Title: High Urinary Polycyclic Aromatic Hydrocarbon Concentrations in Bomet County, Kenya, a Region with a High Incidence of Esophageal Squamous Cell Carcinoma

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Estimated Oesophageal Cancer Mortality Worldwide in 2012: Men

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Estimated age-standardised rates (World) per 100,000
• **Tenwek Hospital**: Located in Bomet county, southwestern Rift Valley. 300 bed mission hospital with a population of ~600,000 within the 50km catchment area.

• EC represents 35% of all malignancies and 90% of EC cases are ESCC.

• 8% of ESCC cases occur in individuals <30yo
Polycyclic Aromatic Hydrocarbons (PAH)

2-7 ring hydrocarbons, products of incomplete combustion

- Naphthalene
- Phenanthrene
- Fluoranthene
- Pyrene

• Carcinogenicity
  - Form DNA adducts which → mutations → cancer
  - IARC class I – B[a]P, coal tars, coke production
## Population Specific PAH Sources

<table>
<thead>
<tr>
<th>Population</th>
<th>Primary exposure</th>
<th>Other exposures</th>
</tr>
</thead>
<tbody>
<tr>
<td>West</td>
<td>Tobacco smoke</td>
<td>Car exhaust, Coal smoke</td>
</tr>
<tr>
<td>China</td>
<td>Coal smoke</td>
<td>Tobacco smoke, Car exhaust</td>
</tr>
<tr>
<td>Iran</td>
<td>Bread? Tea?</td>
<td>Tobacco smoke, Car exhaust</td>
</tr>
<tr>
<td>Brazil</td>
<td>Tobacco smoke, Mate</td>
<td>BBQ meat, Car exhaust</td>
</tr>
<tr>
<td>Kenya</td>
<td>Wood smoke, Mursik?</td>
<td>Tea?</td>
</tr>
</tbody>
</table>

### Possible Sources of PAH Exposure in Western Kenya

- Wood/Charcoal fires
- Smoky windowless huts
- Tea
- Mursik (fermented milk)
Study flow chart

Subjects enrolled
- 333

- Subjects who came to Tenwek for study procedures
  - 313
  - Subjects who completed endoscopy and questionnaire
    - 294
    - Dysplasia
      - 42
      - Mild Dysplasia
        - 33
    - Normal mucosa
      - 111
    - Mild Esophagitis
      - 114
    - Moderate Dysplasia
      - 8
    - Severe Dysplasia
      - 1
    - Subjects who dropped out (scheduling conflicts/missed appointments)
      - 20
    - Subjects excluded at time of questionnaire or endoscopy
      - 19
      - Mod- Severe Esophagitis
        - 27
Questionnaire

All individuals were interviewed face-to-face
The questionnaire included possible PAH relevant exposures such as:

• Age, gender, and marital status
• Tobacco smoking habits (current or past, number of cigarettes/day, for how long they smoked, and time since quitting)
• Environmental exposure to smoke and passive smoke exposure (frequency and location - home or work)
• Alcohol consumption (kind of beverage, average amount in mL/week)
Aims

The primary aim of this study was to quantify the concentration of seven PAH urine metabolites in a cross-section of subjects from Bomet, Kenya, an endemic area for ESCC.

An additional aim was to assess demographic and lifestyle factors that may be associated with the PAH metabolites.
Methods

1. A community-based sample of 294 asymptomatic adults were recruited, who collected spot urine specimens and completed a questionnaire.

2. The urine specimens were analyzed at the National Center for Environmental Health, CDC; the same lab has performed similar analyses on urine samples from the US National Health and Nutrition Examination Survey (NHANES). The seven PAH analytes were hydroxylated metabolites of naphthalene, fluorene, phenanthrene, and pyrene.

3. Median creatinine-adjusted PAH metabolite concentrations (ng/g creatinine) were compared by all relevant questionnaire items.
Results

- All seven measured PAH metabolites in the study population were markedly elevated compared with the US population:

<table>
<thead>
<tr>
<th></th>
<th>Bomet</th>
<th>NHANES</th>
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</thead>
<tbody>
<tr>
<td>Males</td>
<td>1190ng/g</td>
<td>106ng/g</td>
</tr>
<tr>
<td>Females</td>
<td>2840ng/g</td>
<td>133ng/g</td>
</tr>
</tbody>
</table>
Comparison of PAH metabolites for all males and females in STEP and NHANES
Results (continued)

- Significant (p<0.01) association with higher PAH concentrations for all measured metabolites:
  - Age (< 50 years), sex (female), and indoor cooking (yes)

- Regular tobacco use was not reported by many participants (19%), and was not associated with PAH concentration.
Conclusions

• PAH metabolite concentrations in Bomet were very high when compared to the US population.

• Elevated PAH concentrations were associated with age, sex, and indoor cooking.
Future Directions

• Additional studies are needed to define the association between high PAH exposure and risk of developing ESCC and to determine the sources of PAH exposure in this high-risk population.

• Further work is needed to better understand ESCC in East Africa and identify prevention and control strategies. To that end, we are working to establish a Consortium of sites conducting ESCC research.
Acknowledgements

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