

This is supplementary material related to paper

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Supplementary figures 1A – B Absolute numbers and population incidence of admission to QECH, by HIV status.

Supplementary tables 1A and 1B Measured population of Blantyre, Malawi at census in 2010 and 2018, and interpolated / extrapolated population at Q4.2012 and Q3.2019.

Supplementary figures 2A and 2B Sensitivity analyses of incidence of admission, with different missing data handling choices.

Supplementary table 2 Reduction in admission to QECH by age group and sex.

Supplementary figures 3A – D Modelled and observed population incidence of HIV related hospital admission, using various different choices of model (Poisson distribution, Gamma distribution, negative binomial without splines, negative binomial with splines with five knots)

Supplementary table 3 Risk of death if admitted to QECH by age group, sex and HIV status.

Supplementary figure 4 Risk of death if living with HIV (complete cases analysis).

Supplementary figure 5 Risk of death by quarter year, age group, sex and ART status.

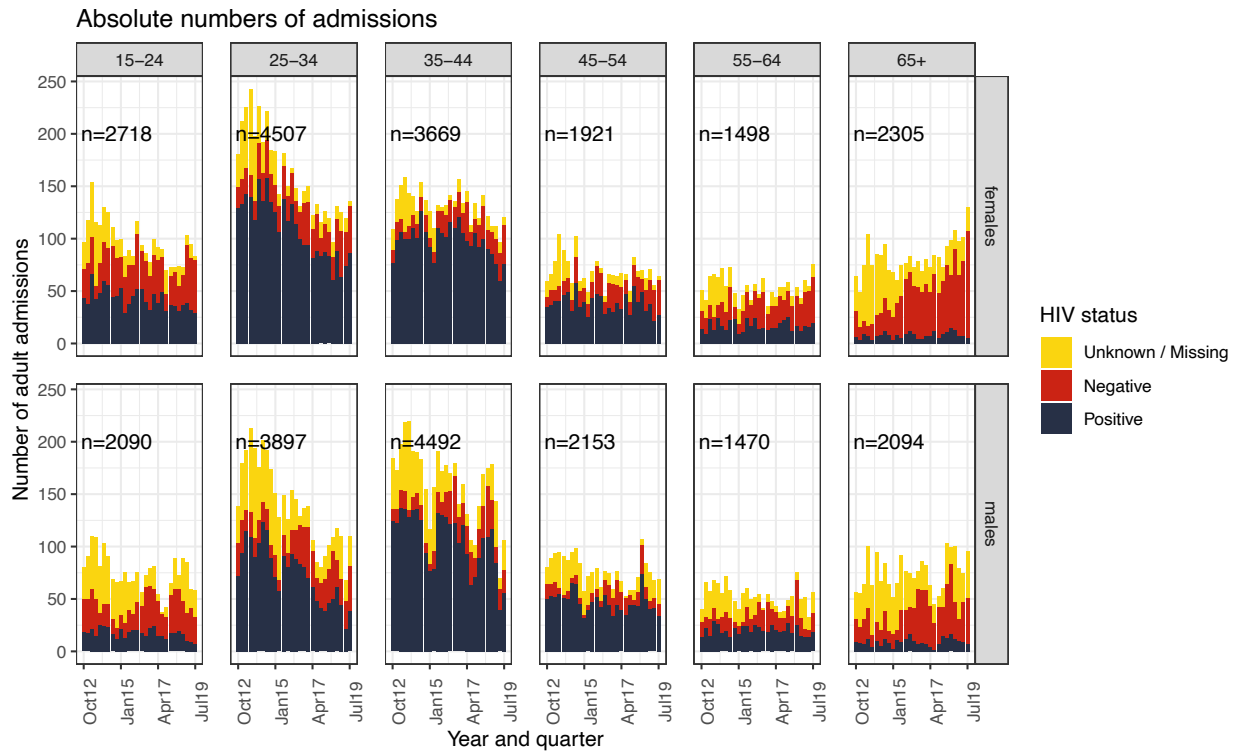
Supplementary figure 6 Risk of death by quarter year, age group and HIV status.

Supplementary table 4 Trend by quarter year in risk of death if living with HIV and admitted, by age and sex.

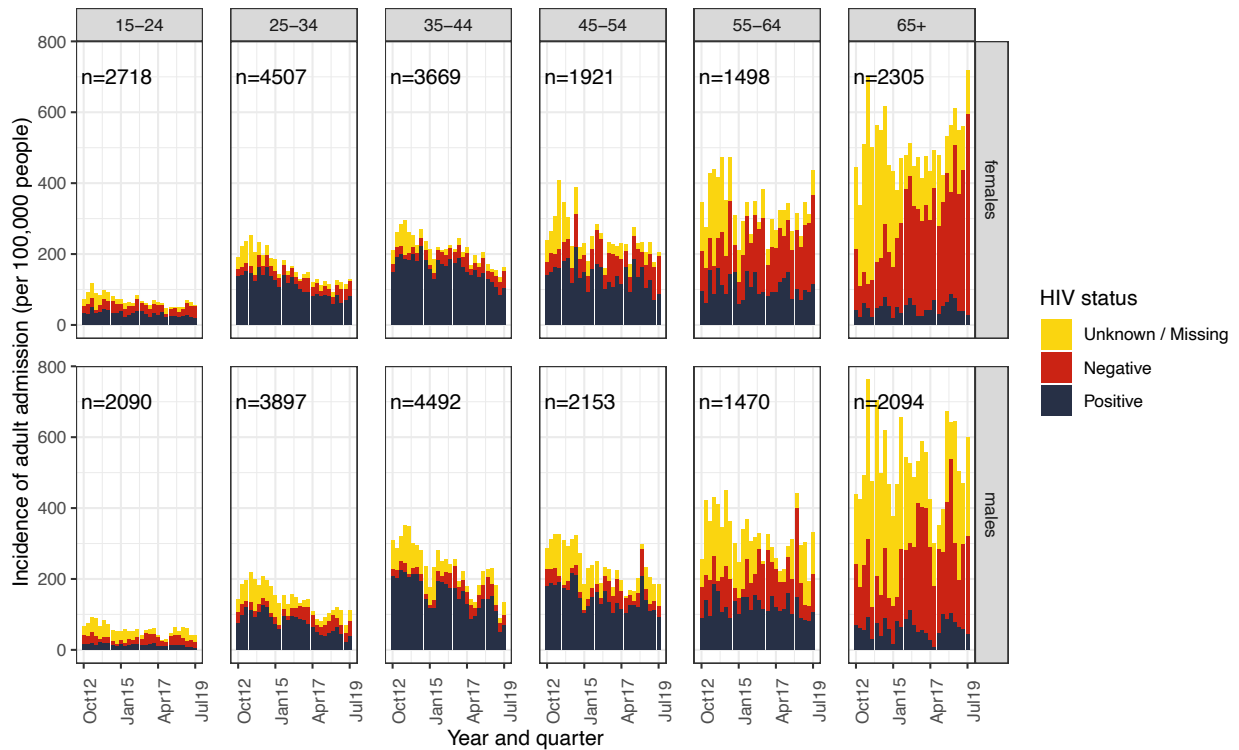
Information about people who resided outside of Blantyre (and are excluded from this analysis)

Supplementary Figure 1: Admissions by age, sex, HIV and quarter-year

S. Figure 1A: Absolute numbers of admissions, stacked bar chart of crude data.



S. Figure 1B: Population level incidence of admissions, stacked bar chart of crude data.



Supplementary table 1: Blantyre census for 2008 and 2018

S Table 1A: Measured population Blantyre (includes Blantyre City and Blantyre Rural administrative districts) at 2008 and 2018 census

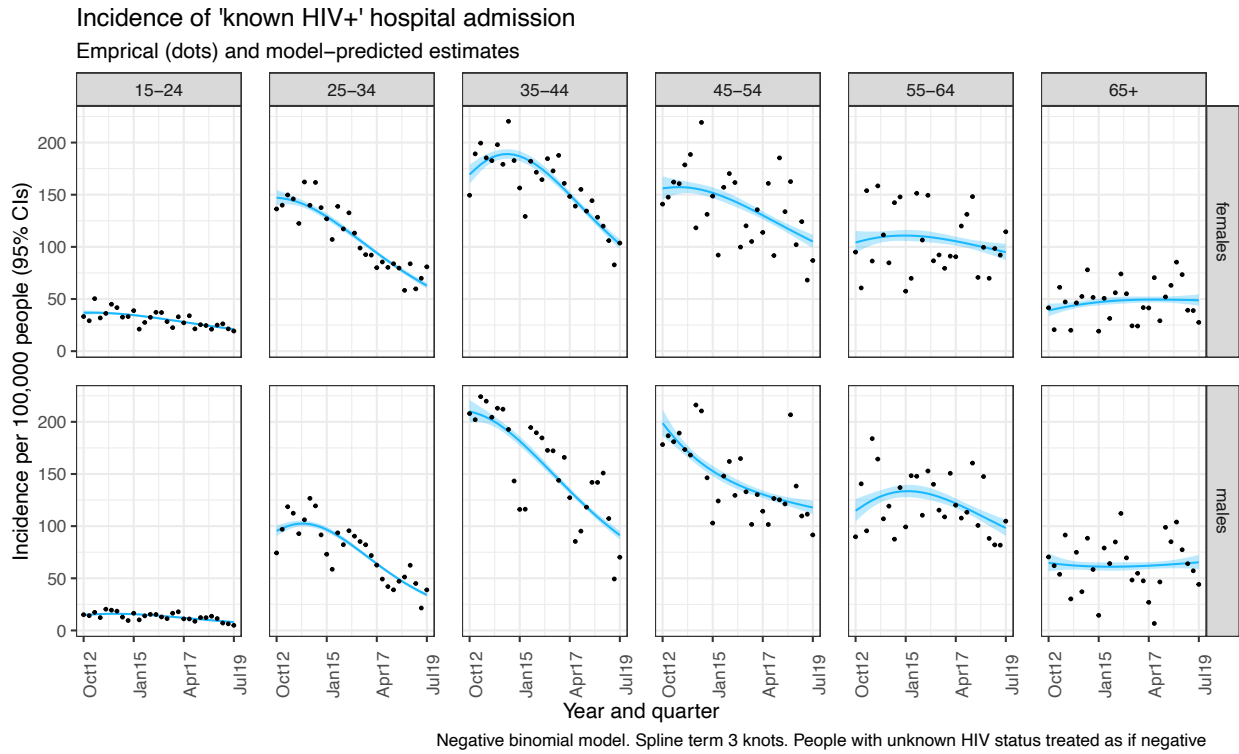
ageg10	sex	2008-04-01	2018-04-01
15-24	females	115573	146543
15-24	males	103290	138639
25-34	females	86762	104200
25-34	males	96314	97602
35-44	females	36968	69311
35-44	males	46176	76067
45-54	females	20676	29912
45-54	males	22000	35461
55-64	females	12915	16974
55-64	males	14529	16887
65+	females	11962	17441
65+	males	10728	15286

S Table 1B: Population Blantyre at start (Q4.2012) and end (Q3.2019) study period [calculated using linear interpolation and extrapolation]

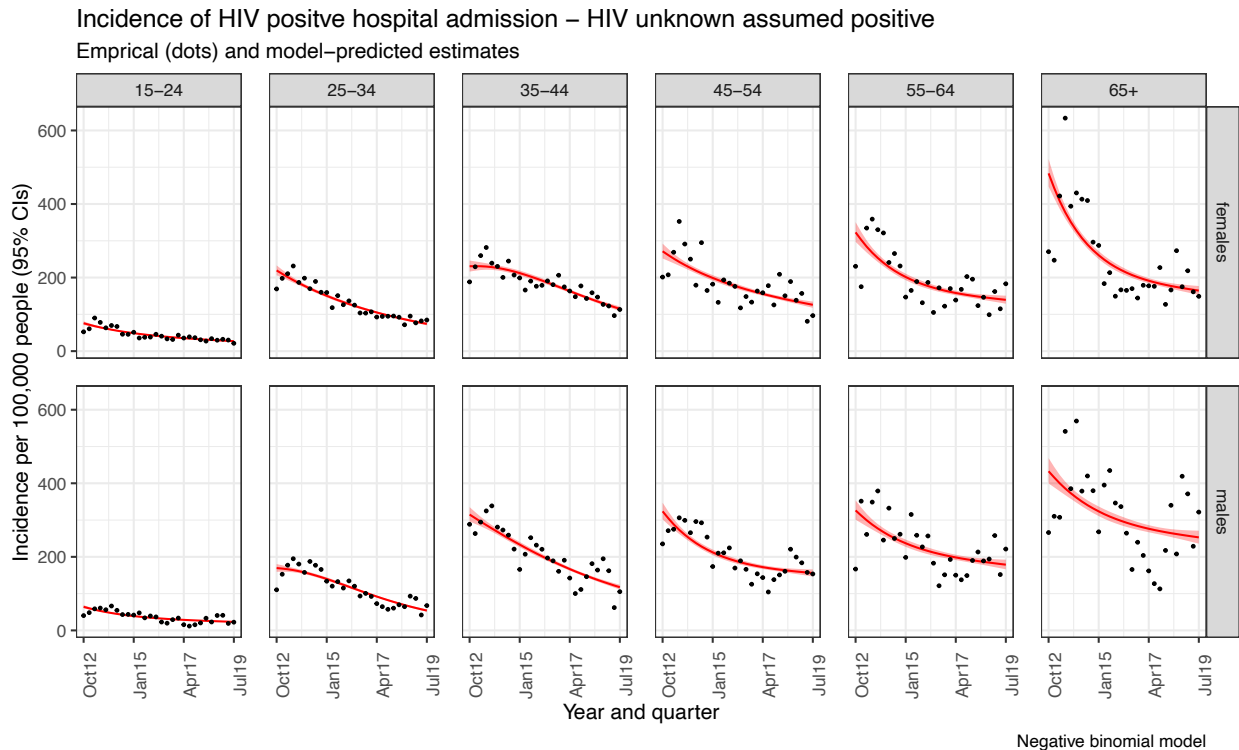
ageg10	sex	2012-10-01	2019-07-01	change
15-24	females	129510	150378	14%
15-24	males	119197	143016	17%
25-34	females	94609	106359	11%
25-34	males	96894	97762	1%
35-44	females	51523	73319	30%
35-44	males	59627	79772	25%
45-54	females	24832	31058	20%
45-54	males	28058	37129	24%
55-64	females	14743	17476	16%
55-64	males	15591	17180	9%
65+	females	14427	18121	20%
65+	males	12778	15851	19%

Supplementary figure 2: Sensitivity analysis for incidence (imputation)

S. Figure 2A: Everyone with HIV status unknown / missing is treated as if HIV negative



S. Figure 2B: Everyone with HIV status unknown / missing is treated as if HIV positive

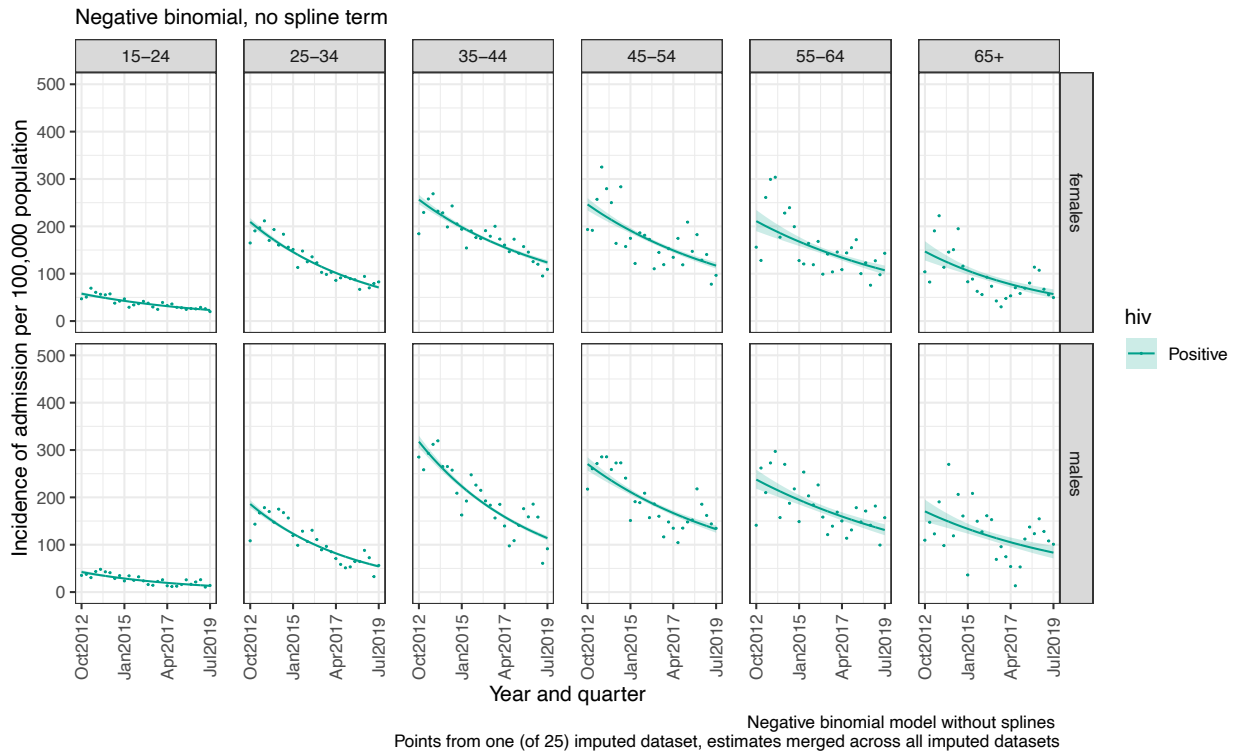


Supplementary Table 2: Reduction in admission to QECH by age group and sex

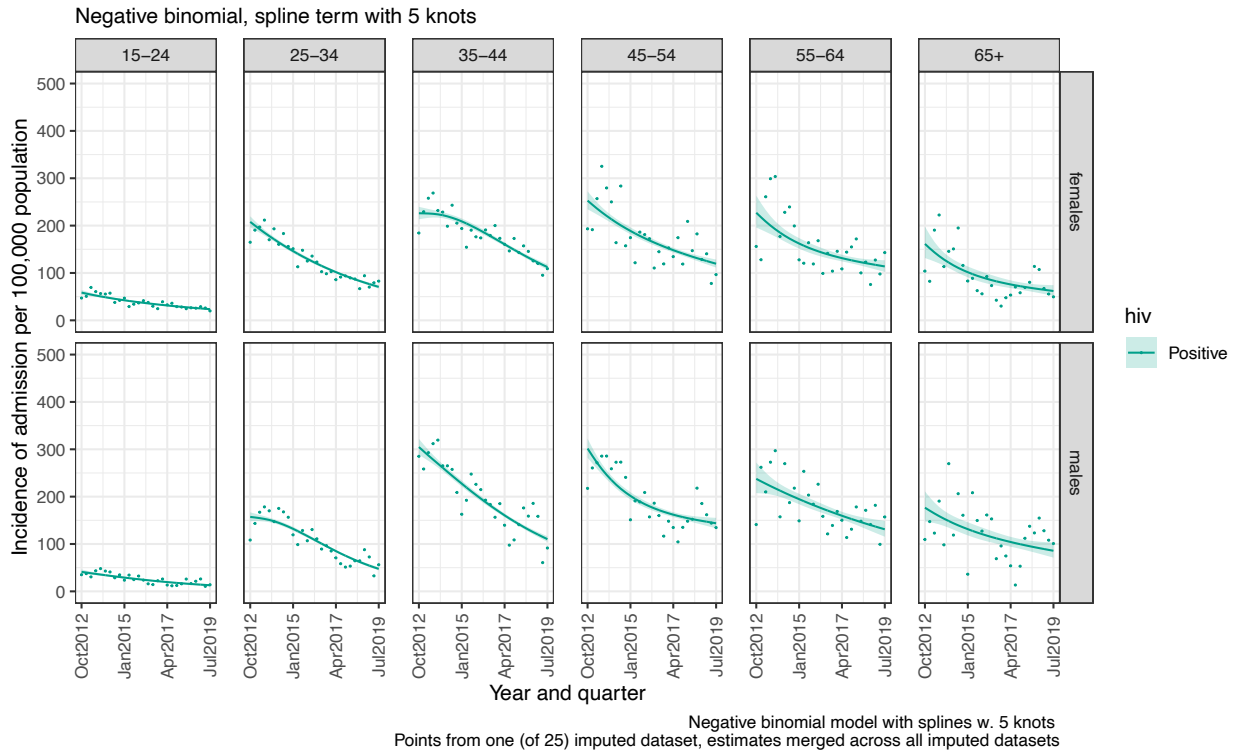
Age group	Sex	HIV status imputed when missing		HIV unknowns assumed negative		HIV unknowns assumed positive	
		Absolute number	Relative decline	Absolute number	Relative decline	Absolute number	Relative decline
15-24	females	815 (612 to 1019)	0.356 (0.299 to 0.414)	253 (164 to 342)	0.175 (0.125 to 0.226)	1248 (1049 to 1447)	0.42 (0.381 to 0.459)
15-24	males	599 (417 to 782)	0.398 (0.325 to 0.472)	66 (19 to 113)	0.121 (0.045 to 0.198)	1039 (879 to 1198)	0.441 (0.403 to 0.479)
25-34	females	2264 (1940 to 2589)	0.388 (0.354 to 0.422)	1078 (873 to 1283)	0.26 (0.223 to 0.297)	2474 (2096 to 2851)	0.401 (0.364 to 0.437)
25-34	males	1330 (1065 to 1595)	0.314 (0.271 to 0.357)	530 (392 to 669)	0.204 (0.161 to 0.246)	1489 (1194 to 1784)	0.322 (0.279 to 0.366)
35-44	females	844 (609 to 1080)	0.215 (0.168 to 0.262)	223 (61 to 385)	0.075 (0.025 to 0.126)	895 (632 to 1157)	0.222 (0.171 to 0.273)
35-44	males	2169 (1828 to 2509)	0.366 (0.329 to 0.402)	1121 (911 to 1331)	0.274 (0.236 to 0.311)	2255 (1877 to 2633)	0.367 (0.328 to 0.406)
45-54	females	635 (481 to 790)	0.322 (0.269 to 0.375)	149 (59 to 239)	0.122 (0.058 to 0.187)	713 (559 to 866)	0.336 (0.287 to 0.384)
45-54	males	1025 (836 to 1213)	0.372 (0.329 to 0.415)	497 (381 to 614)	0.274 (0.227 to 0.321)	1119 (909 to 1329)	0.379 (0.334 to 0.423)
55-64	females	337 (178 to 497)	0.33 (0.226 to 0.435)	-6 (-55 to 43)	-0.013 (-0.119 to 0.094)	595 (476 to 714)	0.409 (0.36 to 0.457)
55-64	males	267 (114 to 420)	0.246 (0.139 to 0.353)	-30 (-82 to 21)	-0.058 (-0.162 to 0.047)	461 (338 to 583)	0.308 (0.251 to 0.364)
65+	females	308 (156 to 459)	0.421 (0.297 to 0.544)	-37 (-65 to -8)	-0.207 (-0.398 to -0.016)	1081 (911 to 1252)	0.491 (0.451 to 0.531)
65+	males	225 (102 to 348)	0.319 (0.2 to 0.438)	9 (-26 to 43)	0.033 (-0.096 to 0.162)	498 (366 to 630)	0.287 (0.233 to 0.341)

Supplementary figure 3A: Sensitivity analysis for incidence (choice of model)

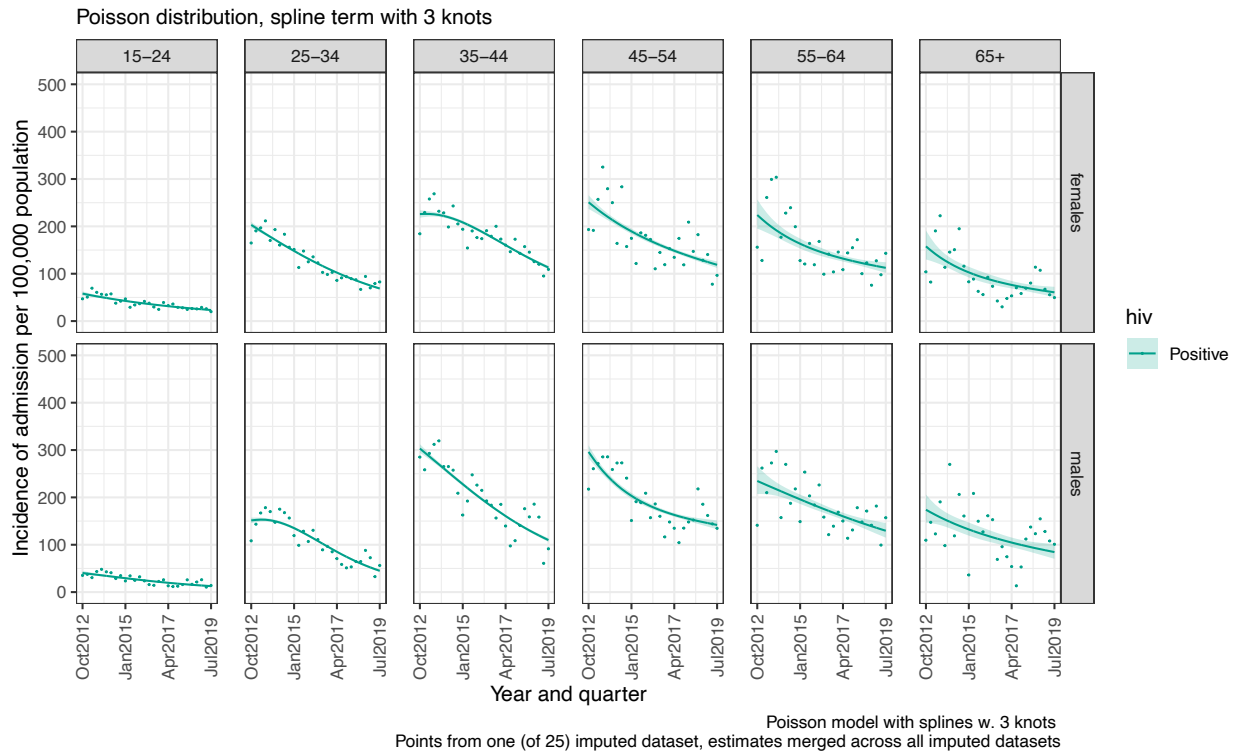
S. Figure 3A: Negative binomial distribution without spline terms



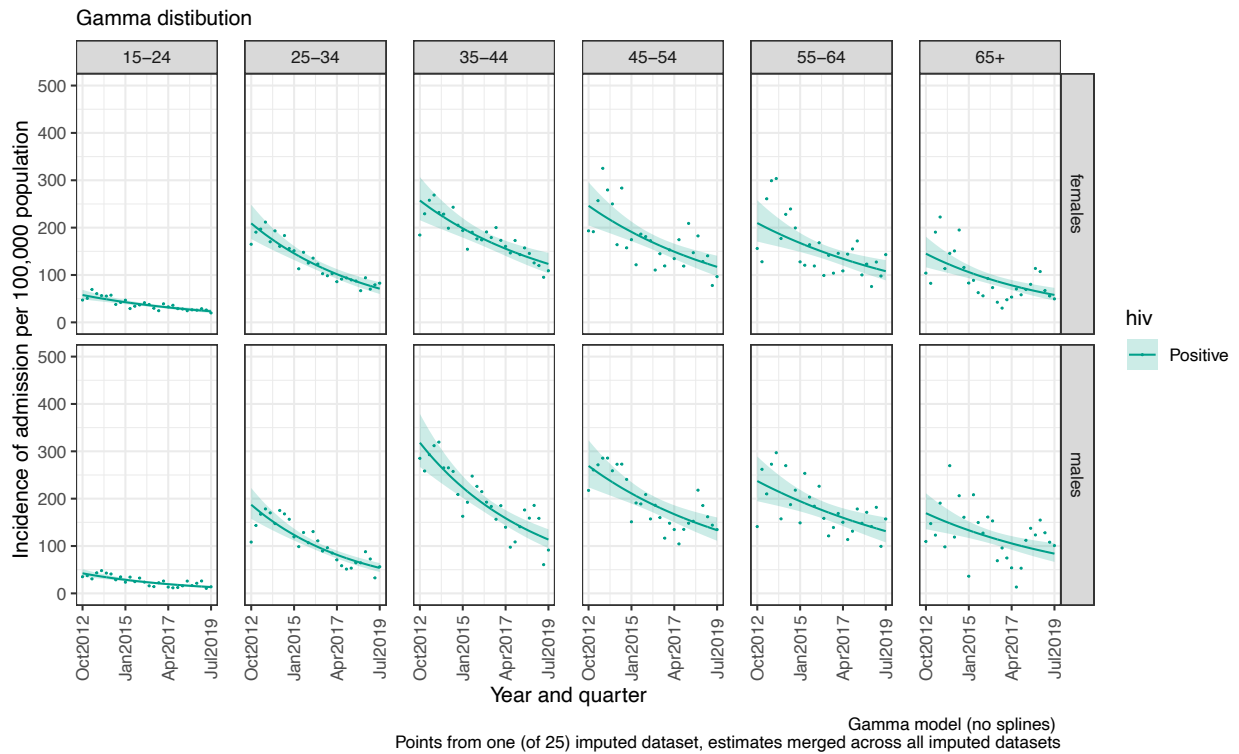
S. Figure 3B: Negative binomial distribution with 5 knots in spline



S. Figure 3C: Poisson distribution, 3 knot splines



S. Figure 3D: Gamma distribution, no splines



Supplementary table 3: Death risk by age group and sex

Table 3A: Crude Data

hivart		(Missing) (N=2687)	Died (N=6071)	Discharged alive (N=24056)
HIV negative	ageg10			
	15-24	73 (4.1%)	124 (7.0%)	1575 (88.9%)
	25-34	66 (4.2%)	135 (8.6%)	1366 (87.2%)
	35-44	96 (8.5%)	123 (10.9%)	909 (80.6%)
	45-54	79 (9.5%)	104 (12.6%)	645 (77.9%)
	55-64	119 (11.1%)	143 (13.4%)	809 (75.5%)
	65+	258 (12.6%)	323 (15.8%)	1463 (71.6%)
	sex			
	females	403 (8.6%)	448 (9.6%)	3814 (81.8%)
	males	288 (7.7%)	504 (13.5%)	2953 (78.9%)
HIV positive, ART status unknown	ageg10			
	15-24	3 (15.8%)	2 (10.5%)	14 (73.7%)
	25-34	22 (22.9%)	18 (18.8%)	56 (58.3%)
	35-44	20 (19.6%)	16 (15.7%)	66 (64.7%)
	45-54	3 (8.3%)	6 (16.7%)	27 (75.0%)
	55-64	6 (30.0%)	7 (35.0%)	7 (35.0%)
	65+	0 (0.0%)	4 (36.4%)	7 (63.6%)
	sex			
	females	24 (20.2%)	19 (16.0%)	76 (63.9%)
	males	30 (18.2%)	34 (20.6%)	101 (61.2%)
HIV positive, not on ART	ageg10			
	15-24	15 (4.0%)	73 (19.4%)	288 (76.6%)
	25-34	115 (10.8%)	168 (15.8%)	783 (73.5%)
	35-44	110 (11.0%)	179 (17.9%)	712 (71.1%)
	45-54	32 (8.5%)	87 (23.2%)	256 (68.3%)
	55-64	11 (7.1%)	31 (19.9%)	114 (73.1%)
	65+	9 (11.8%)	20 (26.3%)	47 (61.8%)
	sex			
	females	123 (9.0%)	195 (14.2%)	1055 (76.8%)
	males	169 (10.1%)	363 (21.6%)	1145 (68.3%)
HIV positive, on ART	ageg10			
	15-24	138 (10.8%)	184 (14.5%)	951 (74.7%)
	25-34	389 (9.8%)	748 (18.8%)	2838 (71.4%)
	35-44	487 (10.6%)	965 (20.9%)	3160 (68.5%)
	45-54	202 (10.2%)	430 (21.7%)	1346 (68.0%)
	55-64	82 (9.6%)	230 (26.8%)	545 (63.6%)
	65+	41 (10.8%)	108 (28.5%)	230 (60.7%)
	sex			
	females	739 (10.2%)	1210 (16.7%)	5315 (73.2%)
	males	600 (10.3%)	1455 (25.0%)	3755 (64.6%)
HIV status unknown	ageg10			
	15-24	29 (2.1%)	179 (13.1%)	1160 (84.8%)
	25-34	54 (3.2%)	328 (19.3%)	1318 (77.5%)
	35-44	41 (3.1%)	331 (25.1%)	946 (71.8%)
	45-54	42 (4.9%)	223 (26.0%)	592 (69.1%)
	55-64	46 (5.3%)	233 (27.0%)	585 (67.7%)
	65+	99 (5.2%)	549 (29.1%)	1241 (65.7%)
	sex			

hivart	(Missing) (N=2687)	Died (N=6071)	Discharged alive (N=24056)
females	125 (3.9%)	641 (20.1%)	2431 (76.0%)
males	186 (3.9%)	1202 (25.0%)	3411 (71.1%)

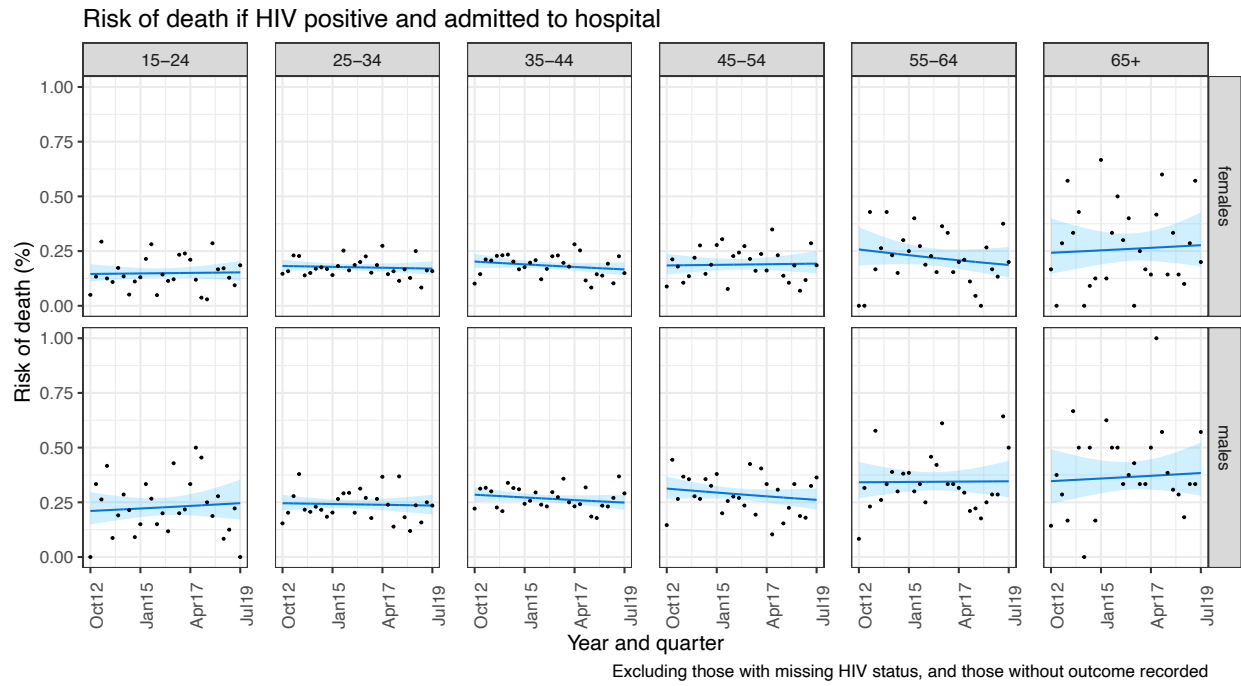
Table 3B: After imputation

Table 2: After imputation for missing data

hivart		Died (N=6656)	Discharged alive (N=26158)
HIV negative	ageg10		
	15-24	185 (7.5%)	2280 (92.5%)
	25-34	178 (9.2%)	1763 (90.8%)
	35-44	158 (11.7%)	1193 (88.3%)
	45-54	158 (15.6%)	855 (84.4%)
	55-64	245 (16.6%)	1234 (83.4%)
	65+	784 (22.5%)	2707 (77.5%)
	sex		
	females	782 (12.8%)	5321 (87.2%)
males	926 (16.4%)	4711 (83.6%)	
HIV positive by imputation, assume no ART for model	ageg10		
	15-24	135 (20.0%)	540 (80.0%)
	25-34	299 (22.5%)	1027 (77.5%)
	35-44	312 (28.5%)	783 (71.5%)
	45-54	190 (28.3%)	482 (71.7%)
	55-64	157 (34.4%)	299 (65.6%)
	65+	185 (41.9%)	257 (58.1%)
	sex		
	females	408 (23.2%)	1351 (76.8%)
males	870 (29.9%)	2037 (70.1%)	
HIV positive, not on ART	ageg10		
	15-24	75 (19.8%)	303 (80.2%)
	25-34	198 (18.1%)	898 (81.9%)
	35-44	213 (20.7%)	816 (79.3%)
	45-54	95 (25.0%)	285 (75.0%)
	55-64	33 (20.9%)	125 (79.1%)
	65+	25 (32.1%)	53 (67.9%)
	sex		
	females	227 (16.2%)	1174 (83.8%)
males	412 (24.0%)	1306 (76.0%)	
HIV positive, on ART	ageg10		
	15-24	211 (16.4%)	1079 (83.6%)
	25-34	863 (21.4%)	3178 (78.6%)
	35-44	1114 (23.8%)	3572 (76.2%)
	45-54	473 (23.5%)	1536 (76.5%)
	55-64	236 (27.0%)	639 (73.0%)
	65+	134 (34.5%)	254 (65.5%)
	sex		
	females	1402 (19.1%)	5953 (80.9%)
males	1629 (27.5%)	4305 (72.5%)	

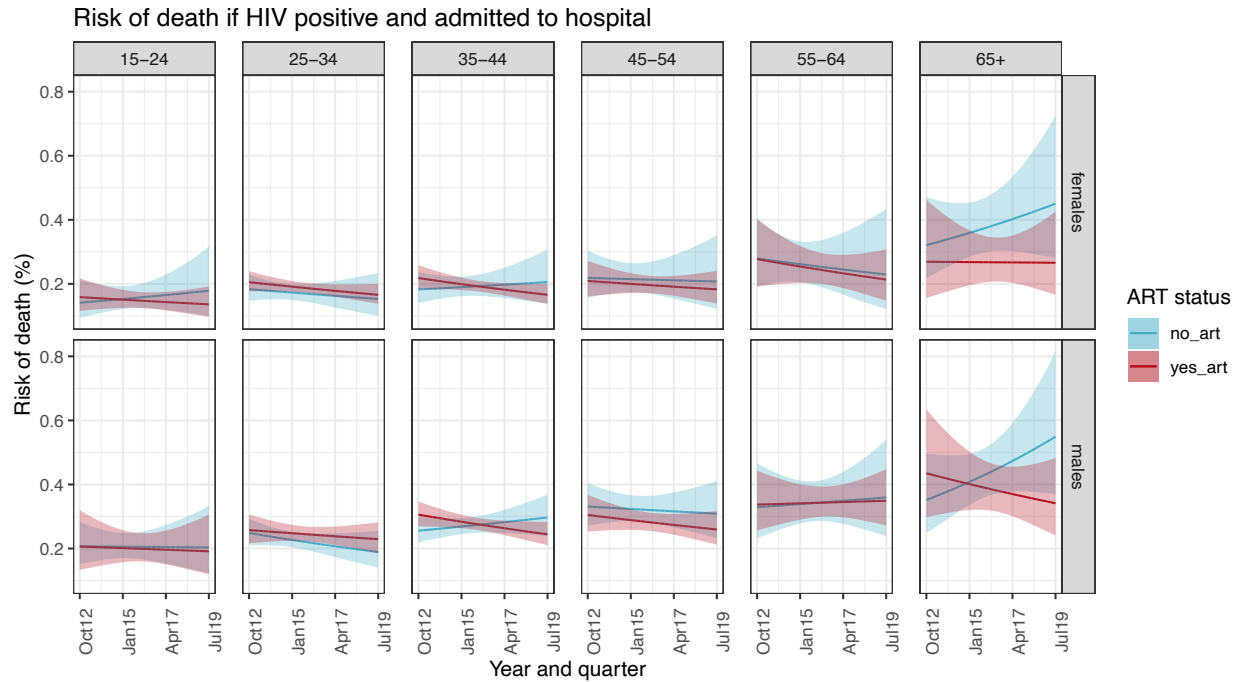
Supplementary figure 4: Sensitivity analysis risk of death

Complete case analysis, HIV and outcome unknown status removed

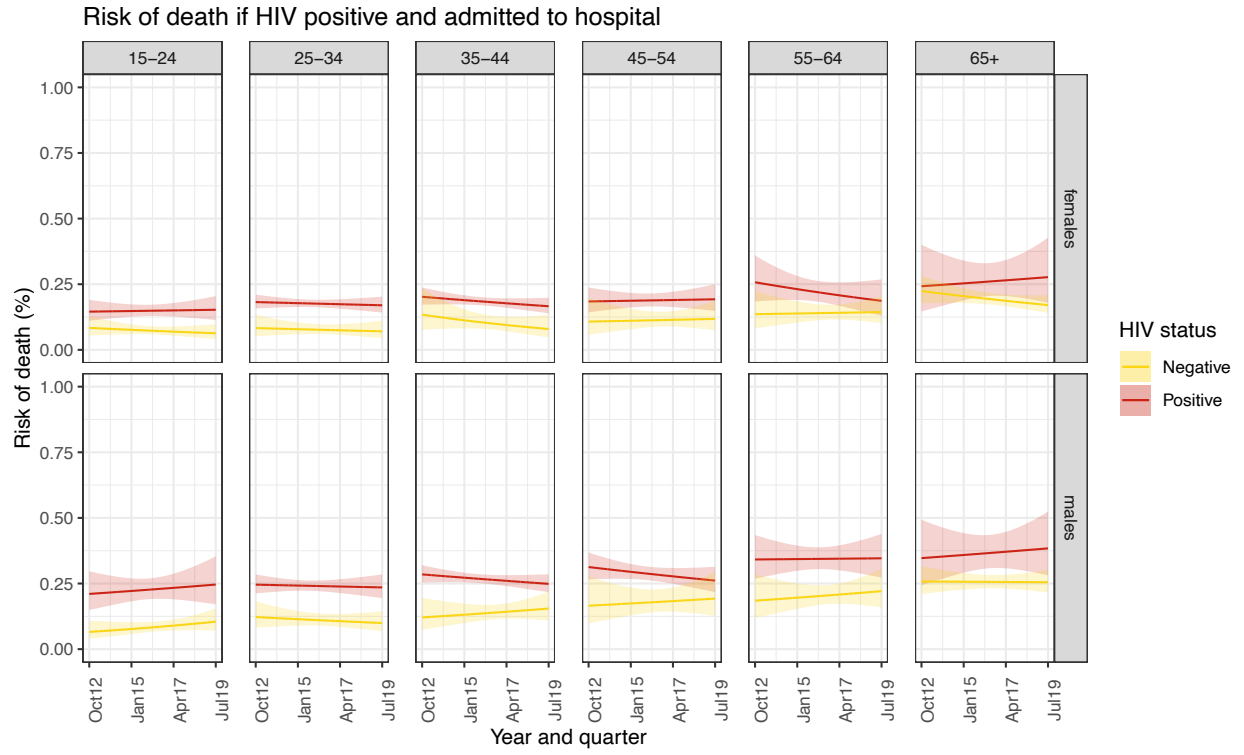


Supplementary figure 5: Risk of death including ART as a covariate

Plot model-predicted risk of death from model incorporating age group, sex, quarter-year and ART status



Supplementary figure 6: Risk of death over time including HIV negative



Supplementary table 4: Trend in outcome by age and sex

Using “emtrends” from “emmeans” package. In every age and sex group, confidence intervals for trend by quarter cross null effect.

ageg10	sex	q.trend	SE	df	asympt.LCL	asympt.UCL
15-24	females	0.0004729613	0.0011636125	Inf	-0.001807677	2.753600e-03
25-34	females	-0.0010007736	0.0008266785	Inf	-0.002621034	6.194864e-04
35-44	females	-0.0017293607	0.0009121361	Inf	-0.003517115	5.839319e-05
45-54	females	-0.0011786709	0.0013566146	Inf	-0.003837587	1.480245e-03
55-64	females	-0.0039595377	0.0020453824	Inf	-0.007968414	4.933821e-05
65+	females	0.0008105217	0.0027584539	Inf	-0.004595949	6.216992e-03
15-24	males	-0.0008936541	0.0016541745	Inf	-0.004135777	2.348468e-03
25-34	males	-0.0012515457	0.0010450936	Inf	-0.003299892	7.968002e-04
35-44	males	-0.0016206534	0.0009252838	Inf	-0.003434176	1.928696e-04
45-54	males	-0.0010379190	0.0013394894	Inf	-0.003663270	1.587432e-03
55-64	males	0.0005027680	0.0020536922	Inf	-0.003522395	4.527931e-03
65+	males	0.0015549194	0.0026720492	Inf	-0.003682201	6.792040e-03

Information about people who resided outside Blantyre

5,511 people were excluded from analysis due to residence outside Blantyre. They had similar characteristics to people who lived in Blantyre.

HIV status of those inside and outside of Blantyre

HIV	Blantyre	elsewhere
Unknown / Missing	24.4% (7996)	25.3% (1392)
Negative	25.6% (8410)	36.2% (1996)
Positive	50.0% (16408)	38.5% (2123)

Age distribution of those inside and outside of Blantyre

ageg10	Blantyre	elsewhere
15-24	14.7% (4808)	17.1% (942)
25-34	25.6% (8404)	23.0% (1269)
35-44	24.9% (8161)	21.6% (1193)
45-54	12.4% (4074)	12.8% (704)
55-64	9.0% (2968)	9.9% (543)
65+	13.4% (4399)	15.6% (860)

Sex distribution of those inside and outside of Blantyre

sex	Blantyre	elsewhere
females	50.6% (16618)	53.9% (2971)
males	49.4% (16196)	46.1% (2540)

Outcomes of those inside and outside of Blantyre

outcome	Blantyre	elsewhere
1. Survived to discharge	73.3% (24056)	71.6% (3946)
2. Died in hospital	18.5% (6071)	23.3% (1283)
3. Missing / unknown	8.2% (2687)	5.1% (282)