Exposure Monitoring of Temascales in San Lorenzo  
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Rationale for Study

The rationale for this study is to assess PM and CO exposures among persons who use temascales, a traditional sauna used in the highlands of Guatemala. There have been no prior studies to quantify CO and PM levels, and not much research has been done to assess who is exposed, how frequently and for how long.

Overview of study

- Study conducted August 9-26, 2003  
- A self-administered survey with a set of open and close-ended questions were administered to 11 fieldworkers who are currently working in the Child ARI Intervention Trial in San Lorenzo. Fieldworkers were asked about their personal temascal (chuj in Mam, sauna bath in English)  
- Of the 11 surveyed fieldworkers, 4 participated in exposure monitoring  
- 3 temascales were monitored twice, one temascal was monitored once

General Construction Characteristics of the Temascal

- Materials used:  
  - Adobe/stone walls  
  - Dirt/mud floor partially covered by wooden platform  
  - Wood beam and mud roof  
  - Fire on wall opposite from door opening  
  - Some structures have a wooden roof suspended over them or plastic sheeting placed directly onto roof to protect temascal from erosion (Figure 1).

- Dimensions:  
  - Average dimensions are 2.3 meters in length, 2 meters in width, and 1.2 meters in height. Door is usually less than a meter.

1 I would like to thank the following people for their assistance: Anaite Diaz for assisting with survey administration; Micaela Isidro Marroquin, Jovita Ramirez, Expedita Ramirez, and Vicente Tema Lopez for allowing us to monitor their temescales; Eduardo Canuz Castro, Freddy Augustin Tomas, John McCracken, Kyra Naumoff, David Kaisel and Rufus Edwards for assisting with the indoor air monitoring; Amod Pokhrel for organizing the needed equipment for the indoor air study; Asheena Khalakdina for assistance with survey design; Kirk Smith for advising on air sampling methodology, and The Brian and Jennifer Maxwell Endowed Chair in Public Health for funding this study.
Temascal Study

- Ventilation:
  - Door opening is covered by blanket when people enter
  - Typically no windows or ventilation holes in structure
  - Out of 11 surveys:
    - 6 characterized the ventilation as “good”
    - 1 characterized the ventilation as “moderate”
    - 2 characterized the ventilation as “poor”
    - 2 didn’t respond

- Age of construction averaged 12.2 years

**Preparation for use of Temascal**

- Fieldworkers were asked to describe the method of *chuj* preparation which confirmed by observation. A few fieldworkers explained the process as follows:
  - “First you get dried logs and the *ocote* (grease wood) or you bring cinders from the stove fire. After you have lit the fire inside the *chuj*, you get the water and put the jugs of water inside the *chuj* so that it heats up for bathing. You wait a while for the fire to heat the rocks and for the smoke to die down. Then when the cinders are left, you can remove them outside. Everyone gets inside and you cover up the door with a blanket so the heat stays inside. You can pour water on the hot rocks and use the *rayan* bush to fan the fire….you need to wait for the smoke to go away otherwise people can get tired and end up with headaches”.

- Fieldworkers stated on the survey that average fire preparation time was 1 ½ hours. During seven observations of temascal use, the average wait time was 2 ¼ hours.

- Fieldworkers were asked in the survey to estimate the time they spent inside the *chuj* bathing. Survey answers averaged 1 hour. During observation, adults and adolescents spent 30-50 minutes in chuj, children spent 10-20 minutes inside on average

**Temascal Use: Practices and Beliefs**

Fieldworkers were asked an open-ended question, “Besides using the temascal for bathing, are there other reasons why the temascal might be of benefit or necessary for you or someone else?”

- Benefits (frequency of response in parentheses):
  - Postpartum recovery (10)
  - Abdominal cramps (6)
  - Arthritis, rheumatism (4)
  - “Cold” illnesses (based on hot/cold belief system) (3)
  - Hygiene (2)
  - C-section scar healing, baby’s growth, muscle cramps, urinary complaints such as nocturia in children (1)

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Fieldworkers were asked an open-ended question, “Is there any other time when temascal use would be contraindicated for you or someone else?”

- Contraindications (frequency of response in parentheses):
  - Injections/vaccines (7)
  - Under medical treatment (6)
  - Alcohol use/ intoxication (3)
  - Headaches, dehydrated children, epilepsy, tooth extraction (1)

**Exposure monitoring of indoor air was conducted as follows:**

- A hole was drilled in the back wall of the temascal opposite the fire at a height of 2 feet. Instrument tubes and wires were drawn through a PVC pipe inserted into the wall. There were two boards with instruments clamped to them, one on the inside and one on the outside of the chuj.
- The location of the sampling boards were roughly located at breathing height if people were sitting inside the temascal, but if they were laying down, as some tended to, this would be above the breathing height by about one foot. The instruments were clearly at the level of the smoke, given the smoky line on the wall inside the chuj (Figure 2)

![Figure 2](image)

- Inside temascal:
  - UCB particle monitor
  - HOBO CO monitor
  - HOBO thermocoupler probe (electronics outside)
  - PM filter attached to a Casella probe (electronics outside)
  - Cyclone (no filter) with tube exiting to personal DataRam (outside)

- Outside temascal (see below):
  - HOBO thermocoupler (temperature gauge)
  - Casella (PM monitor, active sampling for PM$_{2.5}$)
  - Personal DataRam 1200 (PM monitor, active sampling for PM$_{2.5}$), filter attached
o 2 water flasks to collect water condensed in tubes as pass from hot, humid chuj interior to cold outside
o 2 pumps (for active sampling from Casella and pDR lines)
• In addition, breath CO was administered to each chuj user over the age of 9. They were tested before entering the chuj (or before lighting the fire) and again after exiting the chuj.

- In summary, there were 2 PM filters, one inside and one outside. The outside PM filter collected PM after the air was drawn along < 1 meter of tubing and condensation was drawn into the water trap, and after the line went through the pDR. Thus, significant particle loss along the line most likely occurred. On several monitoring sessions, inside filters became wet as water dripped onto them from the cyclone/probe. The filters have not yet been weighed; results are pending.
• There were two measures of CO. The exhaled breath CO was a personal exposure measure. The stationary HOBO CO was also used to quantify exposures. The HOBO CO was set to run before the fire started, so we are able to quantify the CO during the fire phase and the CO when people were actually inside. Several of the HOBO CO monitors turned off due to equipment failure (static electricity), one turned off due to temperatures in excess of 126 Celsius. The CO levels often exceeded the instrument measurement capacity (above 2000 ppm).
• The temperature probe never failed, probably because electronics were outside.
• There were three measurements of continuous PM: the UCB particle monitor, the Casella monitor and the pDR monitor. Each has its advantages and limitations listed below:
  o UCB monitor:
    • Temperatures and humidity caused implausible, wild variations in measurement. Temperature readings from HOBO thermopoupler can be “pasted in” but humidity was not measured except by UCB. As such, I have not been able to construct an algorithm that will make sense of the output from this device.
  o Casella:
    • This collected real time particulate matter by forward light scattering technique using an infra red source. The advantage to this method was that the probe was inside the temascal, thus preventing particle loss in the line. The disadvantage may be that the concentrations (mg/m3) were at times overestimated; that is, as the people inside the chuj poured water on the rocks and fanned the rocks with the rayan branches, the water vapor in the chuj may have caused particle expansion, thus falsely elevating the actual measurements.
  o pDR:
    • Particle loss in the tubing was definitely an issue, as can be demonstrated by the overlapping graph of the two continuous PM measurements using the Casella and the pDR simultaneously.

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Findings:

- **Breath CO results:**
  - Compare our findings to following typical values:
    - Non smoker (0-5 ppm)
    - Light smoker (6-10 ppm)
    - Heavy smoker (11-72)
    - Suspected poisoning (< 72 ppm)

  Table 1. Exhaled CO Breath (ppm):

<table>
<thead>
<tr>
<th>CO breath (ppm)</th>
<th>Before (7 chuj) n=23</th>
<th>After (7 chuj) n=28</th>
<th>Before (5 chuj)* n=16</th>
<th>After (7 chuj)* n=28</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average (SD)</td>
<td>4.05 (2.35)</td>
<td>67.48 (52.82)</td>
<td>3.63 (2.31)</td>
<td>36.95 (17.19)</td>
</tr>
<tr>
<td>Maximum</td>
<td>11</td>
<td>222</td>
<td>11</td>
<td>75</td>
</tr>
<tr>
<td>Minimum</td>
<td>1</td>
<td>10</td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td>Median</td>
<td>3.5</td>
<td>52</td>
<td>3</td>
<td>36</td>
</tr>
</tbody>
</table>

  *2 chuj were removed from analysis, as the users admitted that they entered the chuj before the fire was ready.

  - In addition, we asked several participants to recheck breath CO 1 hour after they exited the temascal and again in the morning to assess decay. Results were:
    - Exit → 123 ppm; 1 hour later → 85 ppm; 10 hours later → 29 ppm
    - Exit → 75 ppm; 1 hours later → 45 ppm; 11 hours later → 15 ppm
    - Exit → 209 ppm; 11 hours later → 34 ppm

- **HOBO CO, stationary monitor results:**
  Presented below is a graph of the four CO tracings that functioned properly. The time scale is hypothetical, but represents time interval when people were inside the *chuj*. Continuous measurements are read every three minutes.

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- **Preliminary results of Particulate Matter** is as follows (have not yet figured out how to resolve the issue of particle loss in line (for pDR) and particle overestimation (in Casella)
Summary of Study

- Directions for future monitoring of temascales:
  - Recommend increasing monitoring to perform exhaled CO on larger sample, and follow more decay curves over 24 hours. This was not possible since many of the fieldworkers did not know how to use the breath monitor.
  - CO passive diffusion tubes (1000 ppm range) could easily be used on participants in study to target a larger sample group.
  - Filters in this study were lost due to condensation/dripping water. Reassess?
  - Set up was difficult, but overall the Casella seemed to perform the best.
  - The airtight chamber was never added to the line, but would be interesting to perform this additional step to estimate particles traveling down the line.
  - More detailed questionnaires about use patterns among women and children would be helpful.

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