

Fine-resolution estimates of HIV prevalence in Blantyre, Malawi: a Bayesian modelling analysis of survey, health facility, and household testing data

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BACKGROUND

In countries with generalized HIV epidemics, transmission is increasingly concentrated in cities, and is highly unevenly distributed by age, sex, and neighbourhoods.

Empirical subnational estimates of HIV prevalence are relatively sparse, due to limited sub-district level HIV data. Spatially and demographically resolved estimates of underlying HIV prevalence are important for planning services, and to underpin epidemiological understanding of localised HIV transmission, incidence and burden.

We leveraged HIV prevalence data from multiple sources to develop fine-resolution estimates of people living with HIV (PLHIV) in Blantyre District, Malawi to better focus care, treatment, and prevention services.

METHODS

WHERE: Blantyre District is in the Southern Region of Malawi and has a population of 1,251,484 people (adults and children) based on the 2018 Government of Malawi Census. Blantyre District (Fig 3, panel A) is made up of “Blantyre City” (shown in detail Fig 3, panel B) and “Blantyre Rural” administrative areas. The smallest administrative units are 22 “wards” in Blantyre City and 8 “Traditional Authorities” (TAs) in Blantyre Rural.

DATA SOURCES: In 2019 we conducted a HIV prevalence survey (“SCALE survey”) in 72 geographical clusters within Blantyre City (Fig. 1), covering areas where about 80% of the Blantyre City population reside. In total, 11,646 adults (age 18 and older) participated in HIV testing in the SCALE prevalence survey. We combined the SCALE survey data (many people tested, from geographically restricted areas in Blantyre City) with cluster-level data from two nationwide HIV prevalence surveys (Malawi Demographic Health Survey (MDHS) 2015-16 and Malawi Population Health Impact Assessment (MPHIA) 2015-16. The MDHS and MPHIA surveys had a considerably smaller sample size for Blantyre but included people from the entire district), and with routine HIV testing prevalence at antenatal care (ANC) from health facilities across Blantyre District. We projected changes in age-specific prevalence between MPHIA and MDHS in 2016 to the 2019 (when SCALE survey conducted) using outputs from the Spectrum model. We used population estimates from 2018 Government of Malawi Census disaggregated to 100m x 100m pixels using WorldPop project.

MODEL: We fitted a spatially-explicit Bayesian regression model (using the integrated nested Laplace approximation) to estimate age-, sex-, and location- (100m grid) HIV prevalence and uncertainty. We incorporated terms for age, sex, a “long range” spatial effect, a “short range” spatial effect (in Blantyre City where we had most dense data), distance from nearest secondary road and population density into our predictions, and bias parameters for ANC prevalence and prevalence measured in the SCALE survey; we assumed MPHIA and MDHS household survey prevalence were representative of population prevalence.

OUTPUTS: Spatially and age/sex disaggregated estimates of HIV prevalence in Blantyre, together with probabilistic uncertainty ranges.

CONCLUSIONS

Highly spatially resolved estimates of prevalent HIV, through combining several sources of information, demonstrated stark heterogeneity in HIV burden across Blantyre District and Blantyre City. This will be of high value for planning services, and potentially for focusing HIV testing and prevention interventions, to contribute to ending the AIDS epidemic.

Local HIV prevalence was increased with higher population density and nearer to primary or secondary roadways, though the large majority of the population lived within 2km of the nearest roadway, in which range there was little systematic variation in prevalence.

The age pattern of HIV prevalence in Blantyre reflected a rapidly aging HIV epidemic with highest burden among adults aged 40 years and older.

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Presented at AIDS 2022 – The 24th International AIDS Conference

RESULTS

Fig. 1

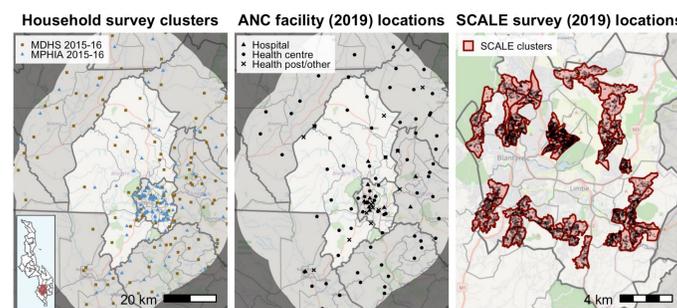


Fig. 2

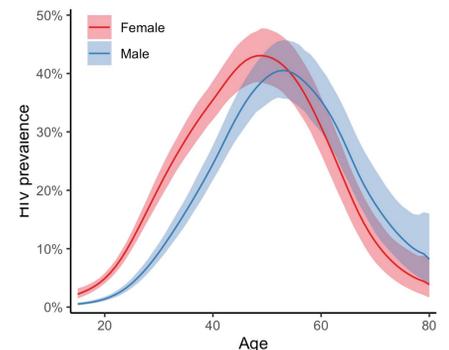


Fig. 3

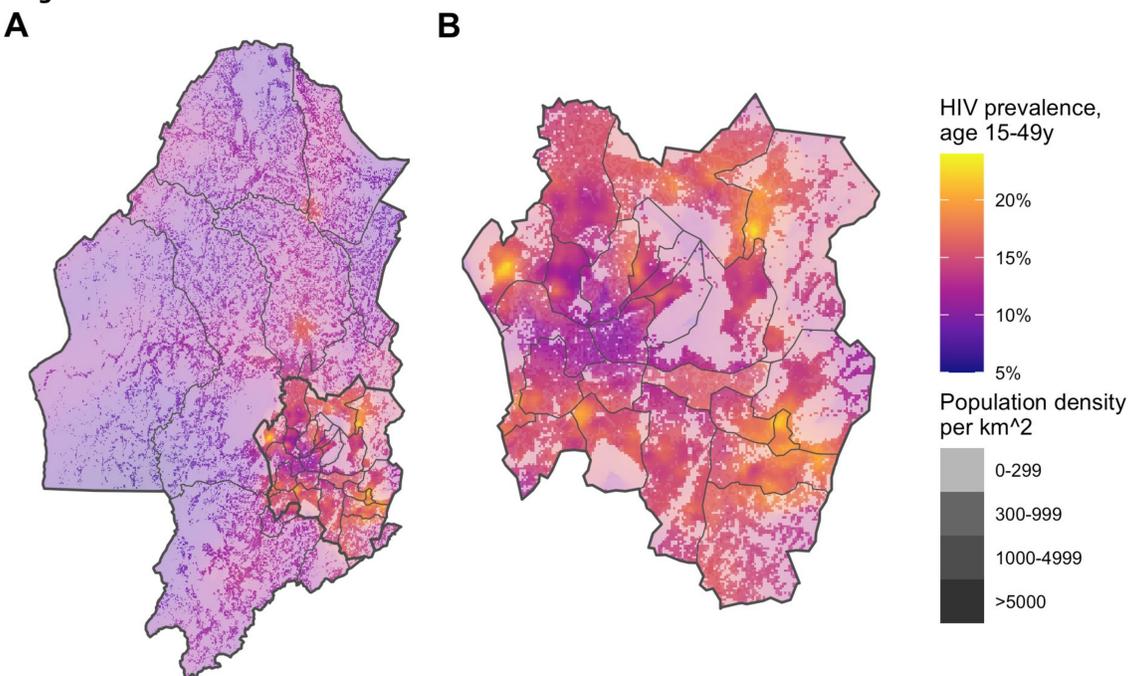


Fig. 4

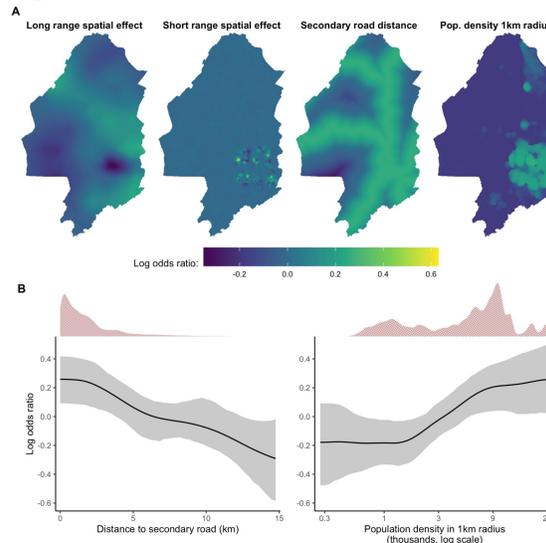


Table 1

	SCALE (2019)		MDHS 2015-16		MPHIA 2015-16	
	N (%)	HIV prev. (SE)	N (wt %)	HIV prev. (SE)	N (wt %)	HIV prev. (SE)
Clusters	72		35		78	
Total N	11646	13.9 (0.5)	584	18.3 (2.2)	3036	18.1 (0.9)
Location						
Blantyre City	11646	13.9 (0.5)	299 (66)	20.8 (2.9)	2664 (72)	17.7 (1.0)
Blantyre Rur.	-	-	285 (34)	13.5 (2.9)	372 (28)	19.0 (1.9)
Sex						
Female	7138 (61)	16.7 (0.6)	330 (56)	21.8 (2.6)	1781 (49)	22.1 (1.0)
Male	4504 (39)	9.6 (0.5)	254 (44)	14.0 (2.3)	1255 (51)	14.1 (1.0)
Age						
15/18-24	4482 (38)	3.6 (0.3)	246 (42)	4.3 (1.6)	1142 (40)	4.6 (0.7)
25-34	3144 (27)	12.5 (0.8)	161 (29)	26.2 (5.0)	879 (28)	20.3 (1.5)
35-49	2597 (22)	28.4 (1.1)	164 (27)	31.2 (4.0)	735 (24)	35.5 (1.8)
50-64	961 (8)	29.1 (1.5)	13 (2)	25.7 (14.0)	280 (9)	25.1 (3.8)
65+	458 (4)	10.0 (1.5)	-	-	-	-
Wealth quint.						
Poorest	2702 (23)	15.9 (0.7)	132 (18)	20.4 (4.5)	249 (16)	20.9 (2.8)
Poorer	2369 (20)	13.9 (0.7)	128 (19)	18.9 (4.0)	513 (19)	22.5 (2.1)
Middle	2349 (20)	14.3 (1.0)	107 (19)	14.6 (4.4)	633 (20)	18.7 (1.8)
Richer	2143 (18)	12.4 (0.9)	106 (22)	18.9 (5.3)	754 (21)	16.3 (1.5)
Richest	2079 (18)	12.6 (0.8)	111 (23)	18.8 (2.9)	887 (25)	13.9 (1.4)
Routine ANC testing						
	N facilities (%)	N clients (%)	HIV prevalence (SE)			
Total	46 (100)	38,636 (100)	11.8 (0.2)			
Blantyre City	26 (57)	25,901 (67)	12.9 (0.2)			
Blantyre Rural	20 (43)	12,735 (33)	9.7 (0.3)			

Fig1: Locations MPHIA/DHS survey clusters, antenatal care facilities, and of households included in SCALE survey.

Fig 2: Overall estimated age- and sex- specific HIV prevalence in Blantyre district (point estimate and 95% credible interval)

Fig 3: Predicted HIV prevalence, population density and ward / TA boundaries for **A:** Blantyre District, **B:** Blantyre City detail.

Fig 4: **A:** Effects of spatial covariates on log-odd ratios of HIV by 100m x 100m grid. **B:** Distribution population of distances to secondary road, and population density, together with log-odds ratio.

Table 1: Descriptive characteristics of HIV prevalence data included in study.

Estimated overall HIV prevalence among adults 15-49 in Blantyre district was 14.0% (95% 12.7–15.3%).

HIV prevalence was highest among men age 53 years (41% prevalence) and women aged 49 years (43% prevalence).

In Blantyre City, adult HIV prevalence varied between 13.1% and 19.3% between wards.