

District overview of travel time to ART facilities: Zomba

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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 Zomba, September 2020.

Total PLHIV (all ages)	58,753 (52,941–65,337)
HIV prevalence, age 15–49 years	11.6% (10.4%–12.9%)
Total patients receiving ART	111,934
Average walking time to nearest ART (minutes)	44 (41–47)
Number PLHIV > 60 minutes walking time	8,730 (7,477–10,088)
Percentage PLHIV > 60 minutes walking time	14.9% (13.6%–16.6%)

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 Mkumbira: 1,596 (965–2,450)	TA Mwambo: 12,212 (10,243–14,585)
15-49 Prevalence	STA Nkapita: 9.8% (7.8%–12.4%)	TA Mwambo: 12.4% (10.4%–14.9%)
Average Walking Time	TA Malemia: 27 min (27–28 min)	TA Mkumbira: 275 min (236–317 min)

Travel time to existing ART facilities

In Zomba, there are 28 ART facilities that had at least 1 patient in September 2020. The median number of ART patients per facility was 1242. 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 Zomba is 44 minutes (41-47 min).
- The shortest estimated average walking time to the closest ART facility is in TA Malemia (27 minutes (27-28 min)).
- The longest estimated average walking time to the closest ART facility is in TA Mkumbira (275 minutes (236-317 min)).

An estimated 14.9% (13.6%–16.6%) of PLHIV reside more than 60 minutes walking time to their nearest ART facility, compared to 15.1% of the total population. This decreases to 4.1% (3.0%–5.5%) of PLHIV and 4.1% 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	284,017	36.4%	21,007 (18,525–23,572)	35.9% (34.5%–37.6%)
60	118,015	15.1%	8,730 (7,477–10,088)	14.9% (13.6%–16.6%)
90	32,250	4.1%	2,399 (1,714–3,261)	4.1% (3.0%–5.5%)
120	22,502	2.9%	1,675 (1,059–2,460)	2.9% (1.9%–4.1%)

Proposed facilities for new ART services

A list of 12 *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 Mwambo (2012 PLHIV (1598-2473) with walking time > 60 minutes).
- The facility that can reach the most PLHIV residing outside 60 minutes travel time is **Mikuyu Adult Clinic**, with 639 PLHIV (493-804) 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

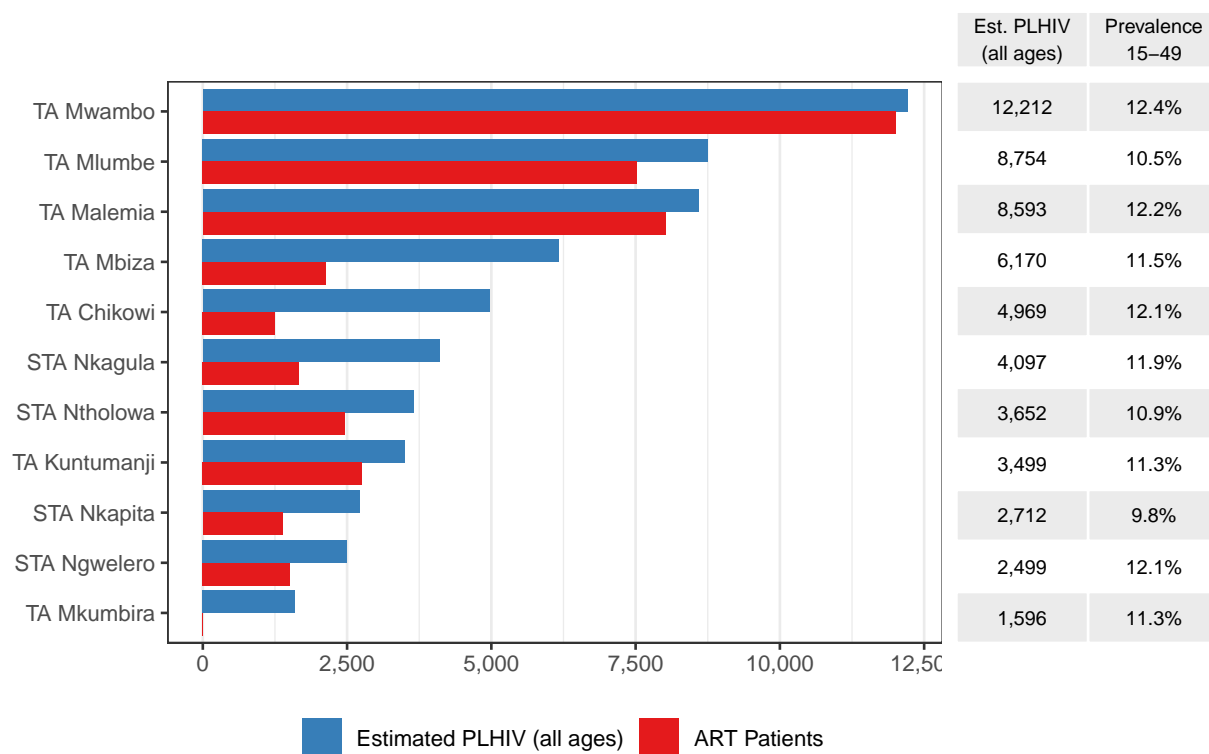


Figure 1: Number registered ART clients within each TA and estimated number of PLHIV within the TA. The right table indicates the estimated 15-49 HIV prevalence.

HIV prevalence in ages 15-49

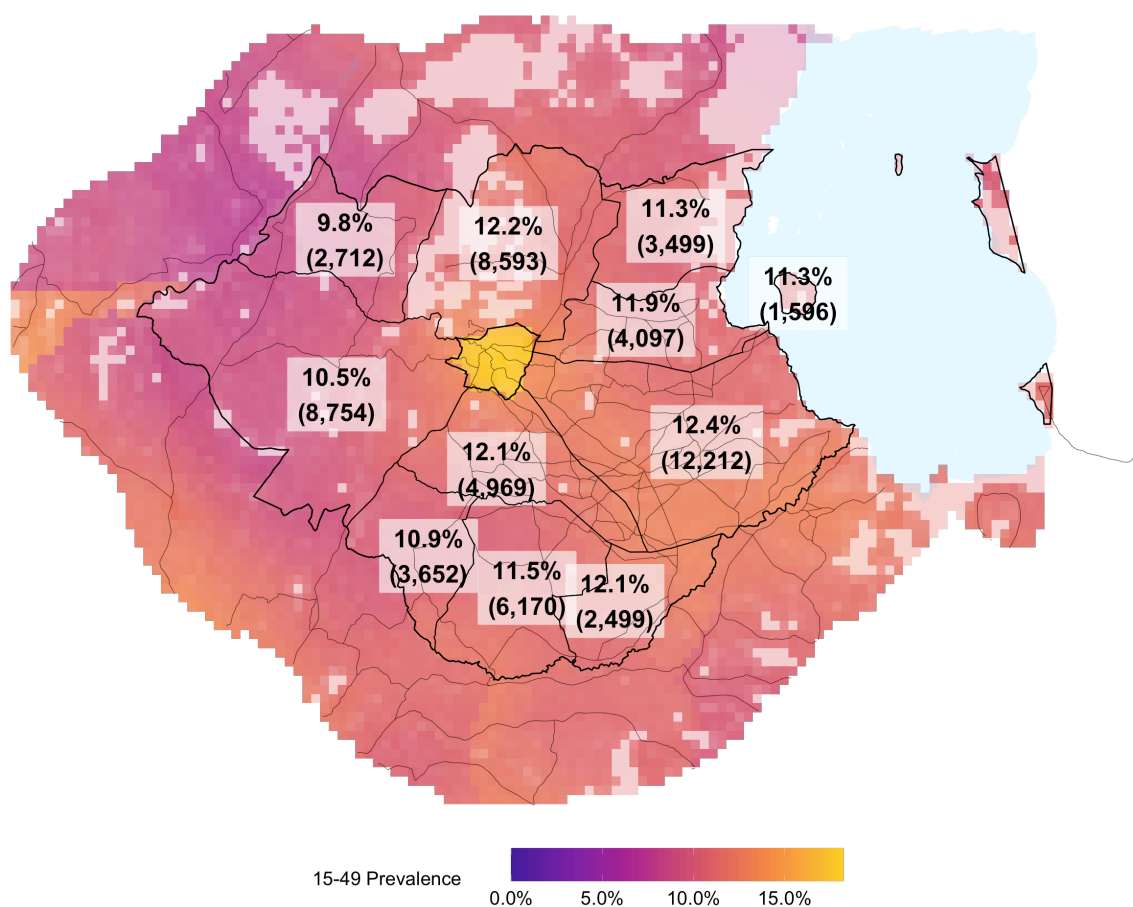


Figure 2: Estimated spatial HIV prevalence. Percentages correspond to TA level 15-49 HIV prevalence and numbers in brackets indicate the estimated number of PLHIV overall.

Estimated number of PLHIV at 1km square

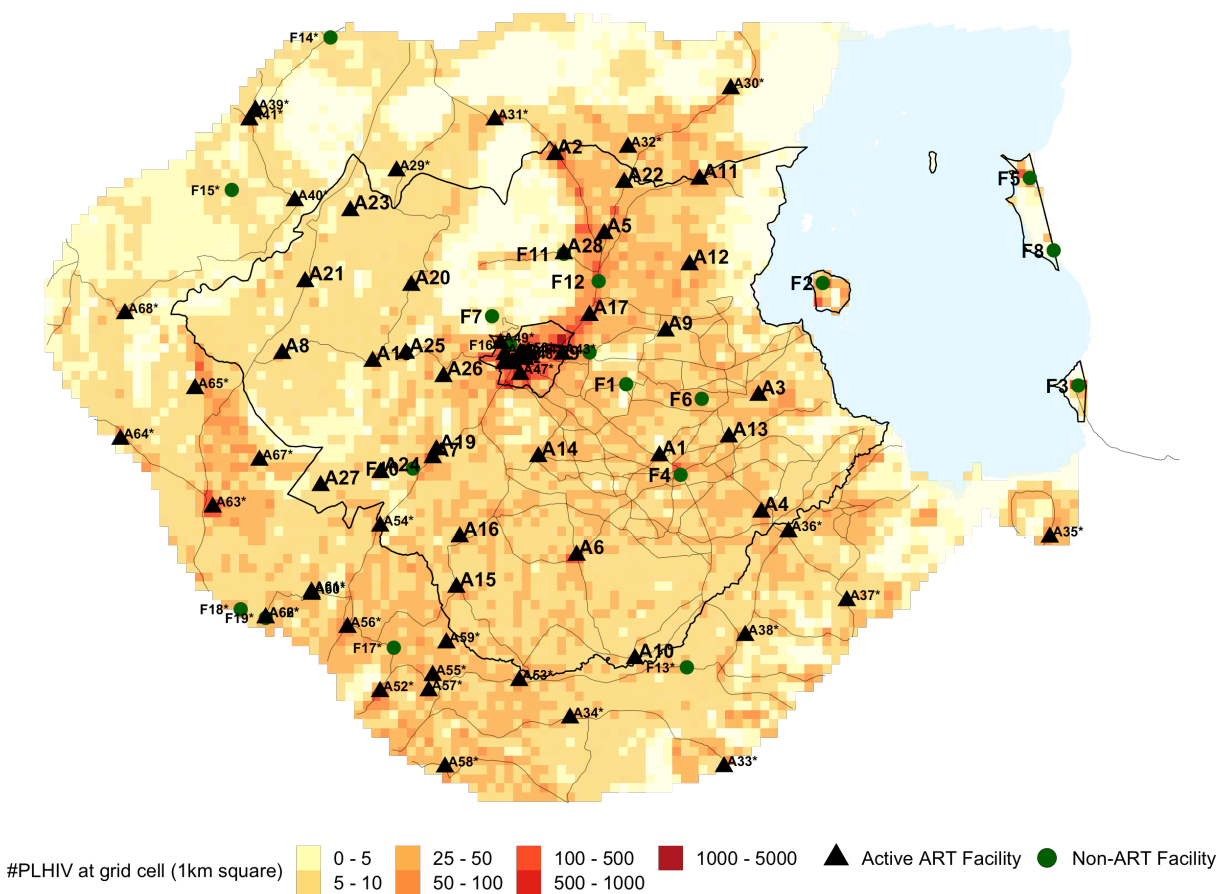


Figure 3: Estimated number of PLHIV on a 1km square.

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	Zomba	TA Mwambo	Pirimiti HC	Health centre	CHAM	35.45	-15.48	4592
A2	Zomba	TA Malemia	St Lukes Mission Hosp.	District hospital	CHAM	35.35	-15.21	3715
A3	Zomba	TA Mwambo	Likangala HC	Health centre	Government	35.54	-15.43	3482
A4	Zomba	TA Mwambo	Matiya HC	Health centre	CHAM	35.55	-15.53	2643
A5	Zomba	TA Malemia	Domasi Rural Hosp.	Rural/Community	Government	35.40	-15.28	2381
A6	Zomba	TA Mbiza	Mayaka HC	Health centre	CHAM	35.37	-15.57	2134
A7	Zomba	TA Mlumbe	Thondwe HC	Health centre	Government	35.24	-15.48	1878
A8	Zomba	TA Mlumbe	Chipini HC	Health centre	CHAM	35.10	-15.39	1667
A9	Zomba	STA Nkagula	Makwapala HC	Health centre	Government	35.46	-15.37	1667
A10	Zomba	STA Ngwelerero	Ngwelerero HC	Health centre	Government	35.43	-15.67	1508
A11	Zomba	TA Kuntumanji	Namasalima HC	Health centre	Government	35.49	-15.23	1438
A12	Zomba	TA Kuntumanji	Bimbi HC	Health centre	Government	35.48	-15.31	1319
A13	Zomba	TA Mwambo	Chamba HC	Health centre	Government	35.52	-15.47	1287
A14	Zomba	TA Chikowi	Lambulira HC	Health centre	Government	35.34	-15.48	1249
A15	Zomba	STA Ntholowa	Nasawa HC	Health centre	Government	35.26	-15.60	1234
A16	Zomba	STA Ntholowa	Magomero HC	Health centre	CHAM	35.26	-15.56	1221
A17	Zomba	TA Malemia	Naisi HC	Health centre	Government	35.39	-15.36	1125
A18	Zomba	TA Mlumbe	Chingale HC	Health centre	Government	35.18	-15.40	933
A19	Zomba	TA Mlumbe	Namikango HC	Health centre	CHAM	35.24	-15.48	898
A20	Zomba	STA Nkapita	Nkasala HC	Health centre	Government	35.22	-15.33	825
A21	Zomba	TA Mlumbe	Chilipa HC Zomba	Health centre	CHAM	35.12	-15.32	665
A22	Zomba	TA Malemia	Machinjiri HC	Health centre	Government	35.42	-15.23	560
A23	Zomba	STA Nkapita	Mmambo HC	Health centre	Government	35.16	-15.26	551
A24	Zomba	TA Mlumbe	Mwandama HC	Health centre	Government	35.19	-15.50	484
A25	Zomba	TA Mlumbe	Changalume Barracks Clinic	Special	Other	35.21	-15.39	385
A26	Zomba	TA Mlumbe	Namadidi HC	Health centre	Government	35.25	-15.41	359
A27	Zomba	TA Mlumbe	Maera HC	Health centre	Government	35.13	-15.51	256
A28	Zomba	TA Malemia	H. Parker Sharp HC (Domasi CCAP)	Health centre	CHAM	35.36	-15.30	237
A29*	Machinga	TA Nkula	Gawanani HC	Health centre	CHAM	35.20	-15.22	927
A30*	Machinga	TA Mposa	Mposa HC	Health centre	CHAM	35.52	-15.15	857
A31*	Machinga	Machinga Boma	Machinga HC	Health centre	Government	35.30	-15.18	689
A32*	Machinga	TA Chamba	Chamba Disp.	Dispensary	Government	35.42	-15.20	501
A33*	Mulanje	TA Nkanda	Mulomba HC	Health centre	Government	35.51	-15.77	1594
A34*	Mulanje	TA Juma	Mkomaola HC	Health centre	Government	35.37	-15.72	478
A35*	Phalombe	TA Chiwalo	Nambazo HC	Health centre	Government	35.82	-15.56	4655
A36*	Phalombe	TA Jenala	Chitekese HC	Health centre	Government	35.57	-15.55	2828
A37*	Phalombe	TA Jenala	Nkhwayi HC	Health centre	Government	35.63	-15.61	1847
A38*	Phalombe	TA Jenala	Mwanga HC	Health centre	CHAM	35.53	-15.65	1134
A39*	Balaka	TA Nkaya	Utale 2 HC	Health centre	Government	35.07	-15.17	879
A40*	Balaka	TA Nkaya	Phimbi HC	Health centre	Government	35.11	-15.25	807
A41*	Balaka	TA Nkaya	Utale 1 HC	Health centre	CHAM	35.06	-15.18	413
A42*	Zomba City	Chambo Ward	Zomba Central Hosp.	Central hospital	Government	35.31	-15.40	7213
A43*	Zomba City	Chirunga Ward	Matawale HC	Health centre	Government	35.36	-15.39	3762
A44*	Zomba City	Zomba Central Ward	Police College Hospital Zomba	Rural/Community	Other	35.33	-15.39	1352
A45*	Zomba City	Mtiya Ward	Cobbe Barracks Hosp.	Health centre	Other	35.30	-15.39	1318
A46*	Zomba City	Zomba Central Ward	City Clinic Zomba	Health centre	Government	35.32	-15.39	1317

A47*	Zomba City	Sadzi Ward	Sadzi HC	Health centre	Government	35.32	-15.41	1051
A48*	Zomba City	Zomba Central Ward	Zomba Central Prison Clinic	Health centre	Other	35.32	-15.40	742
A49*	Zomba City	Mtiya Ward	Zilindo HC	Health centre	Government	35.30	-15.38	255
A50*	Zomba City	Zomba Central Ward	BLM Zomba	Special	NGO	35.32	-15.39	157
A51*	Zomba City	Mbedza Ward	Zomba Mental Hosp.	Special	Government	35.30	-15.40	79
A52*	Chiradzulu	Chiradzulu Boma	Chiradzulu District Hosp.	District hospital	Government	35.19	-15.70	6637
A53*	Chiradzulu	STA Sandareki	Milepa HC	Health centre	Government	35.32	-15.69	3946
A54*	Chiradzulu	TA Mpama	Namadzi HC	Health centre	Government	35.19	-15.55	2934
A55*	Chiradzulu	TA Kadewere	Chileka HC Blantyre	Health centre	Government	35.24	-15.68	2686
A56*	Chiradzulu	TA Mpama	Mbulumbuzi HC	Health centre	Government	35.16	-15.64	2680
A57*	Chiradzulu	TA Kadewere	Ndunde HC	Health centre	Government	35.23	-15.70	2390
A58*	Chiradzulu	TA Kadewere	Thumbwe HC	Health centre	Government	35.25	-15.77	2338
A59*	Chiradzulu	STA Sandareki	Mauwa HC	Health centre	Government	35.25	-15.65	2323
A60*	Chiradzulu	TA Chitera	Chimvu HC	Health post	Government	35.12	-15.61	1169
A61*	Chiradzulu	TA Chitera	Chitera HC	Health centre	Government	35.12	-15.61	1076
A62*	Blantyre	TA Makata	Makhetha Clinic	Dispensary	Government	35.08	-15.63	1729
A63*	Blantyre	TA Lundu	Lirangwe HC	Health centre	Government	35.03	-15.53	1714
A64*	Blantyre	TA Chigaru	Mdeka HC	Health centre	Government	34.94	-15.47	1588
A65*	Blantyre	TA Chigaru	Lundu HC	Health centre	Government	35.01	-15.42	1057
A66*	Blantyre	TA Makata	Makata HC Lunzu	Health centre	Government	35.08	-15.63	760
A67*	Blantyre	TA Lundu	Namikoko HC	Dispensary	Government	35.07	-15.49	466
A68*	Neno	TA Symon Likongwe	Matope HC	Health centre	CHAM	34.95	-15.35	893

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	Zomba	TA Mwambo	Mikuyu Adult Clinic	Special	Government	35.42	-15.42	639	(493-804)
F2	Zomba	TA Mkumbira	Chisi HC	Health Centre	Government	35.61	-15.33	598	(364-939)
F3	Zomba	TA Mkumbira	LUNGAZI	Health Post	Government	35.85	-15.42	533	(245-968)
F4	Zomba	TA Mwambo	HUNGER	Dispensary	CHAM	35.47	-15.50	466	(346-613)
F5	Zomba	TA Mkumbira	CHINGUMA	Health Post	Government	35.80	-15.23	409	(197-727)
F6	Zomba	TA Mwambo	NAMALITHA	Dispensary	Other	35.49	-15.43	347	(265-439)
F7	Zomba	TA Malemia	Zomba Forestry Disp.	Dispensary	Other	35.29	-15.36	35	(27-45)
F8	Zomba	TA Mkumbira	NGOTANGOTA	Health Post	Government	35.82	-15.30	33	(15-60)
F9	Zomba	STA Nkagula	Airwing Disp.	Dispensary	Government	35.39	-15.39	233	(175-303)
F10	Zomba	TA Mlumbe	Thondwe Pastoral Centre	Health Centre	CHAM	35.22	-15.49	0	(0-0)
F11	Zomba	TA Malemia	H Parker Sharp Disp.	Health Centre	CHAM	35.36	-15.30	0	(0-0)
F12	Zomba	TA Malemia	Compassionate Mission Clinic	Clinic	NGO	35.39	-15.32	0	(0-0)
F13*	Mulanje	TA Juma	KAMWENDO	Health Post	Government	35.48	-15.67	408	(311-513)
F14*	Balaka	TA Msamala	DZIWE	Health Post	Government	35.14	-15.10	486	(348-638)
F15*	Balaka	TA Nkaya	NJERENJE	Health Post	Government	35.05	-15.24	248	(176-334)
F16*	Zomba City	Mtiya Ward	State House Disp.	Dispensary	Government	35.31	-15.38	0	(0-0)
F17*	Chiradzulu	TA Kadewere	Mwanje DAPP Clinic	Special	NGO	35.20	-15.66	0	(0-0)
F18*	Blantyre	TA Kapeni	Aquid Lifeline Project	Clinic	NGO	35.06	-15.62	73	(53-96)

F19*	Blantyre	TA Makata	Makata Dispensary Ndirande	Health Centre	Government	35.08	-15.63	0	(0-0)
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Travel Times to Closest ART Facilities

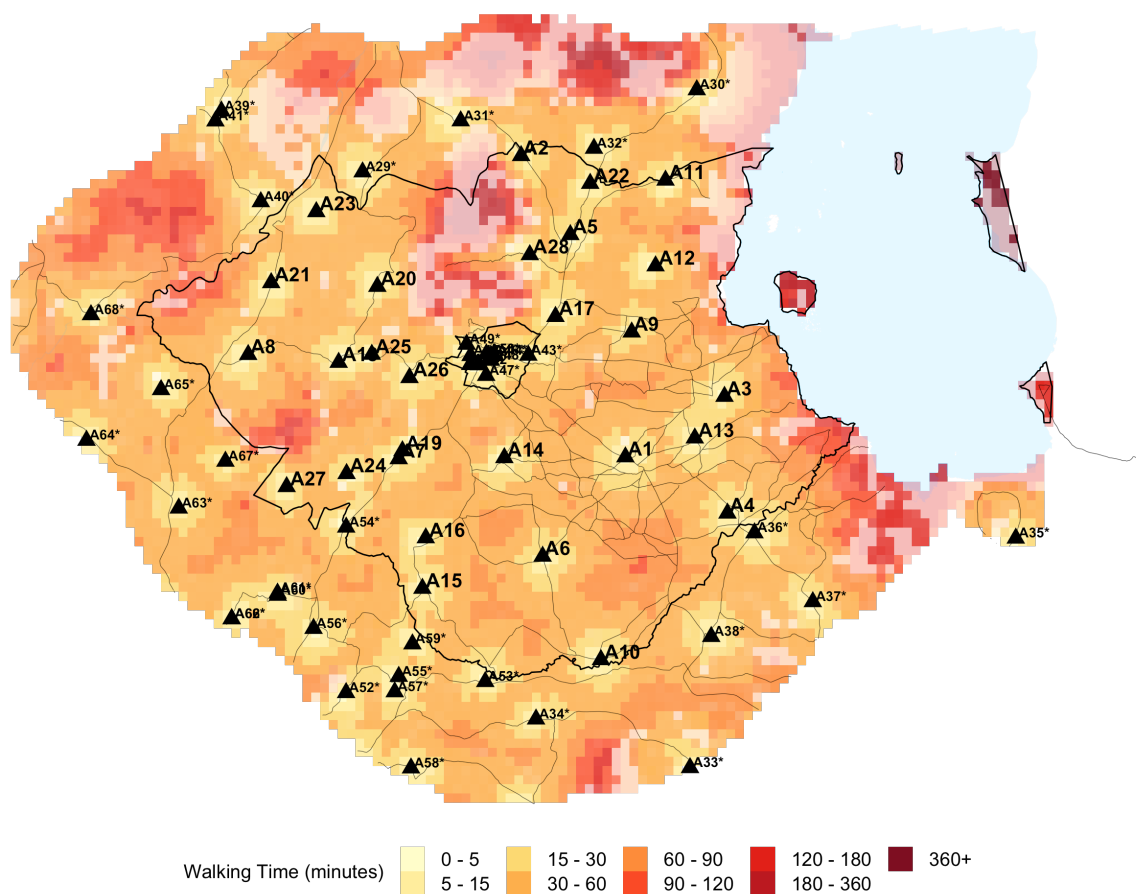


Figure 4: Estimated travel times to the closest ART facility. Travel times were calculated using data on road infrastructure, types of terrain and land elevation.

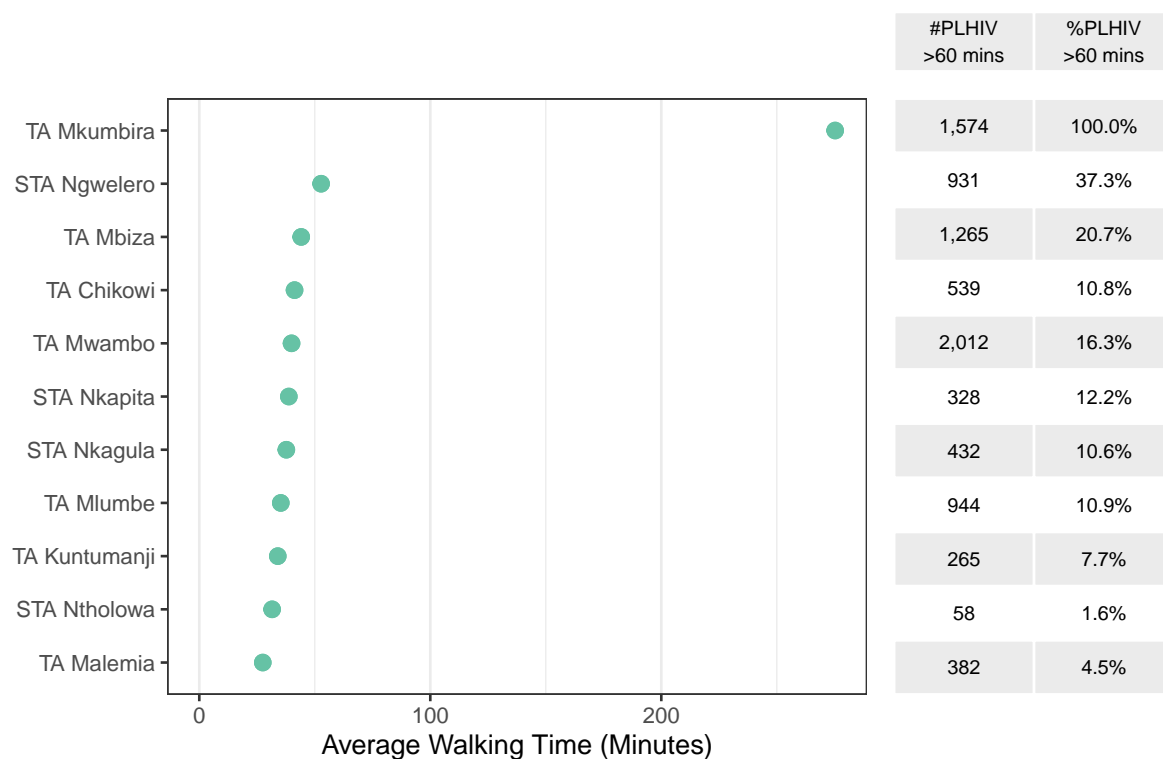


Figure 5: Estimated average walking time to the closest ART facility, weighted by the estimated number of PLHIV within the traditional authority. The right table indicates estimated number and proportion of PLHIV that need more than 60 minutes to travel to the closest ART facility, respectively.

Areas outside 60 minutes travel

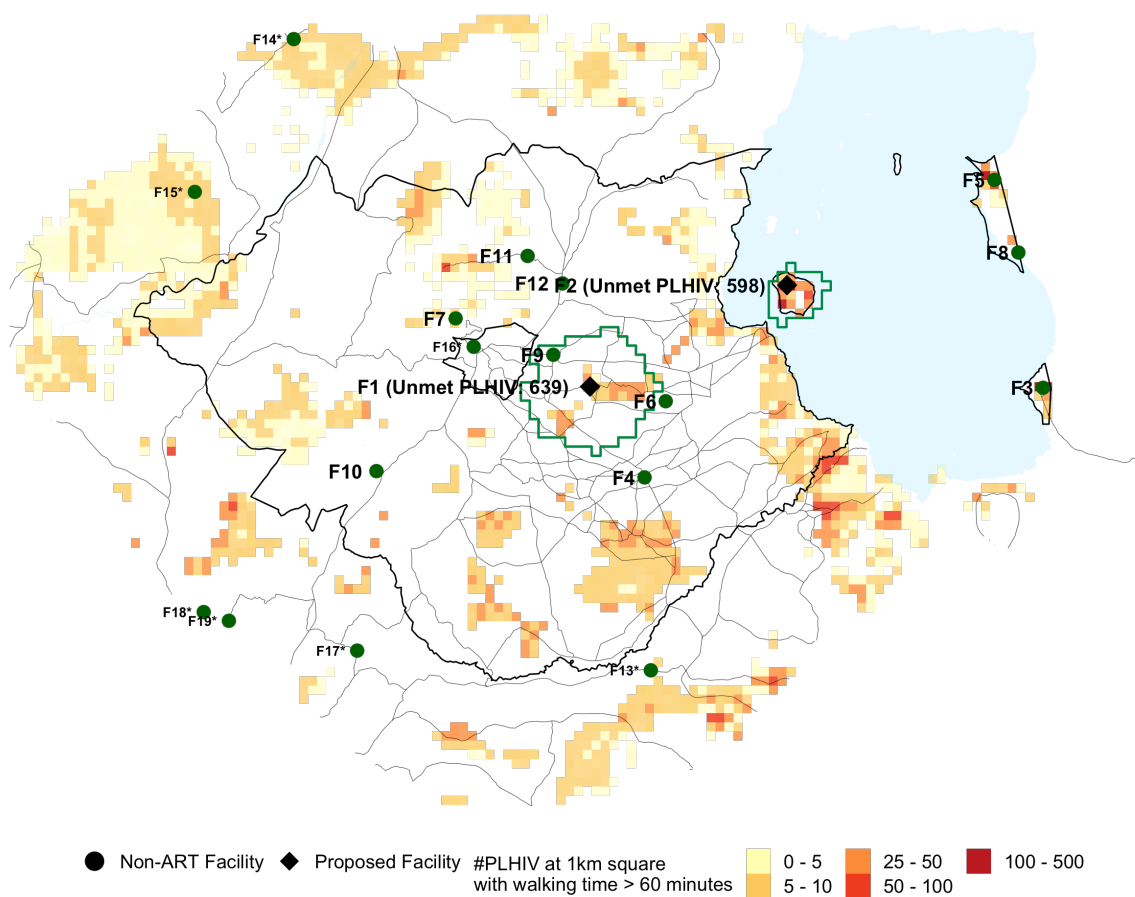


Figure 6: Proposed facility locations. Areas where the walking time to the closest ART facility is <60 minutes have been removed. Green lines indicate the 60-minutes catchment area of the proposed facility.

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.