

District overview of travel time to ART facilities: Dowa

Kevin Lam, Jeffrey W. Eaton, Stone Mbiriya, Brown Chiwandira, Tiwonge Chimpanzule, Thokozi Kalua, Rose Nyirenda, Andreas Jahn. *Department of HIV and AIDS, Ministry of Health, Government of Malawi; MRC Centre for Global Infectious Disease Analysis, School of Public Health, Imperial College London*

Version: 05 March 2022; Correspondence to: Andreas Jahn (ajahn@hivmw.org)

Objectives

- Map the estimated prevalence and number of people living with HIV (PLHIV) by approximately 1 km grid cells.
- Estimate the travel time to the nearest ART facility for PLHIV in Malawi.
- Identify optimal locations for additional facilities with ART service to reach PLHIV with long travel times to existing ART facilities (>60, 90, or 120 minutes).

Interactive results are available at: https://mrc-ide.github.io/mwi-hiv/ART_facilities/index.html.

HIV prevalence and PLHIV estimates

Figure 2 illustrates estimates for spatial HIV prevalence for adults aged 15–49 years. Figure 3 shows the estimated number of PLHIV (all ages), and the locations of health facilities with ART services (labelled with A) and without current ART services (labelled with F).

Table 1: Summary estimates for Dowa, September 2020.

Total PLHIV (all ages)	16,722 (14,131–19,249)
HIV prevalence, age 15–49 years	3.0% (2.5%–3.4%)
Total patients receiving ART	29,464
Average walking time to nearest ART (minutes)	50 (49–51)
Number PLHIV > 60 minutes walking time	6,097 (5,243–7,014)
Percentage PLHIV > 60 minutes walking time	37.0% (35.3%–38.5%)

Table 2: Traditional authorities with the lowest and highest estimated number of PLHIV, 15-49 Prevalence, and average walking time, respectively.

	Lowest TA	Largest TA
PLHIV	Dowa Boma: 168 (110–245)	TA Chakhaza: 3,883 (3,018–4,822)
15-49 Prevalence	TA Kayembe: 2.1% (1.5%–2.7%)	TA Mkukula: 3.7% (2.8%–4.7%)
Average Walking Time	Dowa Boma: 5 min (5–5 min)	TA Kayembe: 61 min (59–63 min)

Travel time to existing ART facilities

In Dowa, there are 21 ART facilities that had at least 1 patient in September 2020. The median number of ART patients per facility was 364. The list of *active ART facilities* is in Table 4. Private not-for-profit facilities have been excluded from the analysis. Figure 4 shows the modelled travel times to the nearest active ART facility. The average walking time to the nearest facility for residents in each traditional authority are in (Figure 5).

- The estimated average walking time for PLHIV to the closest ART facility across Dowa is 50 minutes (49-51 min).
- The shortest estimated average walking time to the closest ART facility is in Dowa Boma (5 minutes (5-5 min)).
- The longest estimated average walking time to the closest ART facility is in TA Kayembe (61 minutes (59-63 min)).

An estimated 37.0% (35.3%–38.5%) of PLHIV reside more than 60 minutes walking time to their nearest ART facility, compared to 38.7% of the total population. This decreases to 6.6% (5.9%–7.3%) of PLHIV and 6.9% of the total population residing more than 90 minutes walking time to their nearest ART facility. More details are provided in Table 3.

Table 3: Estimated PLHIV and population not reached at different thresholds

Threshold (minutes)	Population not reached	As % of total population	PLHIV not reached	As % of total estimated PLHIV
45	484,751	59.5%	9,598 (8,313–10,966)	58.2% (56.8%–59.7%)
60	315,007	38.7%	6,097 (5,243–7,014)	37.0% (35.3%–38.5%)
90	56,390	6.9%	1,089 (916–1,279)	6.6% (5.9%–7.3%)
120	2,248	0.3%	58 (43–75)	0.4% (0.3%–0.5%)

Proposed facilities for new ART services

A list of 9 *non-ART facilities* were considered to identify existing health facility locations for expanding ART services, listed in Table 5. Figure 6 shows the number of PLHIV in grid cells where the estimated travel time is longer than 60 minutes and candidate new ART facilities.

- The TA with the largest number of PLHIV residing more than 60 minutes from their closest ART facility is TA Chakhaza (1386 PLHIV (1094-1731) with walking time > 60 minutes).
- The facility that can reach the most PLHIV residing outside 60 minutes travel time is **KAPUTA-LAMBWE**, with 410 PLHIV (276-581) reached.

Limitations

There are several important limitations to this analysis:

- Travel time surfaces and catchments may not optimally reflect typical routine travel or movement patterns, for example for work or other activities.
- Results do not represent uncertainty in the 1km gridded maps of PLHIV arising from uncertainty about the gridded populations.
- There are discrepancies in the gridded HIV prevalence estimates from the Bayesian geostatistical model and the Naomi estimates for some districts which should be further reviewed, especially neighbouring urban and rural districts.
- Geographic locations of some health facilities are discrepant between multiple data sources and need to be confirmed.
- The physical infrastructure and suitability of candidate health facilities for supporting an ART service is unknown.
- Optimisation analysis for locations for new facilities has not considered overcrowding, wait times, or other barriers to access at existing facilities. It could be more optimal to expand services in some geographically dense locations to address barriers to access.

Summary figures and maps

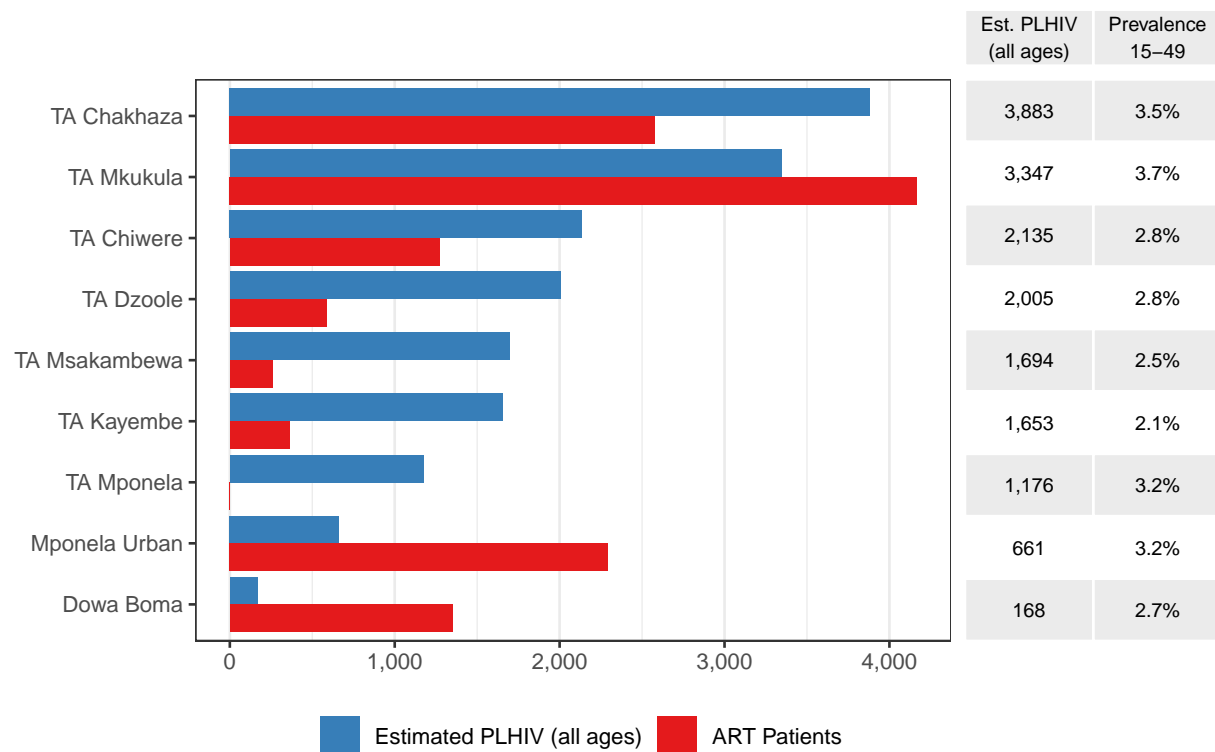


Figure 1: Number registered ART clients within each TA and estimated number of PLHIV within the TA. The right table indicates the estimated 15-49 HIV prevalence.

HIV prevalence in ages 15-49

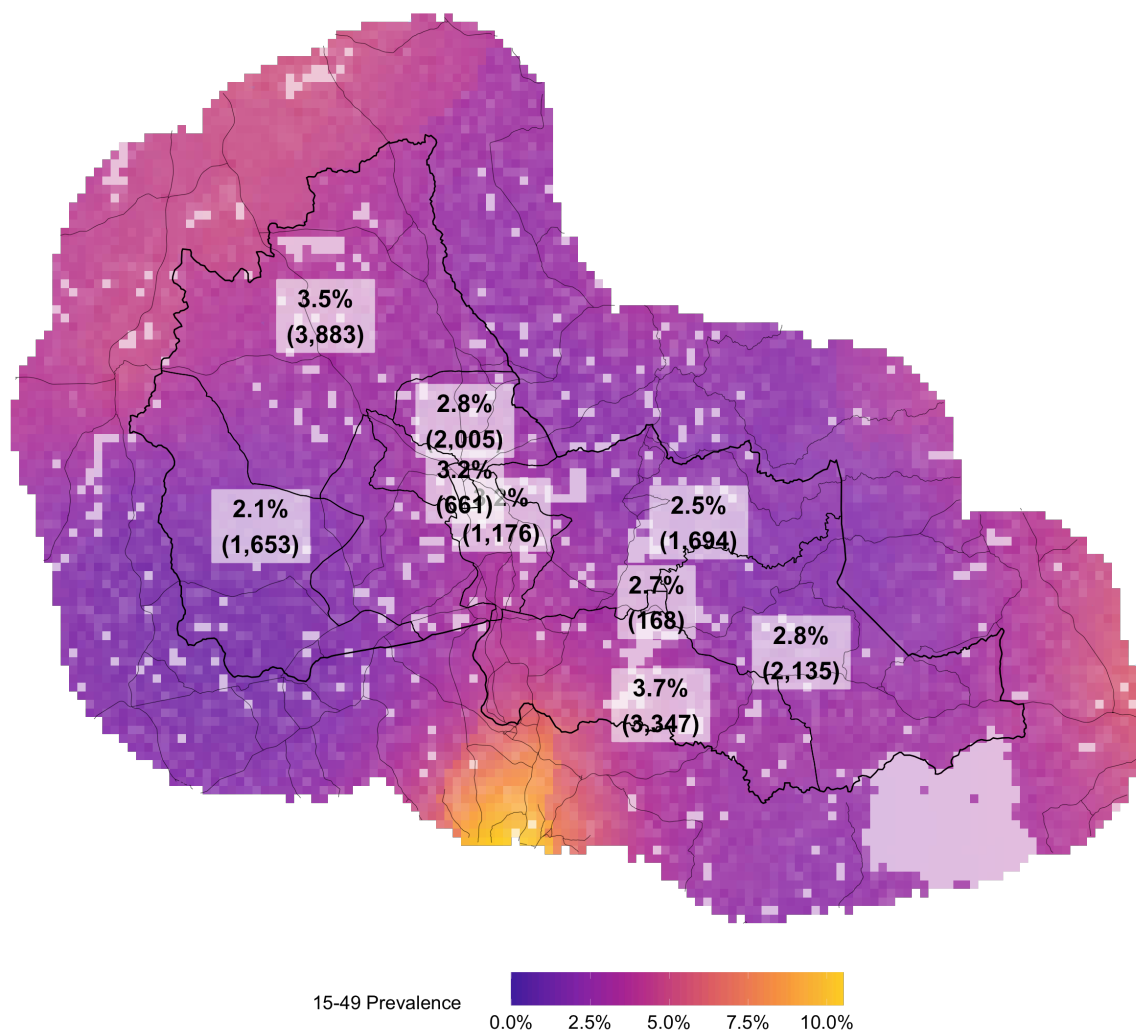


Figure 2: Estimated spatial HIV prevalence. Percentages correspond to TA level 15-49 HIV prevalence and numbers in brackets indicate the estimated number of PLHIV overall.

Estimated number of PLHIV at 1km square

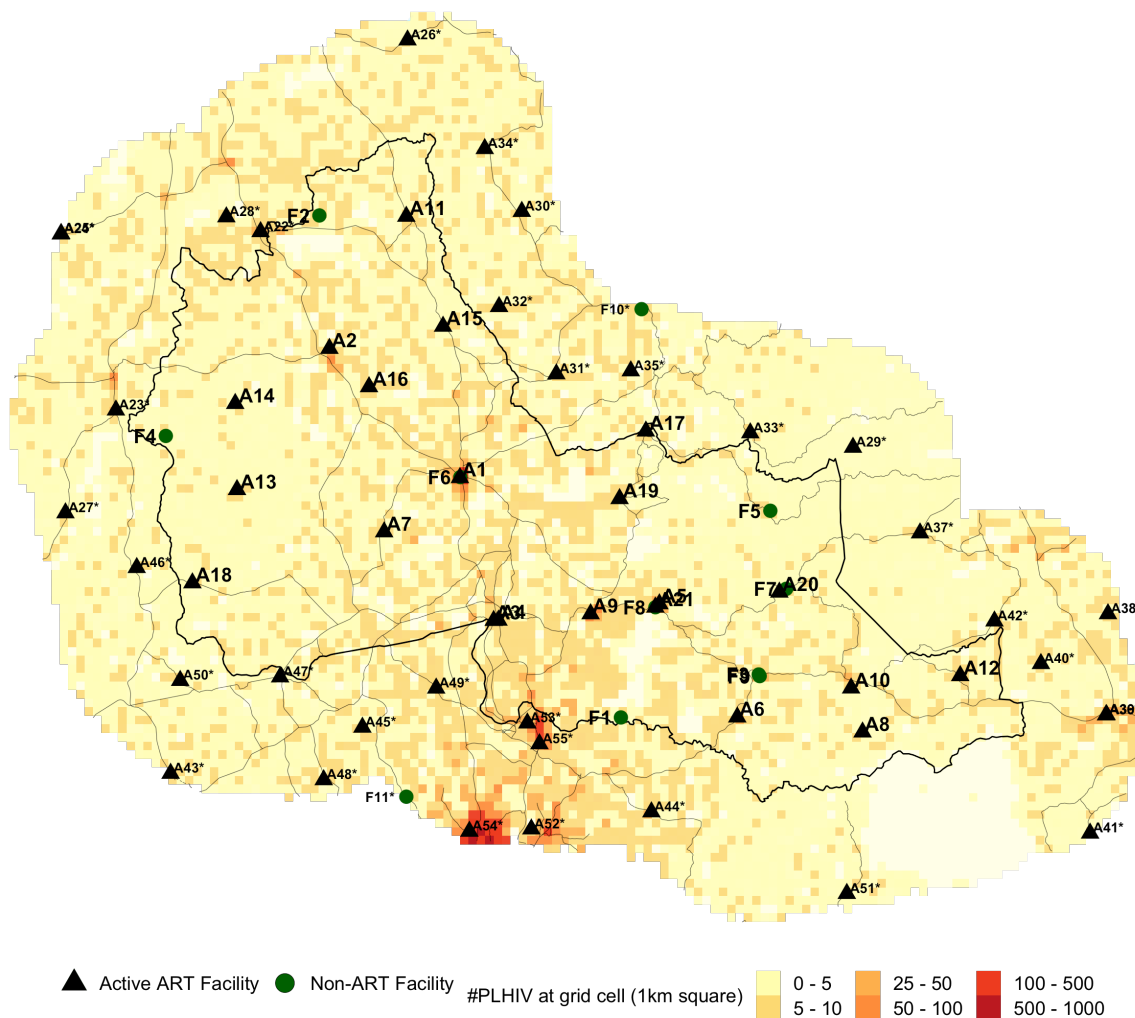


Figure 3: Estimated number of PLHIV on a 1km square.

Table 4: List of active ART facilities that had at least 1 registered ART patient in September 2020. The column "ART" indicates how many ART patients are registered at the ART facility. Facilities outside the district boundaries that may be accessible to residents within the district are marked with "*".

ID	District	TA	Name	Type	Authority	Long.	Lat.	ART
A1	Dowa	Mponela Urban	Mponela Rural Hosp.	Rural/Community	Government	33.74	-13.53	2293
A2	Dowa	TA Chakhaza	Madisi Mission Hosp.	District hospital	CHAM	33.61	-13.41	1620
A3	Dowa	TA Mkukula	Mtengowanthena Community Hosp.	District hospital	CHAM	33.77	-13.67	1547
A4	Dowa	TA Mkukula	Mtengowanthena Dream Project	Special	NGO	33.78	-13.67	1547
A5	Dowa	Dowa Boma	Dowa District Hosp.	District hospital	Government	33.94	-13.66	1331
A6	Dowa	TA Mkukula	Chankhungu HC	Health centre	Government	34.01	-13.77	616
A7	Dowa	TA Dzoole	Dzoole HC	Health centre	Government	33.66	-13.59	585
A8	Dowa	TA Chiwere	Mvera Army Camp	Special	Other	34.14	-13.78	481
A9	Dowa	TA Mkukula	Dzaleka HC	Health centre	Government	33.87	-13.66	457
A10	Dowa	TA Chiwere	Mvera Mission Hosp.	Health centre	CHAM	34.13	-13.74	403
A11	Dowa	TA Chakhaza	Bowe HC	Health centre	Government	33.68	-13.28	364
A12	Dowa	TA Chiwere	Thonje HC	Health centre	Government	34.24	-13.72	288
A13	Dowa	TA Kayembe	Mbingwa HC	Health centre	Government	33.51	-13.54	235
A14	Dowa	TA Chakhaza	Chizolowondo HC	Health centre	Government	33.51	-13.46	205
A15	Dowa	TA Chakhaza	Chinkhwiri HC	Health centre	Government	33.72	-13.39	204
A16	Dowa	TA Chakhaza	Chakhadza HC	Health centre	Government	33.65	-13.44	186
A17	Dowa	TA Msakambewa	Mwangala HC	Health centre	Government	33.92	-13.49	134
A18	Dowa	TA Kayembe	Chisepo HC	Health centre	Government	33.47	-13.63	128
A19	Dowa	TA Msakambewa	Msakambewa HC	Health centre	Government	33.90	-13.55	124
A20	Dowa	TA Chiwere	Nalunga Mafika HC	Health centre	Government	34.06	-13.64	98
A21	Dowa	Dowa Boma	FPAM Clinic Dowa	Health centre	NGO	33.93	-13.66	20
A22*	Kasungu	TA Njombwa	Bua Disp.	Dispensary	Government	33.54	-13.29	937
A23*	Kasungu	TA Santhe	Santhe HC	Health centre	Government	33.39	-13.47	758
A24*	Kasungu	TA Kawamba	Kawamba HC	Health centre	Government	33.34	-13.30	659
A25*	Kasungu	TA Kawamba	Kawinga HC	Health centre	Government	33.34	-13.30	487
A26*	Kasungu	TA Chilowamatambe	Chamwabvi Disp.	Dispensary	Government	33.69	-13.11	323
A27*	Kasungu	TA Santhe	Mkhota Rural Growth HC	Health centre	Government	33.34	-13.57	158
A28*	Kasungu	TA Njombwa	Mziza HC	Health centre	Government	33.50	-13.28	158
A29*	Nkhotakota	TA Mwadzama	Mwansambo HC	Health centre	Government	34.13	-13.50	334
A30*	Ntchisi	TA Malenga	Kansonga HC Ntchisi	Health centre	Government	33.80	-13.27	402
A31*	Ntchisi	TA Kalumo	Khuwi HC	Health centre	Government	33.83	-13.43	288
A32*	Ntchisi	TA Kalumo	Mkhuzi HC	Health centre	Government	33.78	-13.37	148
A33*	Ntchisi	TA Chikho	Mzandu HC	Health centre	Government	34.03	-13.49	130
A34*	Ntchisi	TA Chilooko	Malambo St Theresa HC	Health centre	CHAM	33.76	-13.21	123
A35*	Ntchisi	TA Kalumo	Chinthembwe HC	Health centre	CHAM	33.91	-13.43	23
A36*	Salima	TA Karonga	Khombedza HC	Health centre	Government	34.38	-13.76	1491
A37*	Salima	TA Mwanza	Makiyoni HC	Health centre	Government	34.20	-13.59	377
A38*	Salima	TA Karonga	Chinguluwe HC Salima	Health centre	Government	34.38	-13.66	368
A39*	Salima	TA Karonga	Kaphatenga HC	Health centre	CHAM	34.38	-13.76	309
A40*	Salima	TA Karonga	Katawa HC	Health centre	Government	34.32	-13.71	270
A41*	Salima	TA Kambwiri	Chagunda HC	Health centre	Government	34.37	-13.88	252
A42*	Salima	TA Khombedza	Chitala HC	Health centre	CHAM	34.27	-13.67	215
A43*	Lilongwe	TA Kabudula	Kabudula Rural Hosp.	Rural/Community	Government	33.45	-13.82	1078
A44*	Lilongwe	TA Chimutu	Chiwamba HC	Health centre	Government	33.93	-13.86	602
A45*	Lilongwe	TA Mtema	Ngoni HC	Health centre	Government	33.64	-13.77	310
A46*	Lilongwe	TA Khongoni	Malembo HC Lilongwe	Health centre	Government	33.41	-13.62	308

A47*	Lilongwe	TA Kabudula	Nambuma HC	Health centre	CHAM	33.56	-13.73	278
A48*	Lilongwe	TA Kabudula	Ukwe HC	Health centre	Government	33.60	-13.83	276
A49*	Lilongwe	STA Mbang'ombe	Mbang'ombe 2 HC	Health centre	Government	33.71	-13.74	251
A50*	Lilongwe	TA Kabudula	Chikowa HC Lilongwe	Health centre	Government	33.46	-13.73	235
A51*	Lilongwe	STA Chitekwele	Chimbalanga HC	Health centre	Government	34.12	-13.94	166
A52*	Lilongwe City	Area 27	Daeyang Luke Hosp.	Other hospital	CHAM	33.81	-13.87	2148
A53*	Lilongwe City	Area 53	Lumbadzi HC	Health centre	Government	33.81	-13.77	1392
A54*	Lilongwe City	Area 25	Dzenza HC	Health centre	CHAM	33.75	-13.88	936
A55*	Lilongwe City	Area 53	Blessings Hosp.	Other hospital	Private	33.82	-13.79	408

Table 5: List of non-ART facilities considered in the analysis. The column "PLHIV" indicates the number of PLHIV that currently need more than 60 minutes to walk to the closest ART facility but less than 60 minutes to the listed health facility in the table. Facilities outside the district boundaries that may be accessible to residents within the district are marked with "**".

ID	District	TA	Name	Type	Authority	Long.	Lat.	PLHIV	95% CI
F1	Dowa	TA Mkukula	KAPUTALAMBWE	Health Post	CHAM	33.90	-13.77	410	(276-581)
F2	Dowa	TA Chakhaza	MTAMBALIKA	Health Post	Other	33.60	-13.28	252	(173-366)
F3	Dowa	TA Chiwere	Chezi HC	Health Centre	CHAM	34.04	-13.72	227	(151-322)
F4	Dowa	TA Kayembe	MONDWE	Health Post	Government	33.44	-13.49	185	(128-255)
F5	Dowa	TA Msakambewa	MATEKENYA	Dispensary	Government	34.05	-13.56	177	(121-251)
F6	Dowa	Mponela Urban	BLM Mponela	Special	NGO	33.74	-13.53	79	(58-106)
F7	Dowa	TA Chiwere	Nalunga HC	Health Centre	Government	34.06	-13.64	0	(0-0)
F8	Dowa	Dowa Boma	Family Planning Association of Malawi Dowa	Special	NGO	33.93	-13.66	0	(0-0)
F9	Dowa	TA Mkukula	St. Mary's Rehabilitation Heal	Health Centre	CHAM	34.04	-13.73	227	(151-322)
F10*	Ntchisi	TA Kalumo	Mpherere HC	Health Centre	Government	33.92	-13.37	16	(11-23)
F11*	Lilongwe	TA Mtema	MNGWANGWA	Health Post	Government	33.68	-13.84	442	(315-590)

Travel Times to Closest ART Facilities

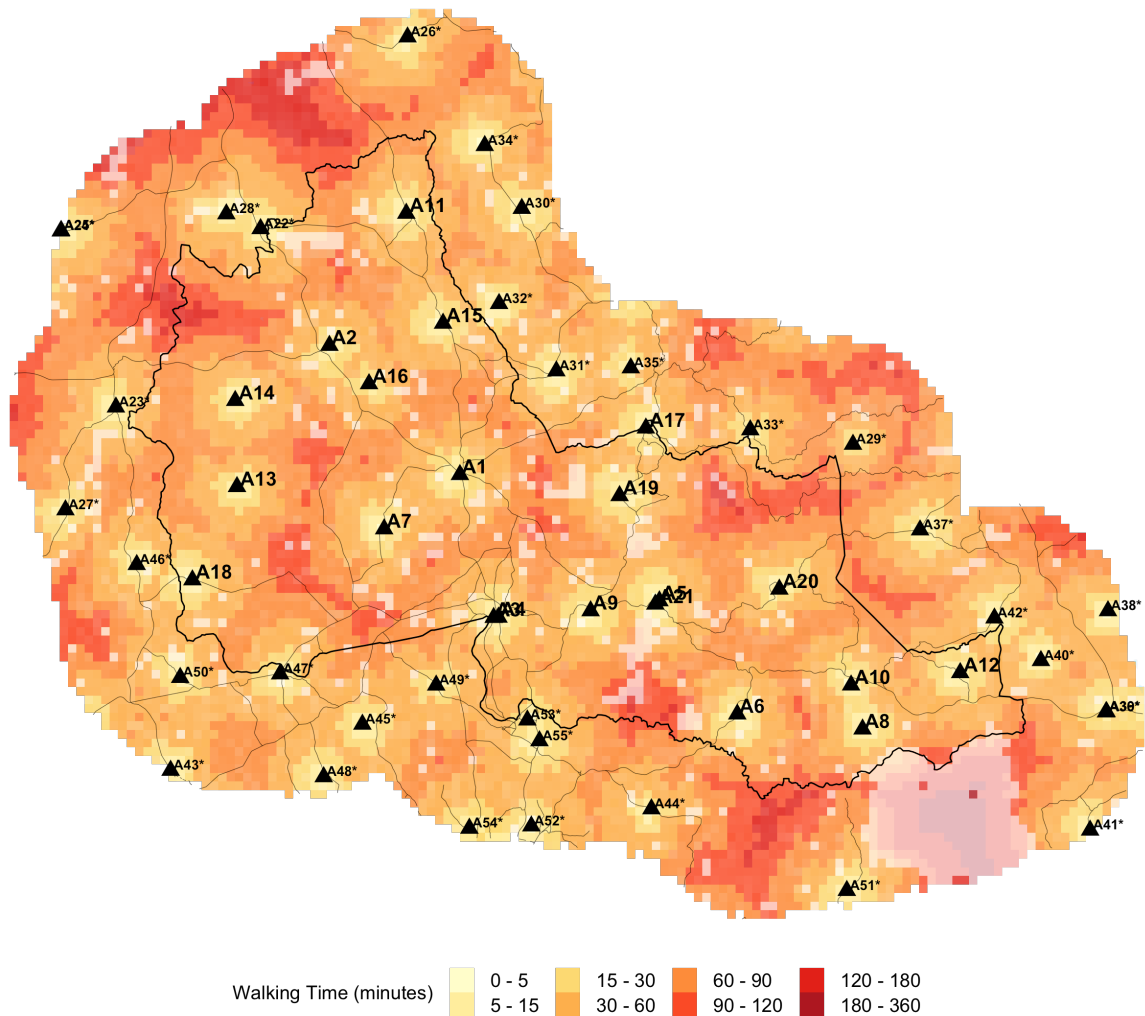


Figure 4: Estimated travel times to the closest ART facility. Travel times were calculated using data on road infrastructure, types of terrain and land elevation.

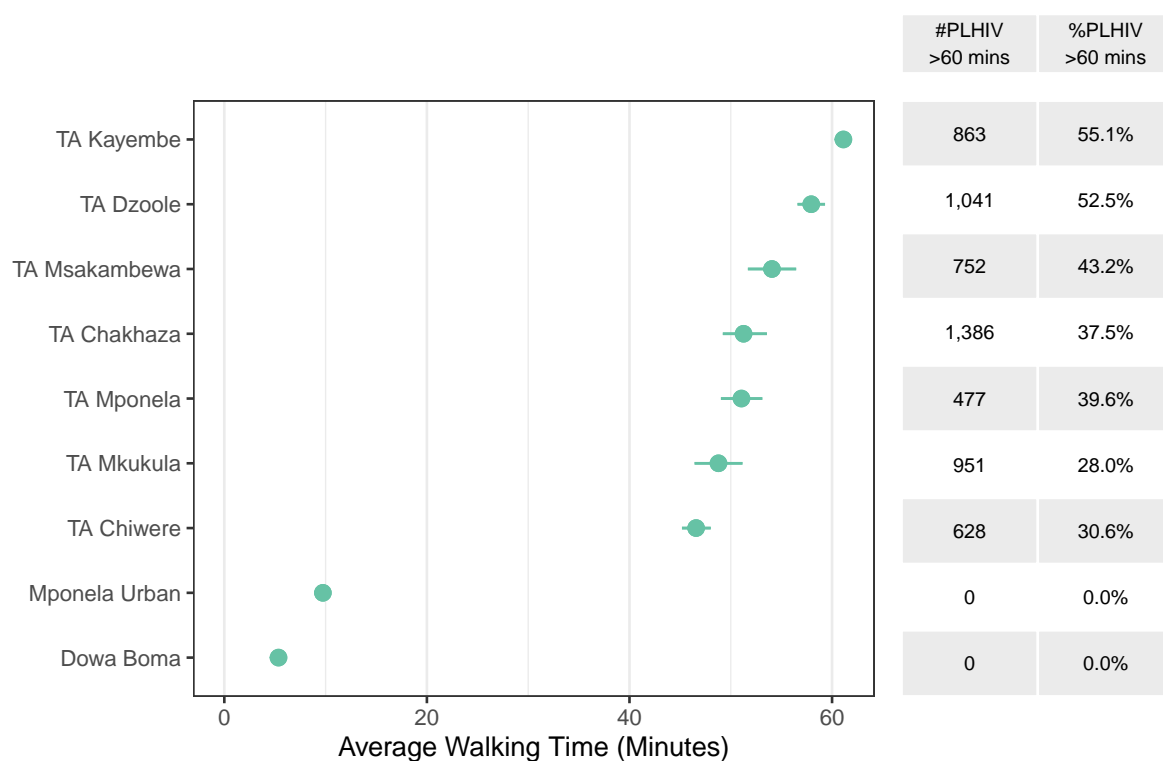


Figure 5: Estimated average walking time to the closest ART facility, weighted by the estimated number of PLHIV within the traditional authority. The right table indicates estimated number and proportion of PLHIV that need more than 60 minutes to travel to the closest ART facility, respectively.

Areas outside 60 minutes travel

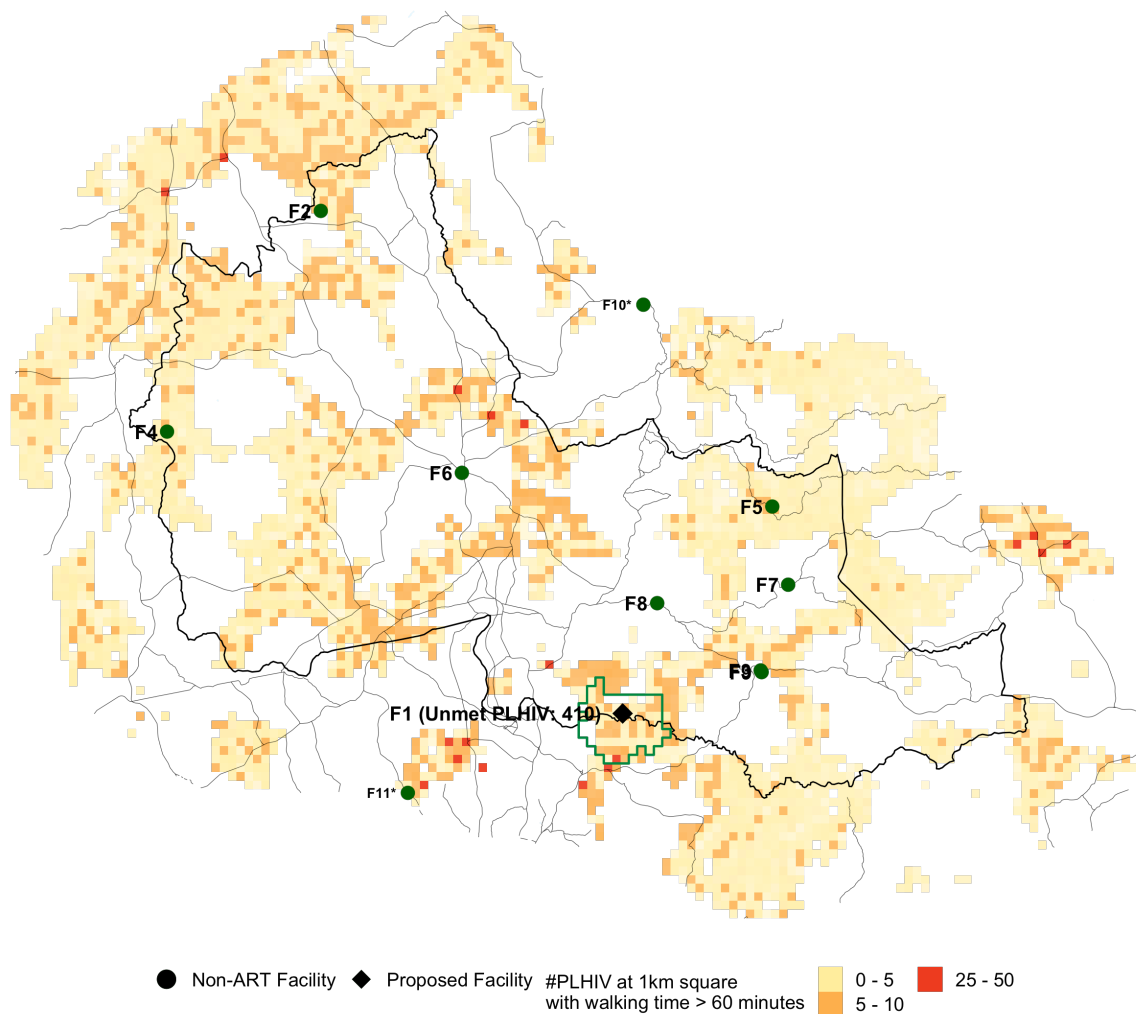


Figure 6: Proposed facility locations. Areas where the walking time to the closest ART facility is <60 minutes have been removed. Green lines indicate the 60-minutes catchment area of the proposed facility.

Appendix (Methods Summary)

The analysis involved several steps:

1. **Creating a map of spatial prevalence by approximately 1km grid cells.** We used cluster-level survey data from the 2015/16 MDHS and MPHIA household surveys and HIV prevalence amongst ANC clients from routine health facility data to obtain a gridded PLHIV prevalence map (1km grid cells).
2. **Calculate the estimated number of PLHIV in each 1km grid cell.**
 - Modelled estimates of total population by 1km grid cell were sourced from the WorldPop project (<https://www.worldpop.org/geodata/summary?id=49698>). Gridded populations are constrained to only grid cells containing built settlements based on satellite imagery.
 - Gridded populations were adjusted to match traditional authority (TA) population data from the 2018 household census, projected forward to 2020 based on district population projections.
 - Gridded HIV prevalence (step 1) was multiplied by population for estimates of the distribution of PLHIV by 1km grid cell.
 - The gridded PLHIV in each district were scaled to align to total PLHIV in each district from the 2020 Naomi model estimates.
3. **Calculate walking travel time for PLHIV to existing ART services.** We used data on land cover terrain type (Global Land Cover 2000), roads (OpenStreetMap), elevation (GMTED2010), and water bodies (NASA Shuttle Radar Topography Mission) to model walking time from each grid cell to 757 public or not-for-profit health facilities providing ART services using the AccessMod software. Walking speed was assumed to be 6-7km/h on roads and 2-3 km/h on non-road surfaces.
4. **Analyse the number and locations of PLHIV residing greater than 60, 90, or 120 minutes walking time from existing ART facilities.** Grid cells were classified by the travel time to the nearest public or not-for-profit ART facility using the travel time model. Maps were filtered for PLHIV residing greater than 60, 90, or 120 minutes, thresholds of interest defined based on discussions with the Department of HIV and AIDS (DHA).
5. **Identify optimal locations to reach the most PLHIV who currently reside greater than 60 or 90 minutes from ART services.** An optimisation algorithm was implemented to systematically select the best facilities and locations where ART service delivery can be introduced to reach the most PLHIV residing outside travel time thresholds.

The list of 757 active facilities currently providing ART services was sourced from DHA-MIS database. Facilities that were private-for-profit were excluded from the analysis of travel time catchments. Health facilities which do not currently provide an ART service, which are candidate locations for expanding ART services, were sourced from facilities visited during the 2018/19 Service Availability and Readiness Assessment (SARA). Candidate facilities included existing health posts which are not staffed full time.