Characterizing Exposures and Cookstove Emissions Using RTI's MicroPEM™ Sensor



RTI International has demonstrated that its MicroPEM sensor for measuring exposure to aerosols is well-suited to characterizing the exposures from indoor air pollution caused by biomass cookstoves. Armed with the advanced capabilities of this sensor, epidemiologists and health professionals can plan and implement a logical series of interventional studies to begin to clarify "how clean is clean" and set realistic emissions targets for improved cookstove designs.

Linking Exposures to Adverse Health Outcomes

For decades, studies of health risks from biomass cookstoves have been limited by excessive uncertainty levels in characterizations of acute and chronic aerosol exposures from the toxic components of smoke from the stoves. Because technologies that directly measure sized aerosols are expensive and complex, surrogate metrics are often applied to estimate the true exposures. While this approach provides reasonable estimates of the mean exposures, those who were most—and least—exposed have been poorly assessed. As a result,

- Dose-response relationships for specific diseases are still poorly defined, for key diseases such as acute lower respiratory infections.
- The strengths of interventions needed to improve cookstoves are difficult to assess.

RTI's MicroPEM sensor will, for the first time, allow health studies to define both acute and chronic exposure patterns for sized aerosols at both indoor and personal levels. Because it accurately measures both the highest and lowest exposures, the MicroPEM sensor can accurately measure the entire dose range. That sensitivity will help accurately determine the extent to which improved stoves must reduce toxic emissions, as compared with a three-stone fire.

Simple, Reliable Device to Facilitate Interventional Studies

The MicroPEM sensor is easy to deploy and use and it produces reliable and robust data. Features include

- Lightweight (<240g) and only slightly larger than a smartphone
- Can operate for at least 40 hours on three AA batteries.
- User-friendly setup and data downloading with simple controls
- On-board collection and quality control of data
- An integrated filter collection to enable conformational post-analyses and identification of potential confounding data from sources such as tobacco smoke.

Armed with these enhanced capabilities, epidemiologists and health professionals can plan and implement a robust and logical series of interventional health studies.

Enabling Indoor and Personal Monitoring

The MicroPEM sensor can collect real-time data identifying exposure levels and patterns experienced by people cooking as either an indoor or low-burden personal monitor.

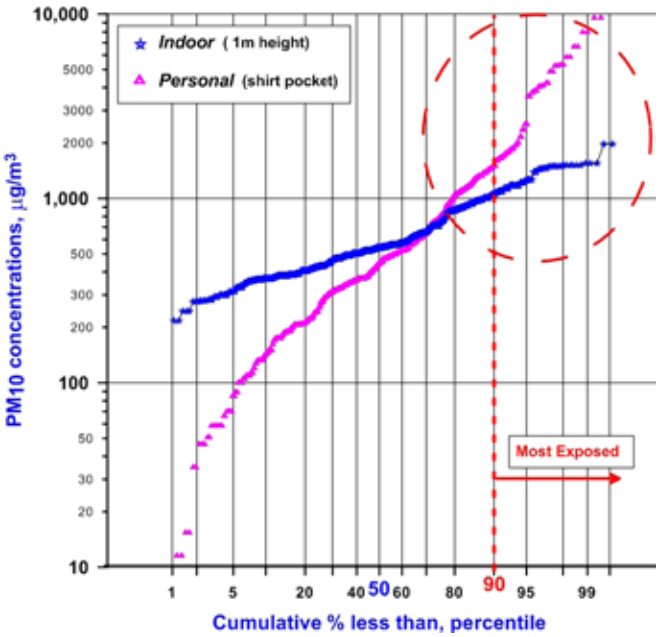
Exposures during brief high-intensity emission episodes account for 31–61% of the total exposure of household members who take part in cooking and 0–11% for those who do not.

Ezzati M, Saleh H, Kammen DM. 2000. The contributions of emissions and spatial microenvironments to exposure to indoor air pollution from biomass combustion in Kenya. *Environmental Health Perspectives* 108:833–839.

As noted by Ezzati et al., 2000, and confirmed by RTI data, brief but high concentration exposures are often apparent in the personal breathing zone, but not captured by indoor monitoring. Similarly, lower concentration exposures experienced away from cooking areas are not captured by simplistic indoor characterizations.

Applying the MicroPEM to cookstove studies should greatly minimize this misclassification bias in defining exposure patterns and enable the people most exposed to be identified with minimal uncertainty.

This graph shows the value added to simplistic indoor monitoring of the cooking process by a viable personal-level approach.



Personal exposures of a cook during 2-hour meal preparation compared with fixed indoor monitor using oak sticks in unmodified Jiko stove.

Facilitating Potential Dose Monitoring

A sensitive triaxial accelerometer in the MicroPEM sensor enables researchers to determine when the monitor was worn in the personal mode. Equally important, the accelerometric data can also reliably estimate ventilation rates for adults in liters per minute.

This advance allows, for the first time, simplistic concentration data to also be reported as potential dose. Thus, the impact of periods of high exposure concentrations and elevated breathing rates can be linked with target health outcomes. This should significantly strengthen the understanding of dose-response relationships and enable researchers to more accurately identify the people most exposed and quantify their exposures.

Advancing the State of the Art

The MicroPEM sensor is directly applicable to a wide range of challenges, including adaptation to interventional health studies in the developing world.

Testing of the MicroPEM sensor to date has been conducted in both controlled and in-country settings. These trials have been extremely useful in defining ruggedness and data, such as biomass smoke concentration calibrations and ranges by fuel and stove types, filter loadings versus pressure drop capabilities, and flowrate stability during high-concentration events.

RTI is seeking research partners to continue validation and reliability testing and to further apply the MicroPEM sensor in studies characterizing a range of exposure settings in-country, with the goal of better defining the MicroPEM sensor's applicability to support large-scale health studies.

More Information

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