
  - Fixed site and real time & filter personal measures of airborne exposure (PM including analysis for organics, e.g., PAHs)
  - Time-lapse photography (one photo per minute) using GoPro cameras
  - Backpack containing instrumentation for personal-level PM data collection
  - Measures of respiratory, cardiovascular & musculoskeletal outcomes
  - Repeated measures on participants over 3 seasons
Sample Collection Work Flow

**Data Collection Flowchart**

- **Station 1: Registration**
  - **Check-in**
    - Informed Consent
    - Participant file created including participant ID, contact details, photo image
  - **Check-out**
    - Schedule date for personal air sampling
    - Check for completion of all stations and partial compensation

- **Station 2: Physical Measures**
  - Height
  - Weight
  - Blood pressure

- **Station 3: Comprehensive + Dietary Questionnaires**
  - Interpreter administered questionnaires

- **Station 4: Biological Sampling and Storage**
  - Blood (whole and plasma)
  - Urine
  - Cool storage at 4°C

- **Station 5: Spirometry**
  - Maneuver performed using an EasyOne portable device
  - Tracings and measures (FEV1, FVC, FEV1/FVC ratio) stored for the best 3 blows

- **Station 6: Electrocardiogram (ECG)**
Collaborators

Thomas Robins, M.D., M.P.H.
University of Michigan School of Public Health

Niladri Basu, PhD, MSc, BS
University of McGill University

Michelle Heacock, PhD
NIEHS, Government Collaborator

Marie S. O'Neill, Ph.D.
University of Michigan School of Public Health

Stuart Batterman, PhD
University of Michigan School of Public Health

Benjamin Fayomi, M.D., M.Sc
University of Abomey at Calavi, Benin

Julius Fobil, DrPH, DTM
University of Ghana School of Public Health
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