Geographic concentration of new HIV infections in South Africa: leveraging HIV incidence proxies from routine data to guide prevention

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Salome Kuchukhidze[1], Lise Jamieson[2,3], Leigh Johnson[4], Gesine Meyer-Rath[2,3,5], Jeffrey W. Imai-Eaton[1,6]

1. Center for Communicable Disease Dynamics, Department of Epidemiology, Harvard T.H Chan School of Public Health, Boston, USA; 2. Health Economics and Epidemiology Research Office (HE2RO), Department of Internal Medicine, Faculty of Health Sciences, University of the Witwatersrand, Johannesburg, South Africa; 3. South African Centre for Epidemiological Modelling and Analysis (SACEMA), Stellenbosch University, Stellenbosch, South Africa; 4. Centre for Integrated Data and Epidemiological Research, University of Cape Town, Cape Town, South Africa; 5. Department of Global Health, School of Public Health, Boston University, Boston, USA; 6. MRC Centre for Global Infectious Disease Analysis, School of Public Health, Imperial College London, London, United Kingdom

BACKGROUND

- South African government is planning for substantial lenacapavir (LEN) scale-up in 2026, which is nearly 100% effective at preventing HIV acquisition
- LEN will have the greatest impact when delivered to groups with the highest rate of new HIV infections
  - Incidence is not directly measurable at small geographic scales
- Reliable proxies of recent HIV acquisition derived from empirical, routinely available data may inform prioritized HIV prevention in South Africa to maximize impact

OBJECTIVES

1. Use routine service delivery data to identify reliable proxies of relative HIV incidence in South Africa
2. Use these proxies to identify high HIV burden areas and quantify the concentration of new HIV infections

METHODS

Data sources

- Aggregate, monthly counts at health subdistrict (n=242) level (2016-2025):
  - HIV program monitoring and evaluation data on HIV status ascertainment at ANC (DHIS2)
  - Health-facility HIV testing services data (DHIS2)
  - Naomi small-area estimation model

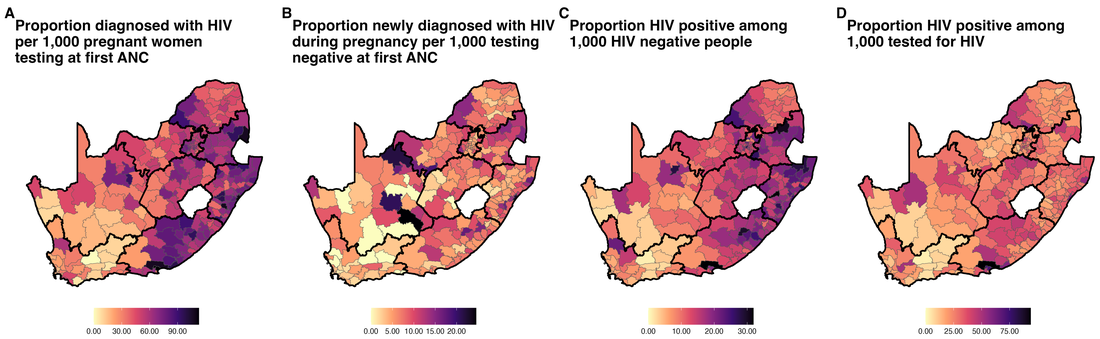
Potential incidence proxies

- HIV positivity at first ANC = $\frac{\text{New HIV diagnoses at ANC1}}{\text{Women tested for HIV at ANC1}}$
- ANC retest diagnoses = $\frac{\text{New HIV diagnoses during HIV retesting}}{\text{Women tested HIV negative at ANC1}}$
- HIV positivity among tested = $\frac{\text{HIV positive tests}}{\text{HIV tests conducted at HTS}}$
- HIV positivity in HIV negative pop. = $\frac{\text{HIV positive tests}}{\text{HIV negative people}}$

Data analysis

- Assessed the consistency and spatio-temporal stability of HIV incidence proxies
  - Variation in subdistrict incidence rankings over time
  - Correlation between incidence proxies and district HIV incidence from Naomi model
- Used most stable proxies to calculate the consensus HIV incidence measure as the average of the proxies
- Quantified the concentration of new HIV infections by constructing Lorenz curves

RESULTS



Median: 55 per 1,000 tested at ANC1

Median: 6.3 per 1,000 testing negative at ANC1

Median: 14.2 per 1,000 HIV negative people

Median: 25.4 per 1,000 tested for HIV

Figure 1. Subdistrict maps of HIV incidence proxies in South African Government Financial Year 2022/2023 (April-March)

- Subdistricts in KZN, Eastern Cape, and Mpumalanga had highest HIV incidence across all proxies (Fig 1)
- **HIV diagnosis proportion during pregnancy** showed the greatest variation (coefficient of variation [CV]=0.61), followed by **HIV positivity among HIV negative people** (CV = 0.42), **HIV positivity among all tested** (CV = 0.41) and **at first ANC** (CV = 0.41)

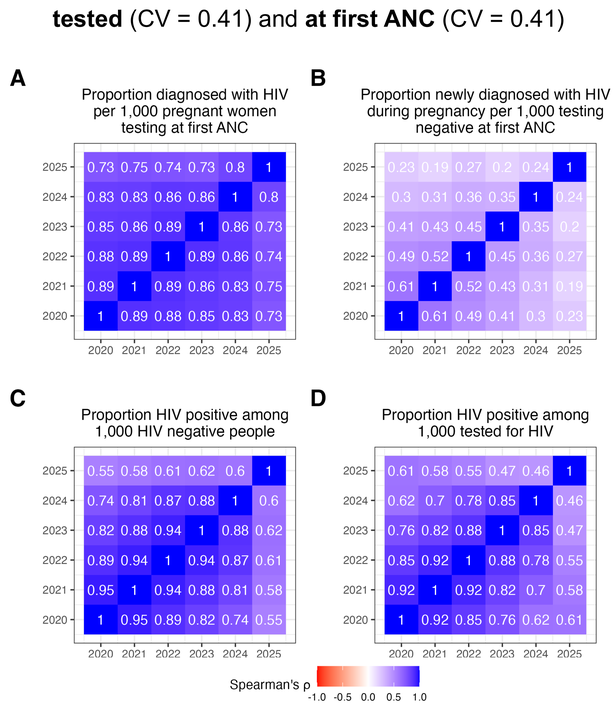


Figure 2. Correlations of subdistrict rankings between adjacent South African Government Financial Years (April-March) for each of the four HIV incidence proxies

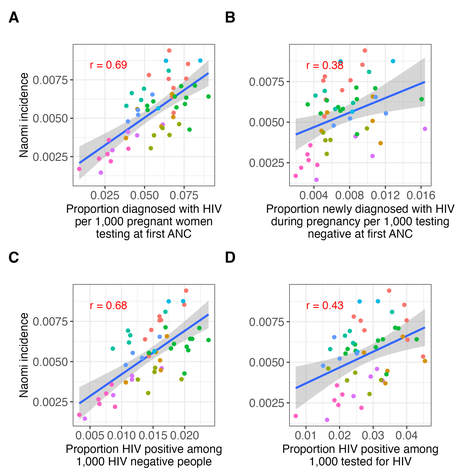
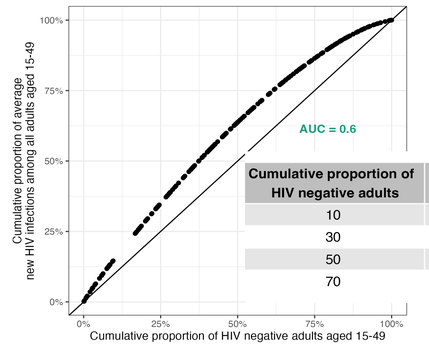


Figure 3. Correlations between each incidence proxy and Naomi district HIV incidence in South African Government Financial Year 22/23 (April-March). Data points represent districts. Colors represent provinces.

- Subdistrict rankings for **HIV positivity at first ANC** in one year were highly correlated with rankings in subsequent years (Fig 2)
- **HIV positivity at first ANC** (Fig 3a) and **HIV positivity in HIV negative people** (Fig 3c) were most correlated with Naomi district incidence



Cumulative proportion of HIV negative adults	Cumulative proportion of new HIV infections
10	15
30	41
50	64
70	83

- **HIV positivity at first ANC** and **HIV positivity among HIV negative** people were used to create the consensus incidence measure
- 15% of infections were in subdistricts with 10% of HIV negative people
- 50% of new infections were in subdistricts with 64% of HIV negative people
- AUC=0.60 → slight departure from equal distribution

CONCLUSION

- Descriptive analyses suggest **HIV positivity at first ANC** and **HIV positivity among HIV negative** people as the most reliable proxies of HIV incidence
  - Subdistricts in KwaZulu-Natal, Eastern Cape, and Mpumalanga had highest incidence rates
- When focused on subdistricts with 30% population, geographic prioritization of LEN could avert around one-third more new infections, compared to uniform geographic allocation

PLAIN LANGUAGE SUMMARY

Targeting HIV prevention in the highest-risk areas would avert more new infections than if the same resources were evenly spread across regions. Routine health data can help identify these priority areas.

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Linganisa

HARVARD T.H. CHAN SCHOOL OF PUBLIC HEALTH

CENTER for COMMUNICABLE DISEASE DYNAMICS

skuchukhidze@hsph.harvard.edu