

Supporting Information for

Antiretroviral therapy is a major cause of tuberculosis decline in southern and eastern Africa

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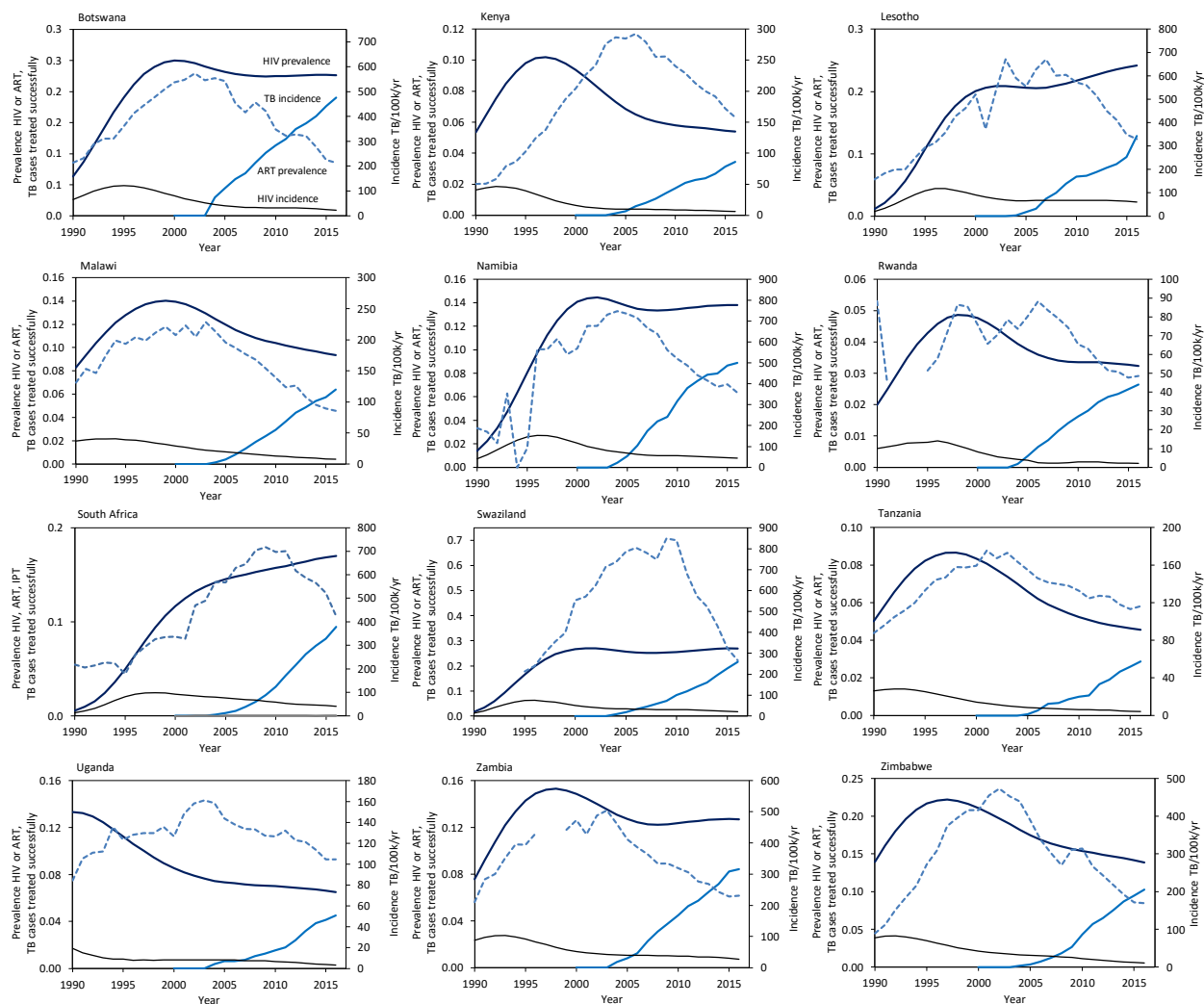
The SI presents additional data on HIV and TB epidemics, and additional Figures to support Materials and Methods in the main text.

Countries included in the analysis



Fig. S1. The 12 African countries included in this analysis of the causes of TB decline. Drawn with mapchart.net/africa.html.

HIV and TB epidemic trajectories for 12 countries of southern and eastern Africa

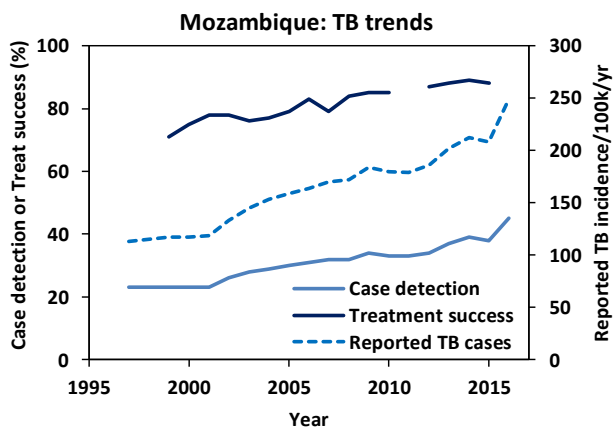


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Fig. S2. Time course of the TB and HIV epidemics in 12 countries of southern and eastern Africa, 1990-2016. Continuous lines (y-axis left) show trends in estimated HIV incidence and prevalence, and ART prevalence (coverage in the whole population). Broken lines show the reported TB incidence (y-axis right). Data are from WHO and UNAIDS (1, 2).

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TB case detection and treatment in Mozambique



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Fig. S3. Reported TB cases, case detection (all TB) and treatment success in Mozambique, 1997-2016

Time delay between starting PLHIV on ART and reducing TB incidence

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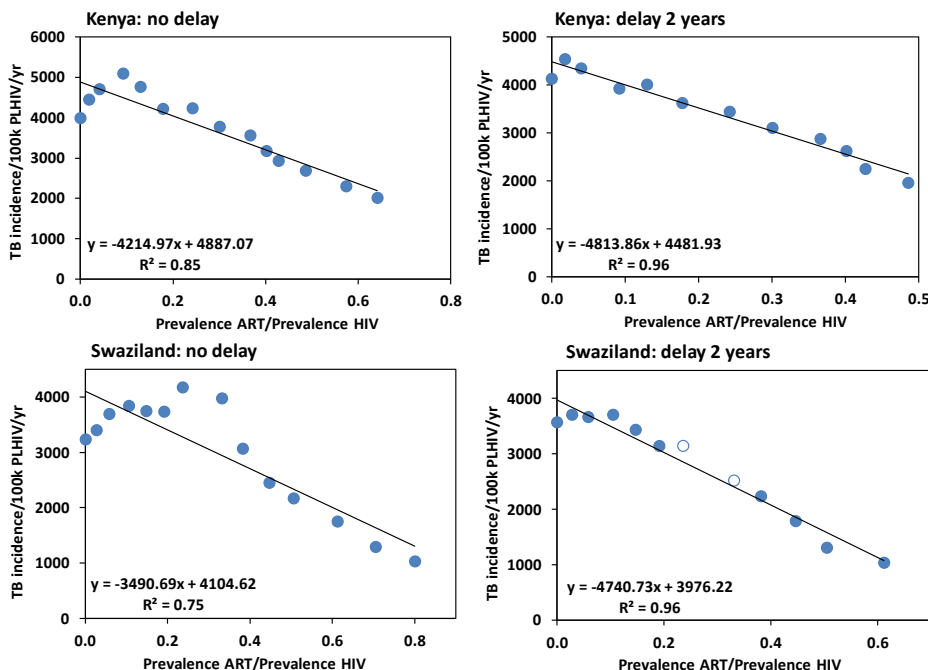


Fig. S4. Fit of the linear regression model without (left) and with (right) a 2-year time delay between TB incidence among PLHIV and the coverage of ART (prevalence of ART/prevalence HIV), illustrated for Kenya and Swaziland. The 2-year delay improves the model fit (r^2 on graph) for these and the other ten countries investigated. For Swaziland, the regression model was fitted with interpolated TB incidence data for 2009 and 2010 (open circles, right panel), replacing outlying points for those two years (left panel).

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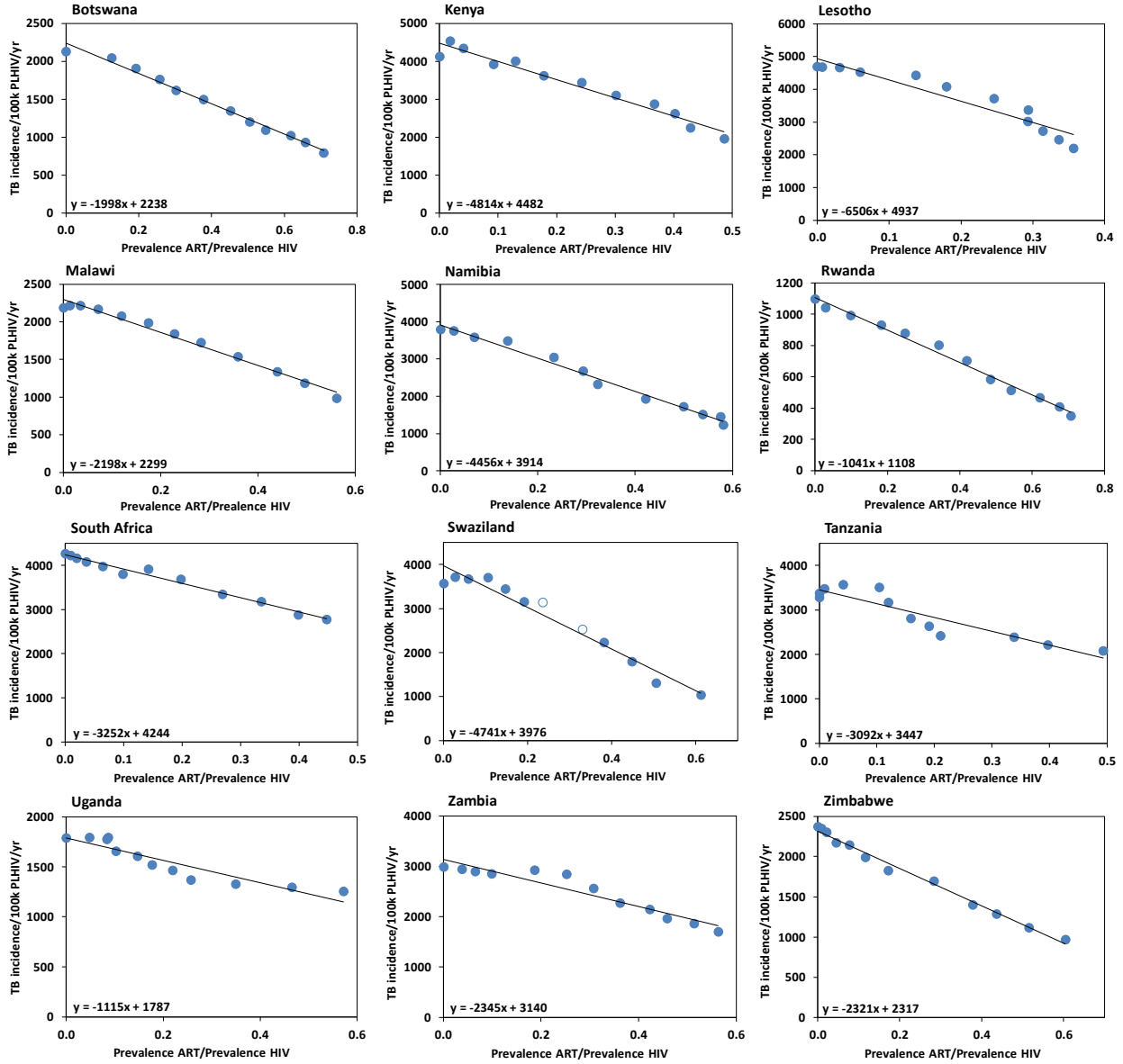
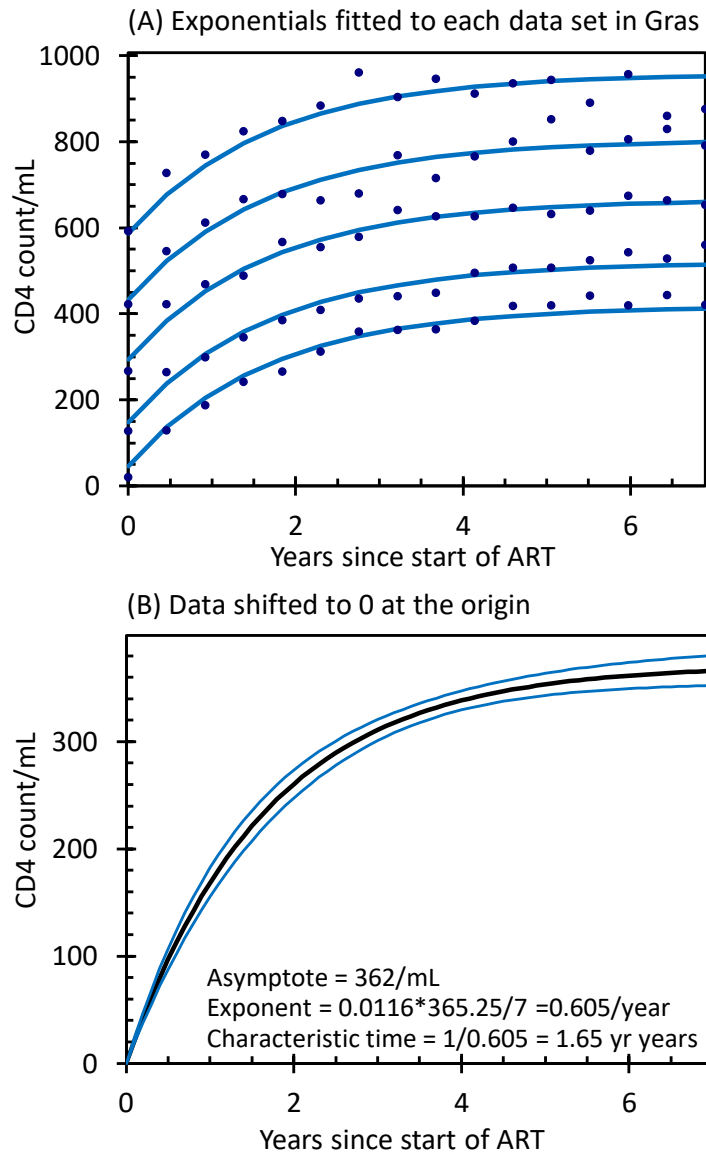


Figure S5. Linear regressions of $T_t/H_{t-\tau}$ on A , which give estimates of parameters α and β in the model describing the effect of ART on TB incidence (Materials and Methods).



5 Fig. S6. The characteristic recovery time of CD4 cell count for HIV-infected people started on ART. Data from Gras et al (3). (a) The data fitted to exponential curves converging to an asymptote of the form $C_i(t) = a_i(1-\exp(-\epsilon t))$. $C_i(t)$ is the CD4 cell count at time t for people starting at each of 5 CD4 cell count groups at the start of treatment and ϵ is the rate of convergence to the asymptote constrained to be the same for all five series of data. (b) The data in (a) but with each data set shifted to an origin of zero and then refitted to show the overall recovery in the CD4 cell count with time with 95% confidence limits on the fitted curve. The recovery in CD4 cell counts after the start of treatment is independent of the value when treatment starts. For the combined data, the recovery rate is $\epsilon = 0.605/\text{year}$; the characteristic time is the inverse, 1.65 years.

Regression statistics

Table S1. Regression statistics for the effect of ART on HIV-positive TB (left column) and for the effect of TB detection and treatment on all TB (right column)

Effect of ART on HIV-positive TB							Effect of TB detection and treatment on all TB								
Country	Coefficients	SE	t Stat	P-value	Lower 95%	Upper 95%	Country	Coefficients	SE	t Stat	P-value	Lower 95%	Upper 95%		
Botswana	α	2304	28.9	79.7	2.37E-15	2239.2	2368.0	r	0.9	0.0	29.08	5.39E-11	0.8	1.0	
	β	-2121	64.2	-33.0	1.53E-11	-2264.1	-1977.9	δ	-0.1	0.1	-1.34	2.11E-01	-0.2	0.1	
Kenya	α	4937	74.8	66.0	1.55E-14	4770.2	5103.5	Kenya	r	2.5	0.3	9.71	2.08E-06	1.9	3.0
	β	-5857	269.8	-21.7	9.61E-10	-6458.7	-5256.3		δ	-4.1	0.7	-6.12	1.13E-04	-5.6	-2.6
Lesotho	α	4926	123.9	39.8	2.42E-12	4649.7	5201.6	Lesotho	r	1.3	0.2	6.50	6.88E-05	0.8	1.7
	β	-6850	541.9	-12.6	1.79E-07	-8057.6	-5642.9		δ	-1.1	0.6	-1.81	1.00E-01	-2.4	0.2
Malawi	α	2456	18.5	132.5	1.47E-17	2415.2	2497.8	Malawi	r	1.2	0.2	5.45	2.81E-04	0.7	1.6
	β	-2459	62.3	-39.5	2.59E-12	-2598.0	-2320.6		δ	-0.6	0.4	-1.34	2.09E-01	-1.5	0.4
Namibia	α	4020	57.5	69.9	8.74E-15	3891.4	4147.6	Namibia	r	1.1	0.1	11.01	6.56E-07	0.9	1.3
	β	-4715	155.0	-30.4	3.45E-11	-5060.6	-4370.0		δ	-0.3	0.2	-1.91	8.51E-02	-0.7	0.1
Rwanda	α	1197	11.9	100.2	2.39E-16	1170.0	1223.2	Rwanda	r	1.2	0.2	6.86	4.43E-05	0.8	1.6
	β	-1190	27.5	-43.3	1.04E-12	-1250.9	-1128.4		δ	-0.5	0.3	-1.82	9.83E-02	-1.2	0.1
S Africa	α	4084	31.2	130.8	1.68E-17	4014.6	4153.8	S Africa	r	1.3	0.1	12.78	1.62E-07	1.1	1.6
	β	-3017	137.7	-21.9	8.75E-10	-3324.1	-2710.6		δ	-0.7	0.2	-3.27	8.38E-03	-1.2	-0.2
Swaziland	α	4251	189.2	22.5	6.88E-10	3829.3	4672.7	Swaziland	r	1.4	0.1	9.98	1.62E-06	1.1	1.7
	β	-5277	594.9	-8.9	4.71E-06	-6602.8	-3951.7		δ	-1.4	0.3	-3.91	2.89E-03	-2.1	-0.6
Tanzania	α	1.4	0.1	10.0	1.62E-06	1.1	1.7	Tanzania	r	1.0	0.2	5.57	2.37E-04	0.6	1.4
	β	-1.4	0.3	-3.9	2.89E-03	-2.1	-0.6		δ	-0.3	0.6	-0.46	6.56E-01	-1.7	1.1
Uganda	α	1827	41.9	43.6	9.75E-13	1734.0	1921.0	Uganda	r	0.9	0.1	10.98	6.72E-07	0.7	1.1
	β	-1136	156.7	-7.2	2.77E-05	-1485.0	-786.5		δ	0.1	0.2	0.71	4.95E-01	-0.3	0.6
Zambia	α	3256	57.8	56.3	7.55E-14	3127.2	3384.8	Zambia	r	0.9	0.1	13.14	1.24E-07	0.7	1.0
	β	-2667	175.2	-15.2	3.03E-08	-3057.3	-2276.8		δ	0.0	0.1	0.38	7.12E-01	-0.2	0.3
Zimbabwe	α	2460	34.2	71.9	6.63E-15	2383.4	2535.9	Zimbabwe	r	1.1	0.1	11.76	3.53E-07	0.9	1.3
	β	-2544	113.3	-22.4	6.92E-10	-2796.8	-2291.7		δ	-0.5	0.2	-2.59	2.68E-02	-0.9	-0.1

Statistically significant P-values are marked in red

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References

1. World Health Organization, *Global tuberculosis report 2017*. (World Health Organization, Geneva, 2017).
2. Joint United Nations Programme on HIV/AIDS (UNAIDS). (Joint United Nations Programme on HIV/AIDS (UNAIDS), Geneva, 2017).
3. L. Gras *et al.*, CD4 cell counts of 800 cells/mm³ or greater after 7 years of highly active antiretroviral therapy are feasible in most patients starting with 350 cells/mm³ or greater. *Journal of Acquired Immune Deficiency Syndromes* **45**, 183-192 (2007).

15