Exploring the Spatial Variation Characteristics and Influencing Factors of PM$_{2.5}$ Pollution in Nairobi City, Kenya: A preliminary Analysis

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Background

• The existence of AQ monitoring stations in cities would enable the tracking of population exposures and assessment of health effects of AP.

• However, AQ monitoring requires significant human, technical and financial resources.

• In Kenya, reliable continuous AQ monitoring stations and the technical capacities to run such facilities is low.

• To address this gap, the Global Environmental and Occupational Health (GEOHealth) Hub for Eastern Africa is undertaking research and capacity building through funding from the NIH (USA) and IDRC (Canada).
Background

• If exposure to air pollution varies spatially, this may lead to significant inequality in related health risk.

• Since air pollution combines with other aspects of the social and physical environment, a likely scenario would be a disproportional disease burden in less affluent parts of society.

• An anecdotal study suggested that fine particulate matter (PM$_{2.5}$) in Nairobi spatially varied between 10.7 and 98.1 μg/m$^3$ as a mean daytime concentration.

• Comparability of that data with many others is difficult due to use of low-cost sensors with no calibration with a reference monitor.
Aims

• The main purpose of the GEOHealth project involves research, training, and capacity building in human health and air pollution risks by:
  • Measuring and defining temporal and spatial variation in outdoor and indoor levels of PM$_{2.5}$ in eight planning zones in Nairobi City County;
  • Developing and validating exposure assessment models; and
  • Determining the chronic effects of ambient PM$_{2.5}$ on childhood lung function and respiratory symptoms in Nairobi.

• Here we report on how we are systematically establishing the long-term population exposure to PM$_{2.5}$ pollution in eight planning zones of Nairobi.
Methods

• Fine particulate matter
• BAM – gold standard reference monitor
• Nephelometers (E-samplers) – low cost sensors
Why the fine particulate matter (PM$_{2.5}$)? Because of its impacts on human health

- PM$_{2.5}$ concentration is characterized by urbanization, industrialization, burning of wastes and use of biofuels (Balakrishnan et al., 2019; Liu et al., 2019; Morelli et al., 2019).

- A recent findings in Ethiopia show a daily mean PM$_{2.5}$ concentrations of 42.4 µg$^{-3}$ leading to 502 deaths in 2020 (Kumie et al., 2021).
Study site: Nairobi City County
10 E-samplers in 8 planning zones
Setup of the AQ sensors
Some preliminary findings

• How reliable are exposure readings from low-cost sensors?
• What we found from co-locating an e-sampler with the BAM
PM$_{2.5}$ exposure levels in Nairobi
How PM$_{2.5}$ measures from BAM and a co-located E-sampler varied over time
The correlation between PM$_{2.5}$ measures from BAM and nephelometer was low positive ($r^2=0.6376$, $p<0.001$)
This association varied at different time ranges
Distribution of environmental factors from the AQ monitors

- Atmospheric Temperature (degrees Celsius)
- Barometric Pressure (mmHg)
- Relative Humidity (%)
High Positive Correlations of Environmental factors measures
Correction factor?

- PM$_{2.5}$ in BAM = 9.76 + 0.59 µg/m$^3$ in co-located nephelometer
- The nephelometers did not measure RH which from the BAM was the most important environmental factor affecting PM$_{2.5}$ concentrations in Nairobi ($r^2$=-0.32, p<0.001)
Inferences

• Low cost sensors remain the most cost effective way of generating rapid spatial AQ data in Kenya.

• However, they require regular calibration to generate reliable and comparable data.

• Although our study seasonally calibrated the nephelometers using the K-factor, the data generated will require further standardization using the following factor $y = 9.762 + 0.589x$ in order to be comparable with the BAM measurements.
Thank you