

District overview of travel time to ART facilities: Lilongwe

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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 Lilongwe, September 2020.

Total PLHIV (all ages)	45,988 (41,157–50,947)
HIV prevalence, age 15–49 years	4.0% (3.6%–4.4%)
Total patients receiving ART	105,411
Average walking time to nearest ART (minutes)	46 (46–47)
Number PLHIV > 60 minutes walking time	12,756 (11,220–14,423)
Percentage PLHIV > 60 minutes walking time	27.0% (25.7%–28.4%)

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	STA Mbang'ombe: 235 (164–327)	TA Malili: 5,504 (4,416–6,886)
15-49 Prevalence	TA Khongoni: 2.0% (1.5%–2.6%)	TA Kalumba: 7.2% (5.5%–9.0%)
Average Walking Time	TA Njewa: 29 min (27–30 min)	TA Khongoni: 64 min (60–67 min)

Travel time to existing ART facilities

In Lilongwe, there are 38 ART facilities that had at least 1 patient in September 2020. The median number of ART patients per facility was 470. 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 Lilongwe is 46 minutes (46–47 min).
- The shortest estimated average walking time to the closest ART facility is in TA Njewa (29 minutes (27–30 min)).
- The longest estimated average walking time to the closest ART facility is in TA Khongoni (64 minutes (60–67 min)).

An estimated 27.0% (25.7%–28.4%) 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 5.1% (4.5%–5.7%) of PLHIV and 6.6% 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	903,640	52.7%	23,222 (20,642–26,230)	49.2% (47.8%–50.6%)
60	523,853	30.5%	12,756 (11,220–14,423)	27.0% (25.7%–28.4%)
90	113,322	6.6%	2,409 (2,027–2,838)	5.1% (4.5%–5.7%)
120	18,580	1.1%	310 (232–406)	0.7% (0.5%–0.9%)

Proposed facilities for new ART services

A list of 14 *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 Malili (1513 PLHIV (1095-2044) with walking time > 60 minutes).
- The facility that can reach the most PLHIV residing outside 60 minutes travel time is **DZABWA**, with 826 PLHIV (565-1157) 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

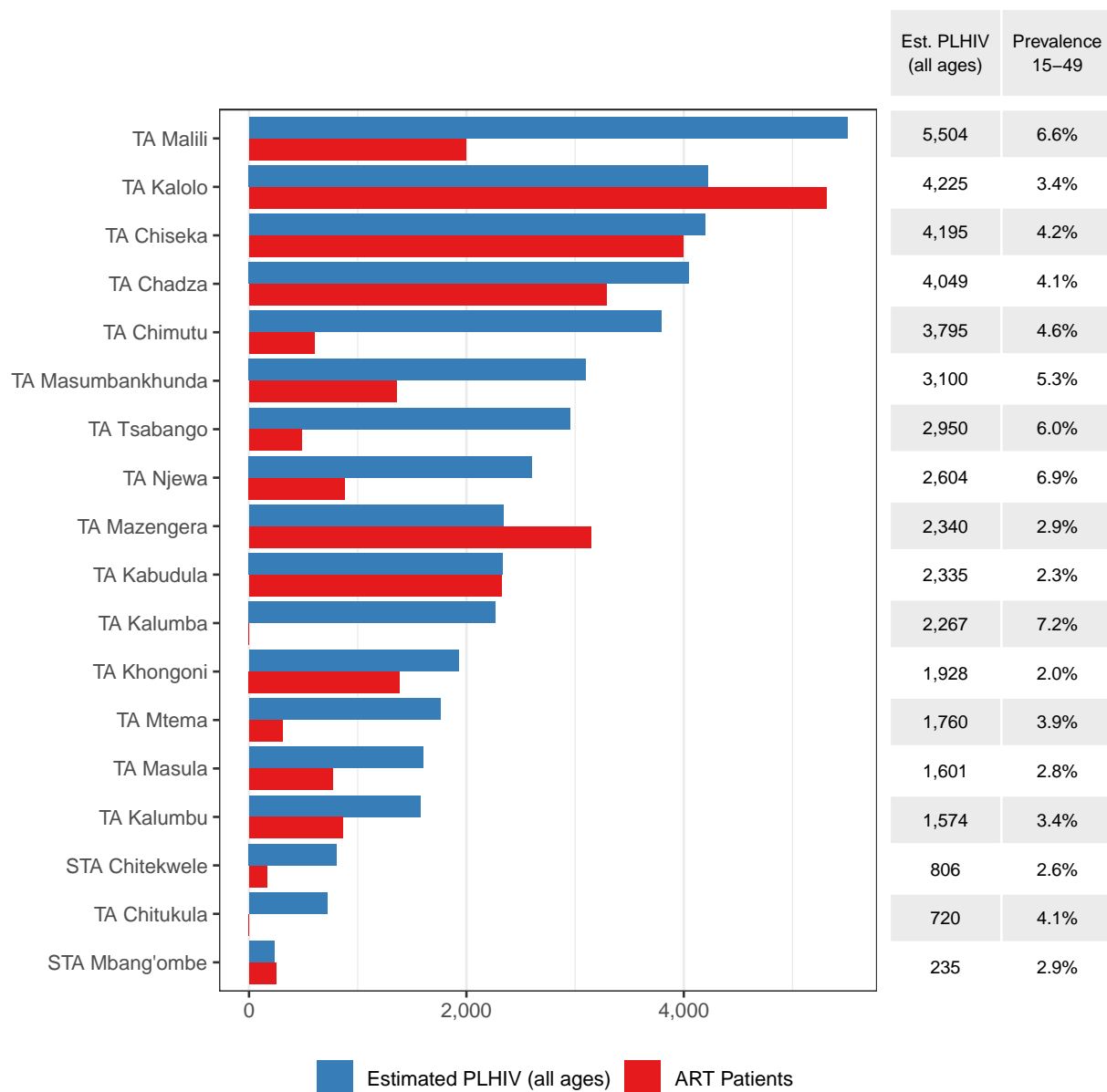


Figure 1: Number registered ART clients within each TA and estimated number of PLHIV within the TA. The right table indicates the estimated 15-49 HIV prevalence.

HIV prevalence in ages 15-49

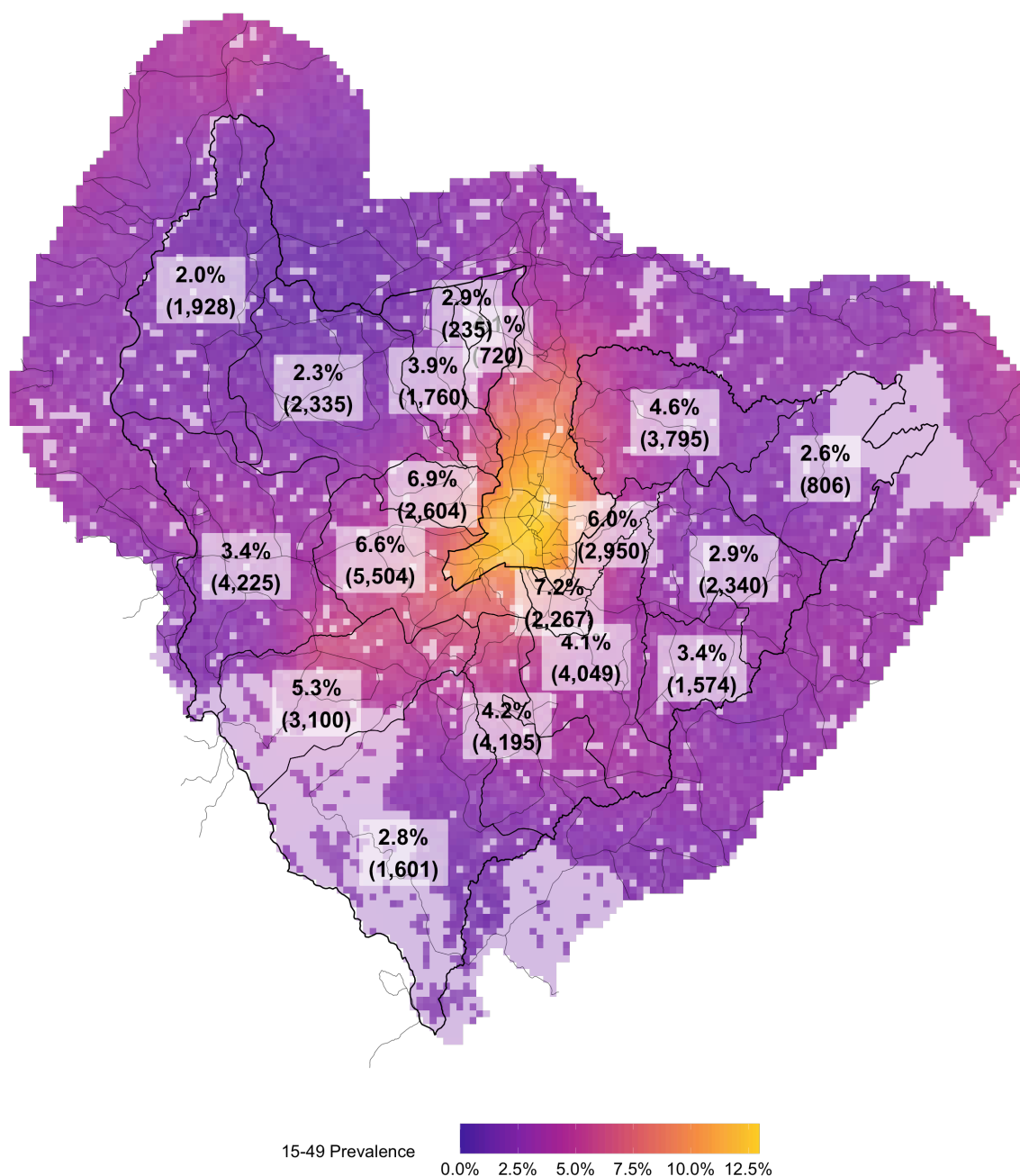


Figure 2: Estimated spatial HIV prevalence. Percentages correspond to TA level 15-49 HIV prevalence and numbers in brackets indicate the estimated number of PLHIV overall.

Estimated number of PLHIV at 1km square

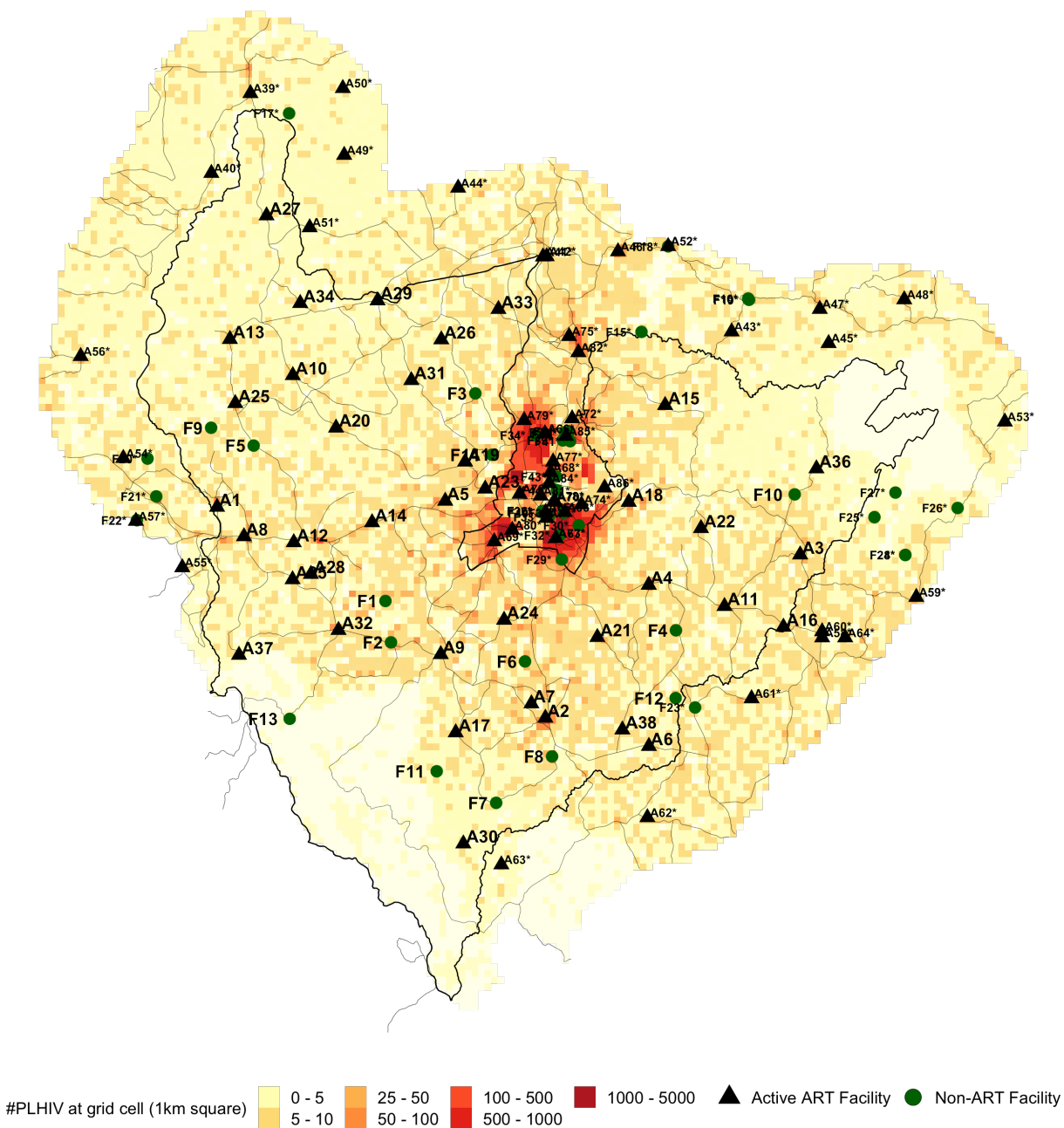


Figure 3: Estimated number of PLHIV on a 1km square.

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	Lilongwe	TA Kalolo	St Gabriel Mission Hosp.	District hospital	CHAM	33.35	-13.98	2724
A2	Lilongwe	TA Chiseka	Mitundu Community Hosp.	Rural/Community	Government	33.77	-14.25	2544
A3	Lilongwe	TA Mazengera	Nkhoma Mission Hosp.	District hospital	CHAM	34.10	-14.04	2212
A4	Lilongwe	TA Chadza	Nathenje HC	Health centre	Government	33.91	-14.08	1672
A5	Lilongwe	TA Malili	Chitedze HC	Health centre	Government	33.65	-13.98	1290
A6	Lilongwe	TA Chadza	Katema HC	Health centre	CHAM	33.91	-14.28	1116
A7	Lilongwe	TA Chiseka	Mlale Mission Hosp.	Rural/Community	CHAM	33.76	-14.23	1101
A8	Lilongwe	TA Kalolo	Chileka HC Lilongwe	Health centre	Government	33.39	-14.02	1101
A9	Lilongwe	TA Masumbankhunda	Static Art Malingunde HC	Health centre	CHAM	33.64	-14.17	1080
A10	Lilongwe	TA Kabudula	Kabudula Rural Hosp.	Rural/Community	Government	33.45	-13.82	1078
A11	Lilongwe	TA Kalumbu	Mtentera HC	Health centre	Government	34.01	-14.11	864
A12	Lilongwe	TA Kalolo	Nthondo HC Lilongwe	Health centre	Government	33.45	-14.03	838
A13	Lilongwe	TA Khongoni	Khongoni HC	Health centre	Government	33.37	-13.77	754
A14	Lilongwe	TA Malili	Mbwatalika HC	Health centre	CHAM	33.55	-14.00	703
A15	Lilongwe	TA Chimutu	Chiwamba HC	Health centre	Government	33.93	-13.86	602
A16	Lilongwe	TA Mazengera	Diamphwi HC	Health centre	Government	34.08	-14.13	522
A17	Lilongwe	TA Masula	Dickson HC	Health centre	Government	33.66	-14.27	490
A18	Lilongwe	TA Tsabango	Kang'oma HC	Health centre	Government	33.88	-13.98	483
A19	Lilongwe	TA Njewa	Mbabvi HC	Health centre	Government	33.67	-13.93	483
A20	Lilongwe	TA Kabudula	Nsaru HC	Health centre	Government	33.50	-13.89	457
A21	Lilongwe	TA Chadza	Chadza HC	Health centre	Government	33.84	-14.15	439
A22	Lilongwe	TA Mazengera	Matapila HC	Health centre	Government	33.98	-14.01	414
A23	Lilongwe	TA Njewa	Airwing Clinic	Health centre	Other	33.70	-13.96	399
A24	Lilongwe	TA Chiseka	Chioza HC	Health centre	Government	33.72	-14.13	349
A25	Lilongwe	TA Khongoni	Chilobwe Majiga HC	Health centre	Government	33.37	-13.85	325
A26	Lilongwe	TA Mtema	Ngoni HC	Health centre	Government	33.64	-13.77	310
A27	Lilongwe	TA Khongoni	Malembo HC Lilongwe	Health centre	Government	33.41	-13.62	308
A28	Lilongwe	TA Kalolo	McGuire Wellness Center (Child Legacy)	Health centre	CHAM	33.47	-14.07	284
A29	Lilongwe	TA Kabudula	Nambuma HC	Health centre	CHAM	33.56	-13.73	278
A30	Lilongwe	TA Masula	Chiunji HC	Health centre	Government	33.67	-14.41	278
A31	Lilongwe	TA Kabudula	Ukwe HC	Health centre	Government	33.60	-13.83	276
A32	Lilongwe	TA Masumbankhunda	Ndaula HC	Health centre	Government	33.51	-14.14	276
A33	Lilongwe	STA Mbang'ombe	Mbang'ombe 2 HC	Health centre	Government	33.71	-13.74	251
A34	Lilongwe	TA Kabudula	Chikowa HC Lilongwe	Health centre	Government	33.46	-13.73	235
A35	Lilongwe	TA Kalolo	Ming'ongo HC	Health centre	Government	33.45	-14.08	204
A36	Lilongwe	STA Chitekwele	Chimbalanga HC	Health centre	Government	34.12	-13.94	166
A37	Lilongwe	TA Kalolo	Mbang'ombe 1 HC	Health centre	Government	33.38	-14.17	161
A38	Lilongwe	TA Chadza	Maluwa HC	Health centre	Government	33.87	-14.26	63
A39*	Kasungu	TA Santhe	Santhe HC	Health centre	Government	33.39	-13.47	758
A40*	Kasungu	TA Santhe	Mkhotla Rural Growth HC	Health centre	Government	33.34	-13.57	158
A41*	Dowa	TA Mkukula	Mtengowanthena Community Hosp.	District hospital	CHAM	33.77	-13.67	1547
A42*	Dowa	TA Mkukula	Mtengowanthena Dream Project	Special	NGO	33.78	-13.67	1547
A43*	Dowa	TA Mkukula	Chankhungu HC	Health centre	Government	34.01	-13.77	616

A44*	Dowa	TA Dzoole	Dzoole HC	Health centre	Government	33.66	-13.59	585
A45*	Dowa	TA Chiwere	Mvera Army Camp	Special	Other	34.14	-13.78	481
A46*	Dowa	TA Mkukula	Dzaleka HC	Health centre	Government	33.87	-13.66	457
A47*	Dowa	TA Chiwere	Mvera Mission Hosp.	Health centre	CHAM	34.13	-13.74	403
A48*	Dowa	TA Chiwere	Thonje HC	Health centre	Government	34.24	-13.72	288
A49*	Dowa	TA Kayembe	Mbingwa HC	Health centre	Government	33.51	-13.54	235
A50*	Dowa	TA Chakhaza	Chizolowondo HC	Health centre	Government	33.51	-13.46	205
A51*	Dowa	TA Kayembe	Chisepo HC	Health centre	Government	33.47	-13.63	128
A52*	Dowa	Dowa Boma	FPAM Clinic Dowa	Health centre	NGO	33.93	-13.66	20
A53*	Salima	TA Kambwiri	Chagunda HC	Health centre	Government	34.37	-13.88	252
A54*	Mchinji	TA Mavwere	Nkhwazi HC	Health centre	Government	33.23	-13.92	1353
A55*	Mchinji	TA Mavwere	Kapanga HC	Health centre	Government	33.31	-14.06	487
A56*	Mchinji	TA Simphasi	Chioshya HC	Health centre	Government	33.17	-13.80	454
A57*	Mchinji	TA Mavwere	Namizana HC	Health centre	Government	33.25	-14.00	30
A58*	Dedza	TA Kaphuka	Kasinje HC	Health centre	Government	34.13	-14.15	1641
A59*	Dedza	TA Tambala	Mayani HC	Health centre	Government	34.25	-14.10	852
A60*	Dedza	TA Kaphuka	Kasina HC	Health centre	CHAM	34.13	-14.14	691
A61*	Dedza	TA Kaphuka	Chitowo HC	Health centre	Government	34.04	-14.22	325
A62*	Dedza	TA Chilikumwendo	Matumba HC	Health centre	Government	33.91	-14.37	285
A63*	Dedza	TA Kachere	Kafele HC	Health centre	Government	33.72	-14.43	174
A64*	Dedza	TA Kaphuka	Tsoyo Disp.	Special	Government	34.16	-14.15	117
A65*	Lilongwe City	Area 2	Bwaila Hosp.	District hospital	Government	33.77	-13.99	24846
A66*	Lilongwe City	Area 25	Area 25 HC	Health centre	Government	33.77	-13.89	5883
A67*	Lilongwe City	Area 36	Partners In Hope Clinic	Special	NGO	33.79	-14.02	5417
A68*	Lilongwe City	Area 18	Area 18 HC	Health centre	Government	33.78	-13.94	4461
A69*	Lilongwe City	Area 58	Likuni Mission Hosp.	District hospital	CHAM	33.71	-14.03	4385
A70*	Lilongwe City	Area 33	Baylor Childrens Centre Of Excellence In Malawi	Central hospital	NGO	33.79	-13.98	2623
A71*	Lilongwe City	Area 37	MACRO Lilongwe	Special	NGO	33.78	-14.00	2611
A72*	Lilongwe City	Area 27	Daeyang Luke Hosp.	Other hospital	CHAM	33.81	-13.87	2148
A73*	Lilongwe City	Area 36	Partners In Hope Clinic	Special	NGO	33.79	-14.02	1922
A74*	Lilongwe City	Area 35	Kamuzu Barracks	Special	Other	33.82	-13.98	1509
A75*	Lilongwe City	Area 53	Lumbadzi HC	Health centre	Government	33.81	-13.77	1392
A76*	Lilongwe City	Area 47	African Bible College Clinic	Special	CHAM	33.74	-13.97	1268
A77*	Lilongwe City	Area 30	Area 30 Police Clinic	Special	Other	33.78	-13.93	1099
A78*	Lilongwe City	Area 33	Kamuzu Central Hosp.	Central hospital	Government	33.79	-13.98	1042
A79*	Lilongwe City	Area 25	Dzenza HC	Health centre	CHAM	33.75	-13.88	936
A80*	Lilongwe City	Area 57	Lilongwe City Assembly Chinsapo	Special	Government	33.73	-14.01	801
A81*	Lilongwe City	Area 6	Maula Prison HC	Health centre	Other	33.77	-13.97	599
A82*	Lilongwe City	Area 53	Blessings Hosp.	Other hospital	Private	33.82	-13.79	408
A83*	Lilongwe City	Area 7	FPAM Clinic Kawale	Health centre	NGO	33.80	-13.99	383
A84*	Lilongwe City	Area 14	Adventist HC Lilongwe	Other hospital	CHAM	33.78	-13.95	281
A85*	Lilongwe City	Area 29	Alliance One Clinic	Special	Private	33.80	-13.90	98
A86*	Lilongwe City	Area 44	New State House Disp.	Dispensary	Government	33.85	-13.96	80

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
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F1	Lilongwe	TA Masumbankhunda	DZABWA	Health Post	CHAM	33.57	-14.10	826	(565-1157)
F2	Lilongwe	TA Masumbankhunda	PHIRILANJUZI	Health Post	CHAM	33.58	-14.15	641	(429-934)
F3	Lilongwe	TA Mtema	MNGWANGWA	Health Post	Government	33.68	-13.84	442	(315-590)
F4	Lilongwe	TA Kalumbu	NYANJA	Health Post	Government	33.94	-14.14	429	(294-619)
F5	Lilongwe	TA Kalolo	Chiwe HC	Health Centre	CHAM	33.40	-13.91	387	(267-537)
F6	Lilongwe	TA Chiseka	Mkwindi HP	Health Post	NGO	33.75	-14.18	318	(228-441)
F7	Lilongwe	TA Masula	KAMBANIZITHE	Health Post	Government	33.71	-14.35	316	(205-459)
F8	Lilongwe	TA Chiseka	KAMPINI	Health Post	Government	33.78	-14.30	311	(206-437)
F9	Lilongwe	TA Kalolo	Lemwe HC	Health Centre	Government	33.34	-13.89	329	(215-470)
F10	Lilongwe	STA Chitekwele	CHITEKWELE	Health Post	Government	34.10	-13.97	249	(162-368)
F11	Lilongwe	TA Masula	KAMPHONI	Health Post	Government	33.63	-14.31	210	(128-318)
F12	Lilongwe	TA Kalumbu	BWESE	Health Post	Government	33.94	-14.22	456	(298-673)
F13	Lilongwe	TA Masumbankhunda	Dzalanyama/Kapombe	Health Centre	Government	33.44	-14.25	67	(37-112)
F14	Lilongwe	TA Njewa	BULI	Health Post	Government	33.71	-13.92	0	(0-0)
F15*	Dowa	TA Mkukula	KAPUTALAMBWE	Health Post	CHAM	33.90	-13.77	410	(276-581)
F16*	Dowa	TA Chiwere	Chezi HC	Health Centre	CHAM	34.04	-13.72	227	(151-322)
F17*	Dowa	TA Kayembe	MONDWE	Health Post	Government	33.44	-13.49	185	(128-255)
F18*	Dowa	Dowa Boma	Family Planning Association of Malawi Dowa	Special	NGO	33.93	-13.66	0	(0-0)
F19*	Dowa	TA Mkukula	St. Mary's Rehabilitation Heal	Health Centre	CHAM	34.04	-13.73	227	(151-322)
F20*	Mchinji	TA Mawwere	MTANGA	Health Post	Other	33.26	-13.92	97	(64-141)
F21*	Mchinji	TA Mawwere	Waliranji	Health Centre	Government	33.27	-13.97	86	(59-120)
F22*	Mchinji	TA Mawwere	Namizana Police Disp.	Dispensary	Other	33.25	-14.00	0	(0-0)
F23*	Dedza	TA Chilikumwendo	Mdeza Disp.	Dispensary	Government	33.97	-14.24	575	(388-827)
F24*	Dedza	TA Tambala	Mjini Disp.	Dispensary	Government	34.24	-14.04	166	(109-246)
F25*	Dedza	TA Tambala	Kalulu HC	Health Centre	Government	34.20	-14.00	136	(87-200)
F26*	Dedza	TA Tambala	MPOMBE	Health Post	Government	34.31	-13.99	126	(83-184)
F27*	Dedza	TA Tambala	KANYERERE	Health Post	Government	34.23	-13.97	91	(55-137)
F28*	Dedza	TA Tambala	MJINI	Dispensary	Government	34.24	-14.04	166	(109-246)
F29*	Lilongwe City	Area 38	Chimwala HC	Health Centre	Government	33.80	-14.05	792	(579-1024)
F30*	Lilongwe City	Area 23	Mlodza SDA Disp.	Dispensary	CHAM	33.82	-14.01	142	(105-183)
F31*	Lilongwe City	Area 29	Africa Leaf Clinic Kanengo	Clinic	Company	33.80	-13.89	1	(0-1)
F32*	Lilongwe City	Area 36	SOS Clinic	Special	NGO	33.79	-14.02	0	(0-0)
F33*	Lilongwe City	Area 1	BLM Falls	Special	NGO	33.78	-14.00	0	(0-0)
F34*	Lilongwe City	Area 25	BLM Area 25	Special	NGO	33.76	-13.89	0	(0-0)
F35*	Lilongwe City	Area 7	BLM Kawale	Special	NGO	33.80	-13.99	0	(0-0)
F36*	Lilongwe City	Area 3	City Assembly Health	Clinic	Government	33.77	-13.99	0	(0-0)
F37*	Lilongwe City	Area 3	Lilongwe City Assembly Staff C	Clinic	Government	33.77	-13.99	0	(0-0)
F38*	Lilongwe City	Area 29	Auction Holdings Clinic	Clinic	Company	33.80	-13.89	0	(0-0)
F39*	Lilongwe City	Area 29	Carlsberg / Sobo Clinic Lilong	Clinic	Company	33.80	-13.90	0	(0-0)
F40*	Lilongwe City	Area 3	Escom Clinic Lilongwe	Clinic	Company	33.77	-13.99	0	(0-0)
F41*	Lilongwe City	Area 39	Kanengo Tobacco Processors Cli	Clinic	Company	33.81	-13.90	1	(0-1)
F42*	Lilongwe City	Area 29	Limbe Leaf Tobacco Co. Ltd. CI	Clinic	Company	33.80	-13.89	0	(0-0)
F43*	Lilongwe City	Area 20	MoH Hq	Clinic	Government	33.79	-13.95	0	(0-0)

F44*	Lilongwe City	Area 16	Reserve Bank of Malawi Clinic	Clinic	Company	33.79	-13.96	0	(0-0)
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Travel Times to Closest ART Facilities

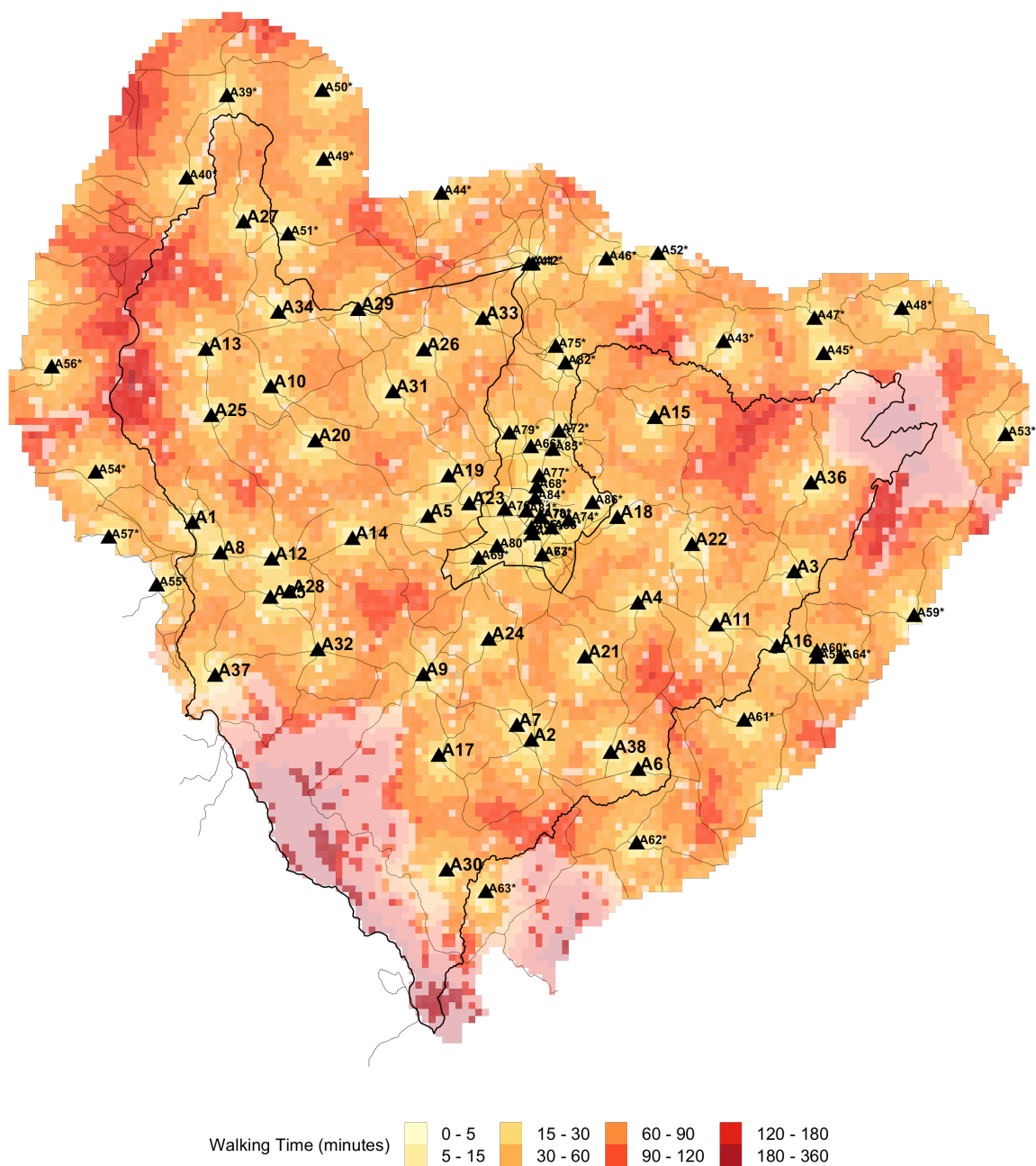


Figure 4: Estimated travel times to the closest ART facility. Travel times were calculated using data on road infrastructure, types of terrain and land elevation.

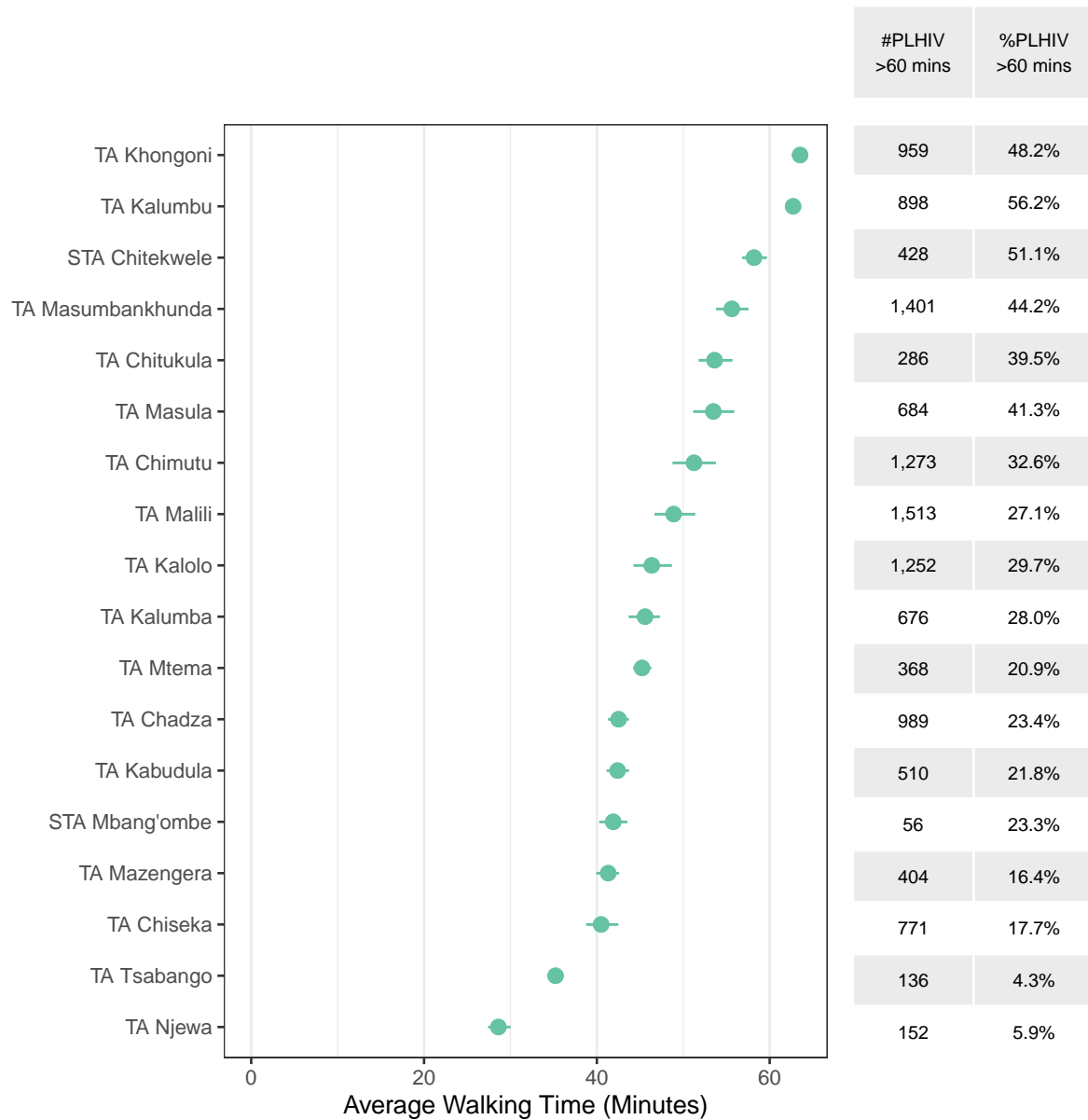


Figure 5: Estimated average walking time to the closest ART facility, weighted by the estimated number of PLHIV within the traditional authority. The right table indicates estimated number and proportion of PLHIV that need more than 60 minutes to travel to the closest ART facility, respectively.

Areas outside 60 minutes travel

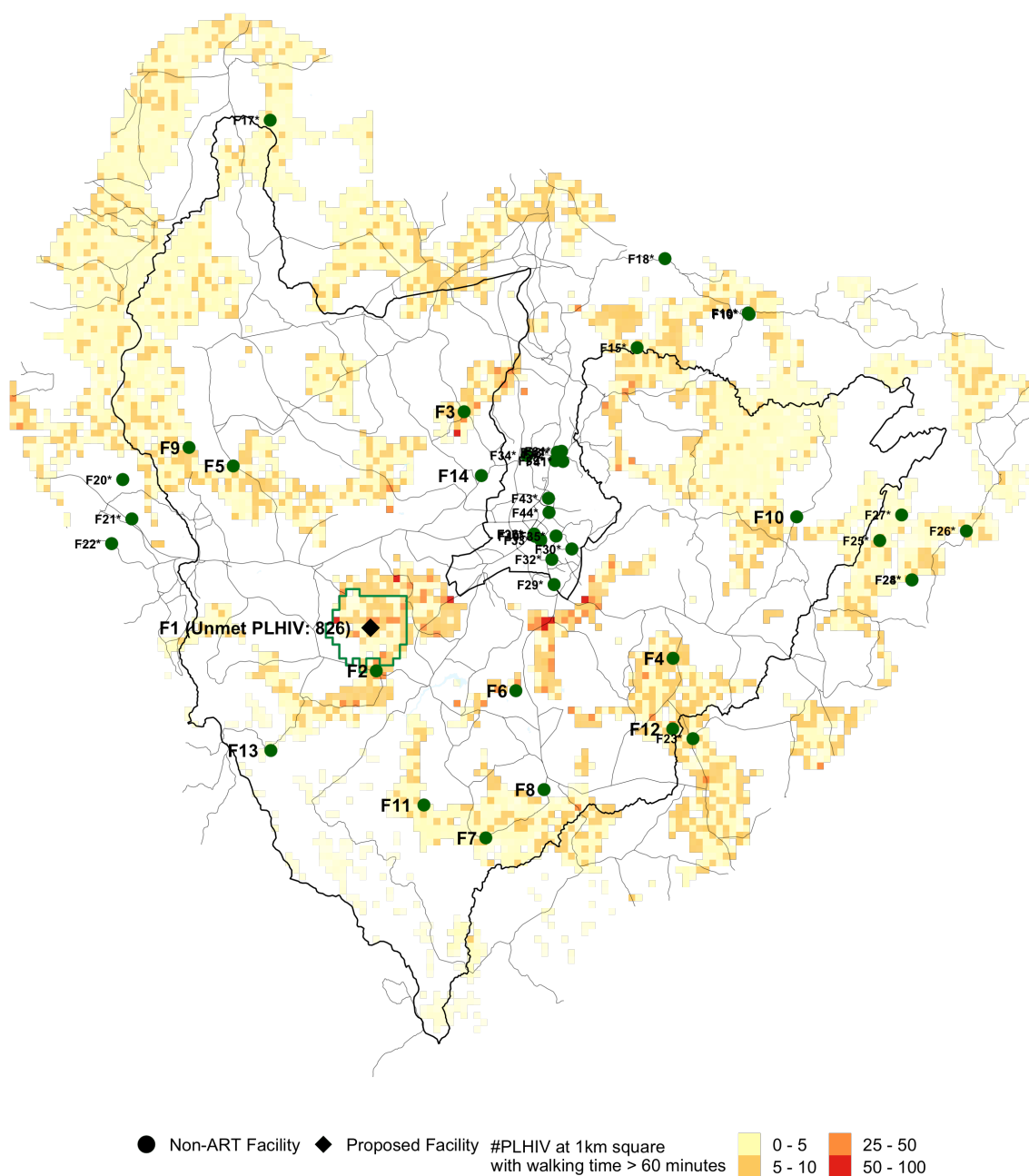


Figure 6: Proposed facility locations. Areas where the walking time to the closest ART facility is <60 minutes have been removed. Green lines indicate the 60-minutes catchment area of the proposed facility.

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.