Household exposures to kerosene lamp emissions and potential health implications

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Kerosene

- A petroleum middle-distillate product (‘fossil fuel’)
- Used for lighting by an estimated 1.6 billion people worldwide
- Few epidemiologic studies have examined health implications of kerosene as a cooking fuel and very few have examined them for kerosene as a lighting fuel.
- Limited evidence suggests kerosene PM$_{2.5}$ emissions may be a more potent cause of respiratory health problems than PM$_{2.5}$ from biomass.
- Until recently, kerosene had been considered by international agencies to be a ‘clean fuel’, along with LPG, biogas, and electricity.
Well-established hazards of kerosene

- **Poisoning**
  - Small amounts often purchased in drink bottles.
  - Most common cause of child poisoning in many developing countries.

- **Fires and explosions**
  - Easy to knock over a kerosene lamp or stove, causing fires.
  - Small amounts of gasoline mixed in increase chances of fire and explosion.
Lighting in African countries

- Electricity supply is either unavailable or too expensive in rural areas of most African countries.

- Most rural people use kerosene or candles for lighting.

- In Kenya, mostly kerosene, subsidized by the government, is used.

- A number of NGOs are working to supply solar lamps to households in African countries.
Possible benefits of replacing kerosene lamps with solar lamps in Kenya

- Economic
  - Savings from not buying kerosene
  - Better and longer light for children to study
  - Better light for working in evenings
  - No soot--cleaner

- Health
  - Less eye irritation
  - Fewer respiratory problems
  - Fewer poisonings and burns.
The Kenya exposure study

- **Purpose**: to obtain data on PM$_{2.5}$ and CO exposures sufficient to design an epidemiologic trial of replacing kerosene lamps with solar.

- **Design**: Recruit 20 families with students in forms 3 or 4 at a Busia high school.

- Measure baseline PM$_{2.5}$ and CO exposures of the student and one adult in each household.

- Re-measure PM$_{2.5}$ and CO exposures of same participants 3-4 weeks after provision of 3 solar lamps per family.
Participating family selection criteria

- Head of household at least 18 yrs old.
- No electricity supply to home.
- Use kerosene lamps as primary lighting source.
- At least one non-smoking adult kerosene lamp user in the house.
- Separate kitchen building from main house.
Main study components

- Kerosene lamp use monitoring (SUMs)
- Solar lamp use monitoring (voltage loggers)
- Area monitoring for PM$_{2.5}$ and CO
- Personal monitoring for PM$_{2.5}$ and CO of school pupil and one adult per household.
- Symptom questions (eye and respiratory)
SUMS attachment
Examples of use patterns for kerosene lamps, as shown by attached SUMs
SunKing Eco lamps and use monitors
Daily solar lamp use patterns, across all households.
Mean hours of daily solar lamp use, across all lamps.
Change in lamp use patterns after solar lamp provision.
Personal monitoring vest

CO Monitor

Tube Inlet

PM Monitor
Baseline and follow-up MicroPEM PM$_{2.5}$ data for one participant.
Mean 48-hr baseline and follow-up MicroPEM PM$_{2.5}$ data for parent/guardian participants.
Mean 48-hr baseline and follow-up MicroPEM PM$_{2.5}$ data for school pupil participants.
### Personal exposures to PM$_{2.5}$ (µg/m$^3$) of adults and school pupils at baseline and follow-up.

<table>
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<tr>
<th></th>
<th>N</th>
<th>Mean (SD)</th>
<th>Median</th>
<th>Min</th>
<th>Max</th>
<th>95% CI</th>
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<td>193</td>
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<tr>
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<td>132 (99)</td>
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<td>Follow-Up</td>
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<td>10</td>
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Comparing with integrated exposure-response functions.
Kenya study conclusions

- Kerosene lamps are associated with substantial PM$_{2.5}$ exposures, averaging around 100 µg/m$^3$ across 24 hours.
- Solar lamps are acceptable to families and largely (~95%) displace kerosene lamp use.
- PM$_{2.5}$ exposure reductions after provision of solar lamps are potentially sufficient for observable health benefits.
- A randomized trial to demonstrate long-term health benefits of replacing kerosene lamps with solar lamps is needed.
Co-investigators

- Nick Lam (U. Illinois)
- Godfrey Muhwezi (CIRCODU, Kampala)
- Fred Isibye (CIRCODU)
- Kat Harrison (SolarAid, London)
- Evans Amukoye (KEMRI)
- Tom Mokaya (KEMRI)
- Margaret Wambua (KEMRI)
- Ilse Ruiz-Mercado (UNAM, Mexico)
- Ian Bailey (UCB Optometry School)
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