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Ultra-High Resolution GPS to Measure Human Mobility in High HIV Prevalence Areas in Rural South Africa

Khai Hoan TRAM[1*], Elphas OKANGO[2], Thulile MATHENJWA[2], Paul MEE[3], Hae-Young KIM[4], Till BÄRNIGHAUSEN[5], Adrian DOBRA[6], Frank TANSER[7]

[1]Department of Medicine, University of Washington, Seattle, WA, USA, [2]Africa Health Research Institute, South Africa, [3]Lincoln International Institute for Rural Health, University of Lincoln, UK, [4]Department of Population Health, NYU Grossman School of Medicine, New York, NY, USA, [5]Heidelberg Institute of Global Health, Medical Faculty, Heidelberg University, Germany, [6]Department of Statistics, University of Washington, Seattle, WA, USA, [7]Centre for Epidemic Response and Innovation (CERI), School of Data Science and Computational Thinking, Stellenbosch University, South Africa

BACKGROUND

- Mobility, including both short-term travel and migration, has been linked to an **increased risk of HIV infection**.
- Ultra-high resolution GPS data collected from study participants offers new insights into the **mobility patterns of a representative sample of young adults** in an HIV hyper-endemic setting

METHODS

- This study involved a random sample of **adults aged 20-30 years** who were consented and tested for HIV in the 2019 Africa Health Research Institute survey.
- Between 6/2021 – 3/2023, participants either received a smartphone with **a customized Ethica mobile app** or installed the app on their own devices.
- **Positional data were recorded** at a frequency of ~1 second (depending on internet connectivity and movement) over a six-month period.
- Data was analyzed to explore **space-time dimensions of mobility** and to quantify time spent in known high HIV prevalence areas.
- In this analysis, the cluster where each individual recorded the most time spent was considered to be their residential cluster.

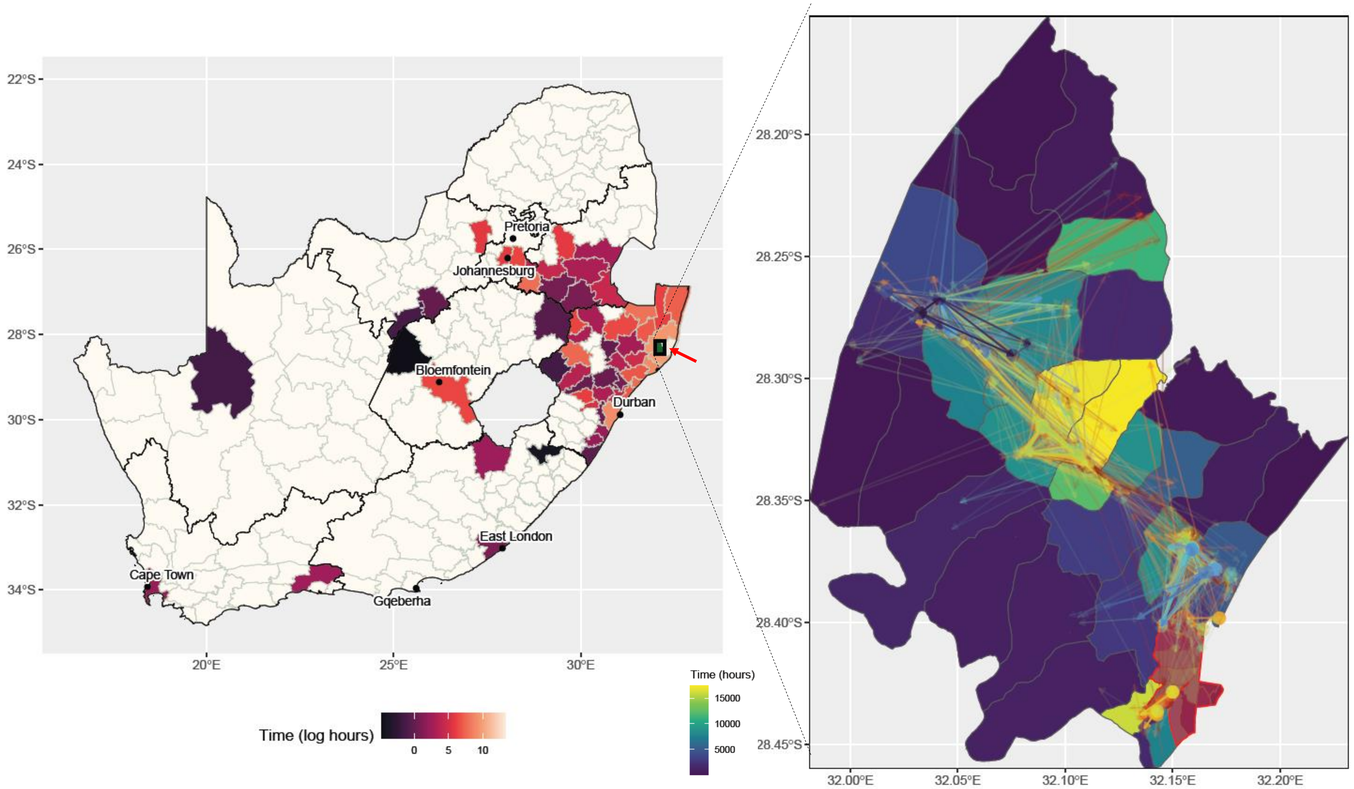

Figure 1. Total time recorded away from residential cluster: across South African municipalities (left) and in the 45 clusters (right). The AHRI study area is indicated by the red arrow. A 3% sample of trajectories (with spatial jittering) illustrates the range of internal mobility. High prevalence HIV clusters are shaded in red.

RESULTS

- In total, **27,151,329 time-stamped location records** were collected for **202 individuals** (median 74,864.5 data points), spatially distributed across 45 clusters within the study area and 57 municipalities across South Africa.
- Participants recorded a median of **129.7 days** (IQR 71.8-161.8) inside the study area versus a median of **17.2 days** (IQR 3.0-48.1) outside the study area. Nearly all (97.0%) made at least one trip outside the study area during this time.

RESULTS (cont.)

- Similar proportions spent greater than 50% of their recorded time outside their own residential cluster:
  - ❖ in other clusters within the study area [**internal mobility**: 13.4%]
  - ❖ outside the study area entirely [**external mobility**: 14.4%].
- Over half (88/157, 56.1%) of those participants who did not reside in a geographical HIV cluster spent time in those areas.

CONCLUSIONS

- Young adults in rural KwaZulu-Natal display **highly dynamic patterns of mobility** both locally and farther afield.
- Over sixty percent of this population either **resided or spent time in clusters** with known high HIV prevalence.
- Determining **typologies of movement** in this age group and quantifying movements in and out of known HIV hotspots can facilitate designing **location-intelligent, real-time precision interventions** for those at high risk of HIV acquisition.

Ultra-high resolution human mobility data from study participants in KwaZulu-Natal demonstrate highly dynamic patterns of movement, both locally and outside the study area.

56.1% of participants not residing in a geographical cluster with high HIV prevalence spent time in those areas.

Author Contact Information

Dr. Khai Hoan Tram - ktram@uw.edu

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