Air pollution exposure in two Nairobi informal settlements

Kuboresha Afya Mitaani (KAM) Project

Air Sensors International Conference
Pasadena, May 2022

Michael Johnson, Timothy Abuya, Ricardo Piedrahita, Deborah Sambu, Daniel Mwanga, George Odwe, Charity Ndwiga, Heather Miller, Madeleine Rossanese, Darby Jack, Sathy Rajasekharan
Kuboresha Afya
Mitaani (KAM)
Project Overview
Advancing MNH outcomes in Nairobi’s Informal Settlements

**2x**
maternal mortality ratio in these settlements is twice that of the national average

**53%**
Increase in U5 mortality rate in these informal settlements compared with the national average

**Project Ambitions**

Contribute to better MNCH outcomes for **60,000 of Nairobi’s most vulnerable women and children.**

Improve the understanding of drivers of poor health and test innovative solutions that will **catalyze political interest.**

Show how approaches to tackling complex urban health challenges can be **replicable across other urban health environments.**
The KAM Quality Ecosystem

KAM is built around a ‘Quality Ecosystem’, which integrates typically siloed actors in the quality of care space around MNCH solutions.

All activities are underpinned by research, documentation, and learning.
Using evidence to understand and address the unique contextual factors affecting mums and babies in urban settings

*Using Implementation Research to... → →*

- Better understand unique, contextual needs of individuals + communities in a fragmented health system
- Develop context-specific, human-centered solutions that center the voices of mothers, and those that support them
- Generate evidence to catalyse government interest in the adoption, implementation, & scale up of the interventions
- Establish a participatory forum of multiple stakeholders to own these interventions, and ensure future sustainability
Objectives

Supporting KAM project to better understand air quality exposures for the target population:

- Characterize environments that contribute to fine particulate matter (PM$_{2.5}$) exposure for mothers and infants.
- Determine the factors associated with increased exposure to PM2.5 and prospects for mitigating that exposure through interventions.

Very little personal exposure data for residents of informal settlements
Methods: Approach

PM2.5 personal exposure: PurpleAir monitors along with GPS loggers for 24 hours
Ambient PM2.5: Purple Air’s in the two sub-counties
PA’s corrected via co-location with BAM at University of Nairobi (thank you AfriQAir!*)
Behavioral and housing characteristic survey

*James G. Gatari, Dan Westervelt, R Subramanian, Mike Giordano

Target of 100 participants: New and expecting mothers
Subsample of KAM project study group
Sampled from two subcounty areas: Dagoretti (in Kawangware) and Starehe (in Mathare)
Sampling occurred from February 22, 2021, to March 26, 2021

Methods: Instrumentation

GPS logger
Purple Air PM2.5 monitor
Instrument insert/backpack
Results: Sample overview

Sampling cut short by COVID-19 restrictions (78 homes reached) ~90% data completeness

<table>
<thead>
<tr>
<th>STUDY SUBCOUNTY</th>
<th>AIR MONITORING SAMPLES</th>
<th>GPS SAMPLES</th>
<th>PRE-SAMPLING SURVEY</th>
<th>POST-SAMPLING SURVEY</th>
</tr>
</thead>
<tbody>
<tr>
<td>STAREHE</td>
<td>47</td>
<td>47</td>
<td>48</td>
<td>48</td>
</tr>
<tr>
<td>DAGORETTI</td>
<td>29</td>
<td>30</td>
<td>30</td>
<td>29</td>
</tr>
<tr>
<td>TOTAL</td>
<td>76</td>
<td>77</td>
<td>78</td>
<td>77</td>
</tr>
<tr>
<td>DATA CLEANED FOR COMPLETENESS AND QUALITY</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TOTAL SAMPLES</td>
<td>71</td>
<td>71</td>
<td>71</td>
<td>71</td>
</tr>
</tbody>
</table>
### Results: 24-hour Personal Exposure and Ambient PM2.5

<table>
<thead>
<tr>
<th>Sample type</th>
<th>Sub-county</th>
<th>N (days)</th>
<th>N greater than 35 µg/m³</th>
<th>Min pm (µg/m³)</th>
<th>Median pm (µg/m³)</th>
<th>Mean pm (µg/m³)</th>
<th>Max pm (µg/m³)</th>
<th>SD pm (µg/m³)</th>
<th>Mean home pm (µg/m³)</th>
<th>Mean away pm (µg/m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ambient</td>
<td>Dagoretti</td>
<td>16</td>
<td>2</td>
<td>27.2</td>
<td>27.2</td>
<td>28.5</td>
<td>40.3</td>
<td>5.0</td>
<td>NaN</td>
<td>NaN</td>
</tr>
<tr>
<td>ambient</td>
<td>Starehe</td>
<td>13</td>
<td>9</td>
<td>25.5</td>
<td>35.8</td>
<td>35.3</td>
<td>42.9</td>
<td>4.9</td>
<td>NaN</td>
<td>NaN</td>
</tr>
<tr>
<td>personal</td>
<td>Dagoretti</td>
<td>29</td>
<td>15</td>
<td>20.0</td>
<td>36.0</td>
<td>43.9</td>
<td>97.7</td>
<td>22.1</td>
<td>43.1</td>
<td>35.5</td>
</tr>
<tr>
<td>personal</td>
<td>Starehe</td>
<td>46</td>
<td>28</td>
<td>20.1</td>
<td>37.2</td>
<td>44.5</td>
<td>171.8</td>
<td>25.0</td>
<td>46.1</td>
<td>32.3</td>
</tr>
</tbody>
</table>
Results: Diurnal patterns

[Graph showing diurnal patterns of PM$_{2.5}$ concentrations with WHO guidelines and interim targets for Dagoretti and Starehe.]
Results: temporal contributions

Fraction of samples by exposure category, by hour

- Exposure < 10 μg/m³
- 10 μg/m³ ≤ Exposure < 35 μg/m³
- Exposure > 35 μg/m³
- Exposure > 100 μg/m³
Results: Exposure and time-location
Results: Exposure and activities
Results: Exposure and Transportation
Spatial hotspots?
Dagoretti
Starehe
Key takeaways

Results:

PM$_{2.5}$ exposures exceeded the WHO annual interim target 1 of 35 µg/m$^3$ in 57% of samples.

Other exposure studies in Nairobi have reported exposure estimates at ~20-40 µg/m$^3$.

Wood and charcoal use associated with higher exposures (potential for intervention).

Higher exposures occurred during evening periods – elevated above ambient.

Ambient pollution likely the largest contributor to exposure.

Approach:

Successful deployment of PA’s as personal monitors (relatively little data loss).

Backpack inserts made instrument management and deployment straightforward and mitigated COVID-19 risks.

Network of reference and low-cost monitors provided simple way to adjust instrument response for personal exposures.
Thanks!