

District overview of travel time to ART facilities: Dedza

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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 Dedza, September 2020.

Total PLHIV (all ages)	21,957 (19,127–25,197)
HIV prevalence, age 15–49 years	3.8% (3.3%–4.3%)
Total patients receiving ART	37,342
Average walking time to nearest ART (minutes)	47 (45–48)
Number PLHIV > 60 minutes walking time	6,515 (5,645–7,437)
Percentage PLHIV > 60 minutes walking time	29.7% (27.8%–31.4%)

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	TA Chauma: 535 (378–734)	TA Kachindamoto: 4,861 (3,749–6,070)
15-49 Prevalence	TA Chilikumwendo: 2.9% (2.2%–3.9%)	TA Kachindamoto: 5.5% (4.2%–6.9%)
Average Walking Time	Dedza Boma: 8 min (8–8 min)	TA Chilikumwendo: 66 min (64–69 min)

Travel time to existing ART facilities

In Dedza, there are 29 ART facilities that had at least 1 patient in September 2020. The median number of ART patients per facility was 371. 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 Dedza is 47 minutes (45-48 min).
- The shortest estimated average walking time to the closest ART facility is in Dedza Boma (8 minutes (8-8 min)).
- The longest estimated average walking time to the closest ART facility is in TA Chilikumwendo (66 minutes (64-69 min)).

An estimated 29.7% (27.8%–31.4%) of PLHIV reside more than 60 minutes walking time to their nearest ART facility, compared to 30.5% of the total population. This decreases to 7.1% (6.3%–7.8%) of PLHIV and 7.3% 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	437,178	50.3%	10,678 (9,307–12,145)	48.7% (46.8%–50.6%)
60	264,923	30.5%	6,515 (5,645–7,437)	29.7% (27.8%–31.4%)
90	63,311	7.3%	1,546 (1,315–1,802)	7.1% (6.3%–7.8%)
120	11,156	1.3%	314 (250–387)	1.4% (1.2%–1.7%)

Proposed facilities for new ART services

A list of 13 *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 Kachindamoto (1577 PLHIV (1213-2001) with walking time > 60 minutes).
- The facility that can reach the most PLHIV residing outside 60 minutes travel time is **Mdeza Disp.**, with 575 PLHIV (388-827) 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

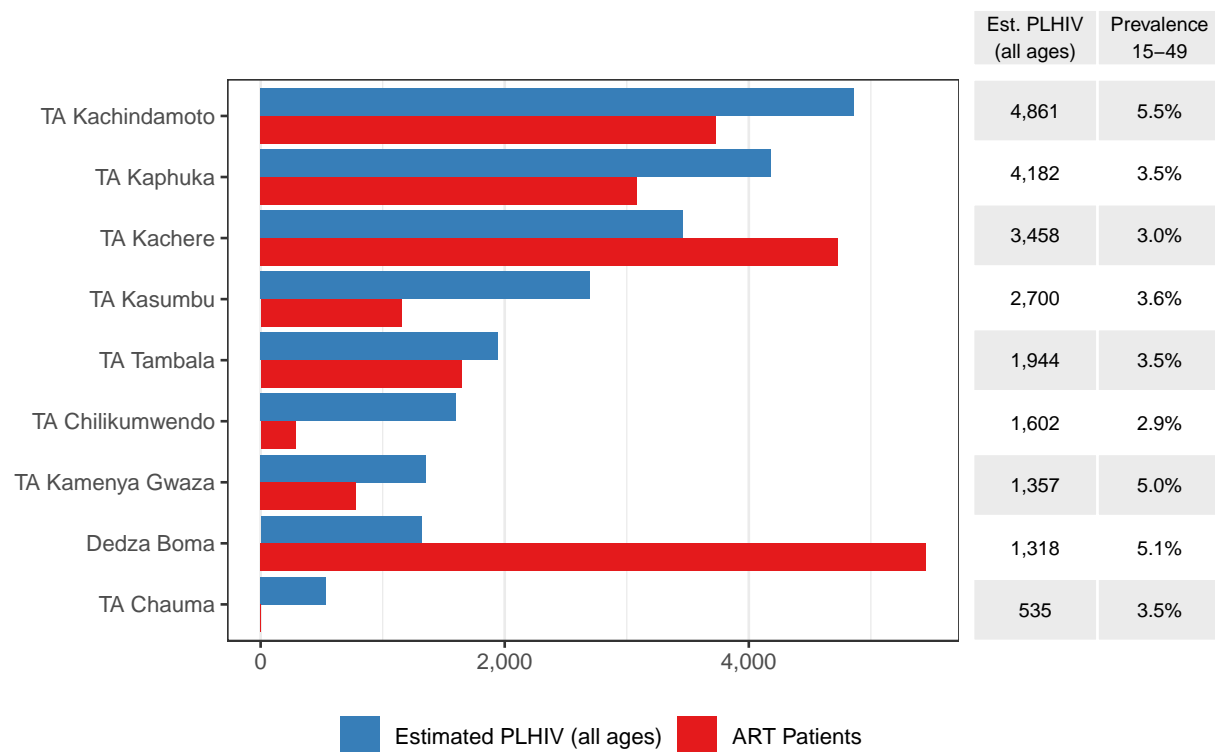


Figure 1: Number registered ART clients within each TA and estimated number of PLHIV within the TA. The right table indicates the estimated 15-49 HIV prevalence.

HIV prevalence in ages 15-49

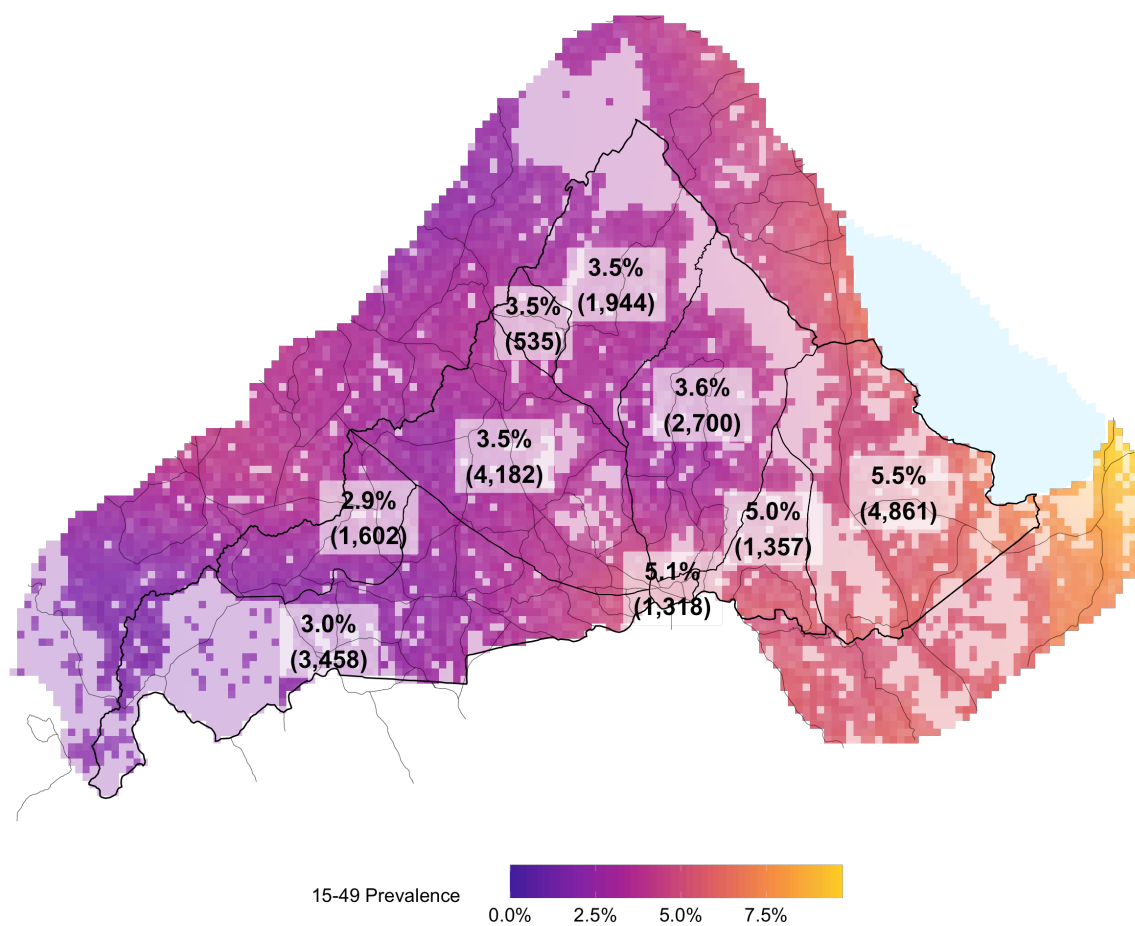


Figure 2: Estimated spatial HIV prevalence. Percentages correspond to TA level 15-49 HIV prevalence and numbers in brackets indicate the estimated number of PLHIV overall.

Estimated number of PLHIV at 1km square

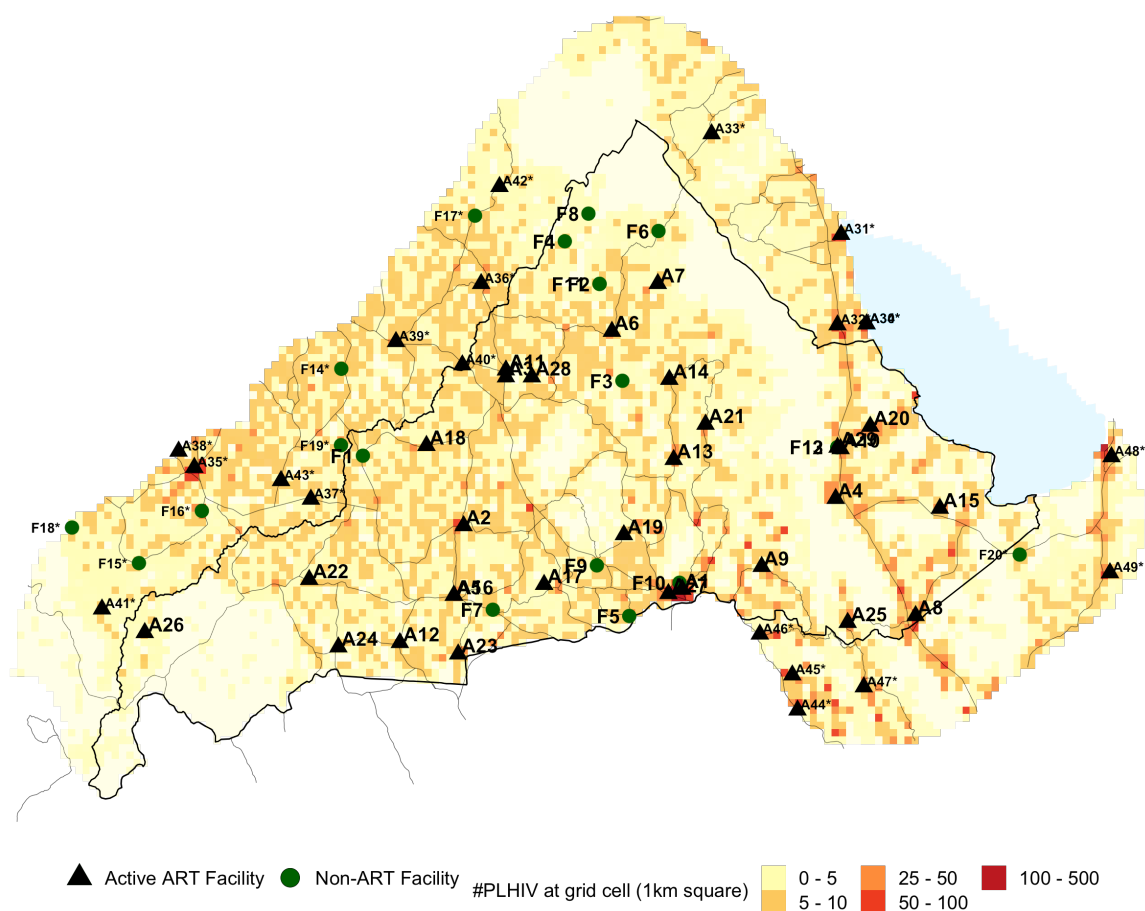


Figure 3: Estimated number of PLHIV on a 1km square.

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	Dedza	Dedza Boma	Dedza District Hosp.	District hospital	Government	34.33	-14.38	5282
A2	Dedza	TA Kachere	Mtendere HC	Health centre	CHAM	34.08	-14.31	1855
A3	Dedza	TA Kaphuka	Kasinje HC	Health centre	Government	34.13	-14.15	1641
A4	Dedza	TA Kachindamoto	Mua Mission Hosp.	District hospital	CHAM	34.51	-14.28	1287
A5	Dedza	TA Kachere	Lobi Rural Hosp.	Health centre	Government	34.07	-14.39	1048
A6	Dedza	TA Tambala	Mayani HC	Health centre	Government	34.25	-14.10	852
A7	Dedza	TA Tambala	Kaphuka HC	Health centre	Government	34.31	-14.04	794
A8	Dedza	TA Kachindamoto	Golomoti HC	Health centre	Government	34.60	-14.41	785
A9	Dedza	TA Kamenya	Bembeke HC	Health centre	CHAM	34.42	-14.36	782
A10	Dedza	Gwaza TA Kachindamoto	Mtakataka HC	Health centre	Government	34.51	-14.23	700
A11	Dedza	TA Kaphuka	Kasina HC	Health centre	CHAM	34.13	-14.14	691
A12	Dedza	TA Kachere	Chimoto HC	Health centre	Government	34.01	-14.44	448
A13	Dedza	TA Kasumbu	Kanyama HC	Health centre	Government	34.32	-14.24	433
A14	Dedza	TA Kasumbu	Chikuse HC	Health centre	Government	34.32	-14.15	432
A15	Dedza	TA Kachindamoto	Kavuzi HC	Health centre	Private	34.63	-14.29	371
A16	Dedza	TA Kachere	Kanyezi HC	Health centre	Government	34.07	-14.39	348
A17	Dedza	TA Kachere	Mphunzi HC	Health centre	Government	34.18	-14.38	330
A18	Dedza	TA Kaphuka	Chitowo HC	Health centre	Government	34.04	-14.22	325
A19	Dedza	TA Kaphuka	Chongoni HC	Health centre	Other	34.27	-14.32	309
A20	Dedza	TA Kachindamoto	Nakalazi HC	Health centre	CHAM	34.55	-14.20	302
A21	Dedza	TA Kasumbu	Dzindevu HC	Health centre	Government	34.36	-14.20	289
A22	Dedza	TA Chilikumwendo	Matumba HC	Health centre	Government	33.91	-14.37	285
A23	Dedza	TA Kachere	Mphati HC	Health centre	Government	34.08	-14.46	281
A24	Dedza	TA Kachere	Mikondo Disp.	Dispensary	CHAM	33.94	-14.45	245
A25	Dedza	TA Kachindamoto	Mganja HC	Health centre	Government	34.52	-14.42	189
A26	Dedza	TA Kachere	Kafele HC	Health centre	Government	33.72	-14.43	174
A27	Dedza	Dedza Boma	FPAM Clinic Dedza	Health centre	NGO	34.32	-14.39	171
A28	Dedza	TA Kaphuka	Tsoyo Disp.	Special	Government	34.16	-14.15	117
A29	Dedza	TA Kachindamoto	Police College HC Mua	Health centre	Other	34.51	-14.23	95
A30*	Salima	TA Kambalame	Life Line Salima HC	Health centre	NGO	34.54	-14.09	1392
A31*	Salima	Chipoka Urban	Chipoka HC	Health centre	Government	34.52	-13.99	873
A32*	Salima	TA Kambalame	Ngodzi HC	Health centre	Government	34.51	-14.09	284
A33*	Salima	TA Kambwiri	Chagunda HC	Health centre	Government	34.37	-13.88	252
A34*	Salima	TA Kambalame	Parachute Battalion Clinic	Dispensary	Other	34.54	-14.09	101
A35*	Lilongwe	TA Chiseka	Mitundu Community Hosp.	Rural/Community	Government	33.77	-14.25	2544
A36*	Lilongwe	TA Mazengera	Nkhoma Mission Hosp.	District hospital	CHAM	34.10	-14.04	2212
A37*	Lilongwe	TA Chadza	Katema HC	Health centre	CHAM	33.91	-14.28	1116
A38*	Lilongwe	TA Chiseka	Mlale Mission Hosp.	Rural/Community	CHAM	33.76	-14.23	1101
A39*	Lilongwe	TA Kalumbu	Mtentera HC	Health centre	Government	34.01	-14.11	864
A40*	Lilongwe	TA Mazengera	Diamphwi HC	Health centre	Government	34.08	-14.13	522
A41*	Lilongwe	TA Masula	Chiunjiza HC	Health centre	Government	33.67	-14.41	278
A42*	Lilongwe	STA Chitekwele	Chimbalanga HC	Health centre	Government	34.12	-13.94	166
A43*	Lilongwe	TA Chadza	Maluwa HC	Health centre	Government	33.87	-14.26	63
A44*	Ntcheu	TA Chakhumbira	Lizulu HC	Health centre	Government	34.47	-14.52	1289
A45*	Ntcheu	TA Masasa	Mlanda HC	Health centre	CHAM	34.46	-14.48	334
A46*	Ntcheu	TA Masasa	Masasa HC	Health centre	Government	34.42	-14.43	321
A47*	Ntcheu	TA Chakhumbira	Chigodi HC	Health centre	CHAM	34.54	-14.49	213

A48*	Mangochi	TA Nankumba	Malembo HC Mangochi	Health centre	Government	34.83	-14.24	1459
A49*	Mangochi	TA Nankumba	Nankumba HC	Health centre	Government	34.82	-14.37	1097

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	Dedza	TA Chilikumwendo	Mdeza Disp.	Dispensary	Government	33.97	-14.24	575	(388-827)
F2	Dedza	TA Tambala	Mjini Disp.	Dispensary	Government	34.24	-14.04	166	(109-246)
F3	Dedza	TA Tambala	MTEMWENDE	Health Post	Government	34.26	-14.15	140	(97-194)
F4	Dedza	TA Tambala	Kalulu HC	Health Centre	Government	34.20	-14.00	136	(87-200)
F5	Dedza	TA Kachere	Mlangali Disp.	Dispensary	Government	34.27	-14.41	118	(75-175)
F6	Dedza	TA Tambala	MPOMBE	Health Post	Government	34.31	-13.99	126	(83-184)
F7	Dedza	TA Kachere	Maonde HC	Health Centre	Government	34.12	-14.41	72	(48-106)
F8	Dedza	TA Tambala	KANYERERE	Health Post	Government	34.23	-13.97	91	(55-137)
F9	Dedza	TA Kaphuka	CHILAMBA	Health Post	Government	34.24	-14.36	75	(52-107)
F10	Dedza	Dedza Boma	BLM Dedza	Special	NGO	34.33	-14.38	2	(1-3)
F11	Dedza	TA Tambala	MJINI	Dispensary	Government	34.24	-14.04	166	(109-246)
F12	Dedza	TA Kachindamoto	Mtakataka Police College HC	Health Centre	Other	34.51	-14.23	0	(0-0)
F13	Dedza	TA Kachindamoto	Ntakataka Police Disp.	Health Centre	Government	34.51	-14.23	0	(0-0)
F14*	Lilongwe	TA Kalumbu	NYANJA	Health Post	Government	33.94	-14.14	429	(294-619)
F15*	Lilongwe	TA Masula	KAMBANIZITHE	Health Post	Government	33.71	-14.35	316	(205-459)
F16*	Lilongwe	TA Chiseka	KAMPINI	Health Post	Government	33.78	-14.30	311	(206-437)
F17*	Lilongwe	STA Chitekwele	CHITEKWELE	Health Post	Government	34.10	-13.97	249	(162-368)
F18*	Lilongwe	TA Masula	KAMPHONI	Health Post	Government	33.63	-14.31	210	(128-318)
F19*	Lilongwe	TA Kalumbu	BWESE	Health Post	Government	33.94	-14.22	456	(298-673)
F20*	Ntcheu	TA Masasa	Phanga Disp.	Dispensary	Government	34.72	-14.34	211	(139-316)

Travel Times to Closest ART Facilities

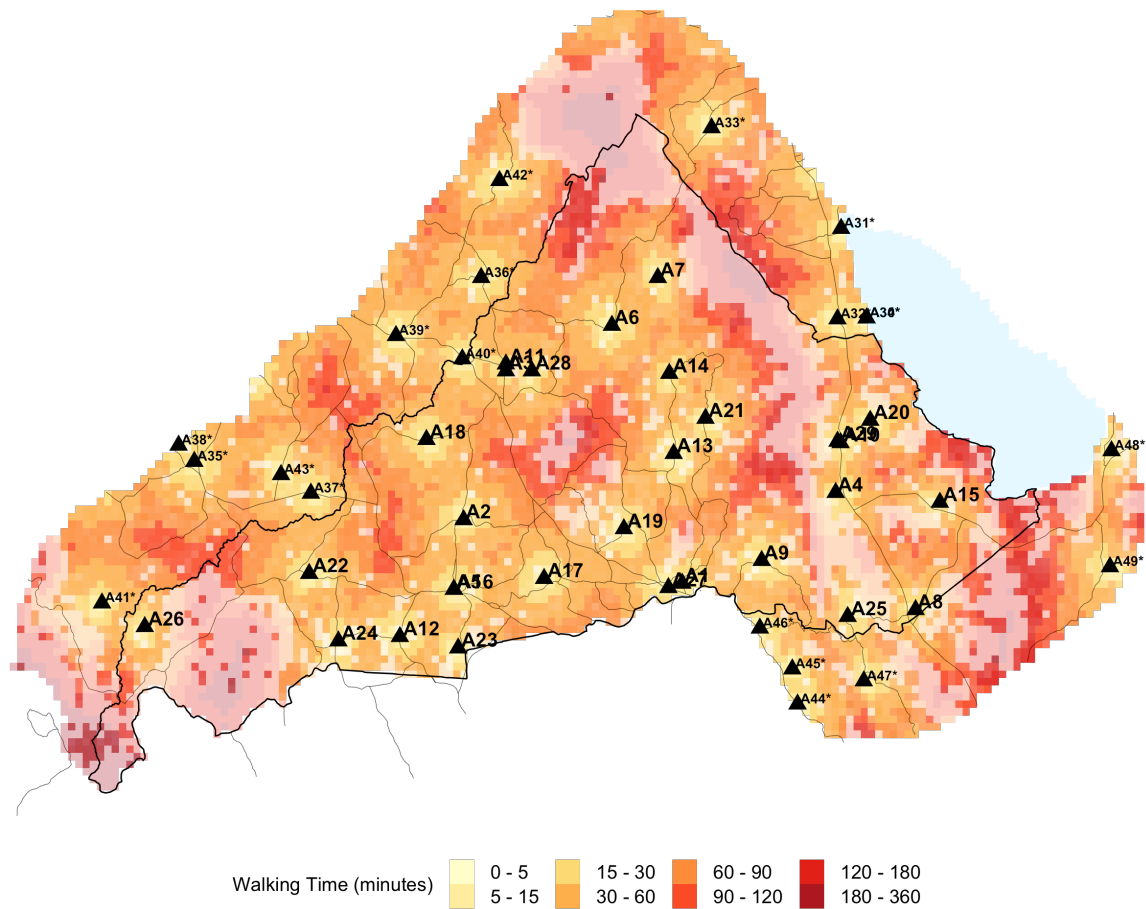


Figure 4: Estimated travel times to the closest ART facility. Travel times were calculated using data on road infrastructure, types of terrain and land elevation.

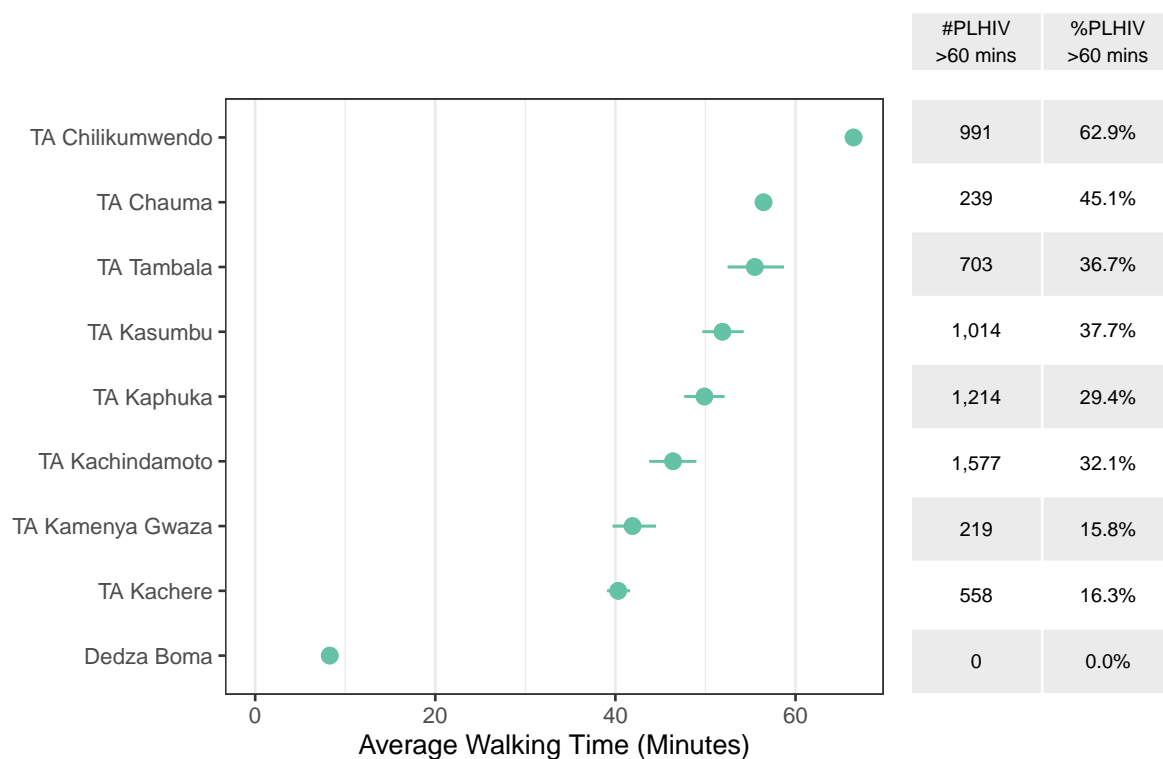


Figure 5: Estimated average walking time to the closest ART facility, weighted by the estimated number of PLHIV within the traditional authority. The right table indicates estimated number and proportion of PLHIV that need more than 60 minutes to travel to the closest ART facility, respectively.

Areas outside 60 minutes travel

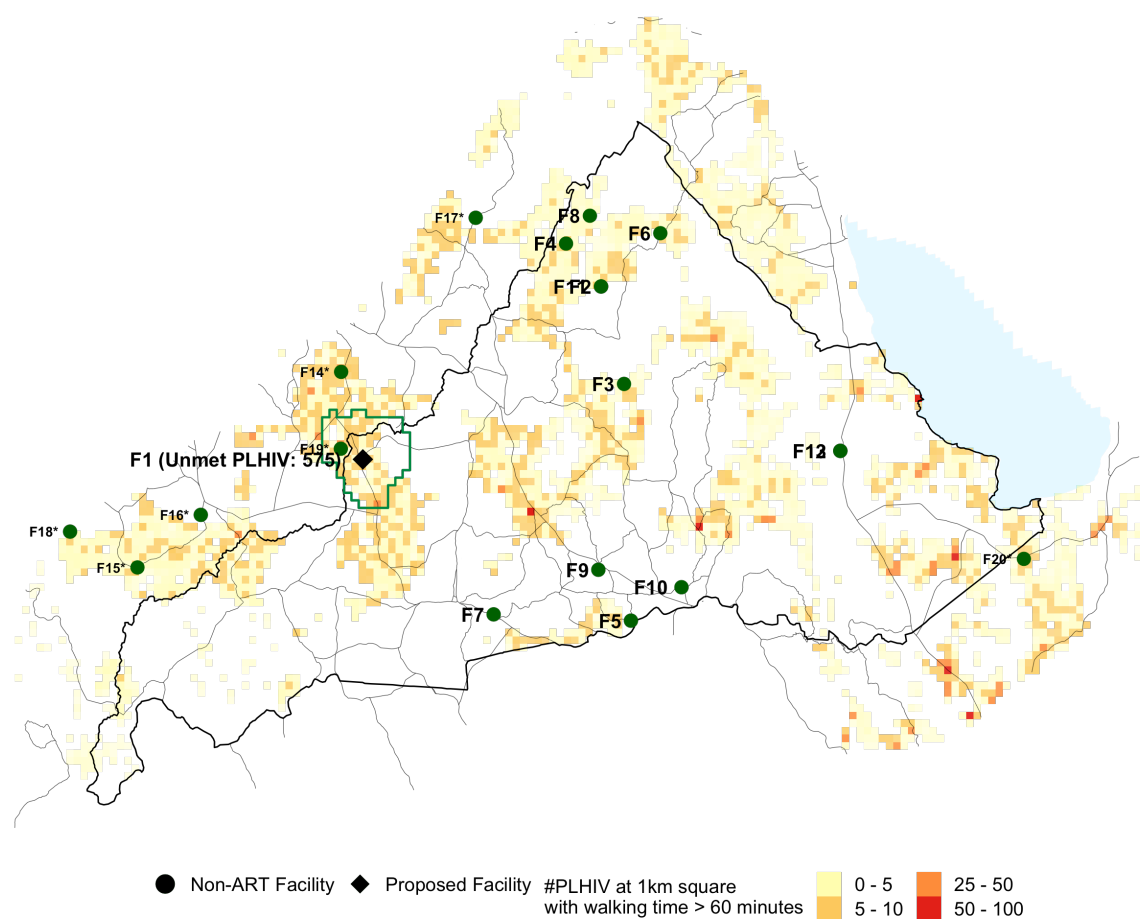


Figure 6: Proposed facility locations. Areas where the walking time to the closest ART facility is <60 minutes have been removed. Green lines indicate the 60-minutes catchment area of the proposed facility.

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.