

# Effects of increased antiretroviral scale-up on HIV transmission: analysis of 53 low and middle-income countries

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## Introduction

In the HPTN 052 trial, antiretroviral treatment (ART) lowered the risk of HIV transmission by 96% in sero-discordant couples [1]. Increased ART coverage has also been associated with lower rates of HIV transmission at the community level [2].

The aims of this study were (1) to investigate the relationship between the percentage of HIV infected individuals on ART and HIV incidence in a multi-country analysis; (2) To compare ART coverage rates between low, middle and high-income countries.

## Methods

This analysis was based upon UNAIDS standardised country-level estimates for 2013: number of people with HIV-infection, receiving antiretroviral treatment and new HIV infections [3]. There were 36 African countries included, plus 17 non-African low and middle-income countries with at least 40,000 HIV-infected individuals. Data from high-income countries were extracted from national reports, conference proceedings and articles (Canada [4], France [5], Russia [6], UK [7], USA[8]). The number of adults on ART is used to adjust for the longer survival of people receiving ART in the calculation of incidence. In addition, people taking ART are assumed to have a 92% lower rate of HIV transmission, compared to untreated people. This assumption can be adjusted by countries as needed. Spectrum then estimates the number of new infections per year based on the incidence curve estimated from HIV prevalence and the population data within Spectrum (from the UN Population Divisions 2012 World Population Prospects).

Weighted least squares and linear regression methods were used to investigate the association between the percentage of HIV-infected individuals receiving ART and the number of new infections (as percentages of the national HIV epidemic). The relevance of GDP [9] and PEPFAR status [10] was assessed using nested models and likelihood ratio testing.

## Results

ART coverage varied widely between countries (Figure 1 and Table 1). In the 53 low and middle income countries, the mean percentage of HIV-infected individuals receiving antiretroviral treatment was 35% (range <1% in Madagascar to 70% in Botswana).

There were examples of low or middle income countries with higher ART coverage rates than high income countries. For example Botswana, Cambodia and Rwanda had ART coverage rates above 60%, which was not achieved in Canada or USA. There were 7 countries with ART coverage rates below 15%: Central African Republic (14%) Russia (11%), Indonesia (8.5%), Sudan (6.5%), Pakistan (6.5%), Iran (6.4%), South Sudan (4.6%) and Madagascar (<1%).

The mean HIV transmission rate (percentage of new HIV infections in 2013, relative to the total number of people HIV positive in each country), was 6%, ranging from 2% in Cambodia to 21% in Pakistan. There was a correlation between higher ART coverage and lower percentage incidence (Figure 2). However this would be expected from the Spectrum model, which assumes a 92% lower HIV transmission rate for people on ART. Even so, there was a wide scatter around the line of correlation, as shown in Figure 2. Some countries had HIV transmission rates substantially higher or lower than would be predicted by their ART coverage rates. Weighted least squares regression analysis showed that each 10% increase in ART coverage was associated with a 1.14% reduction in new HIV infections (Figure 2).

Figure 1: Percentage of HIV-positive people taking antiretroviral treatment, by country

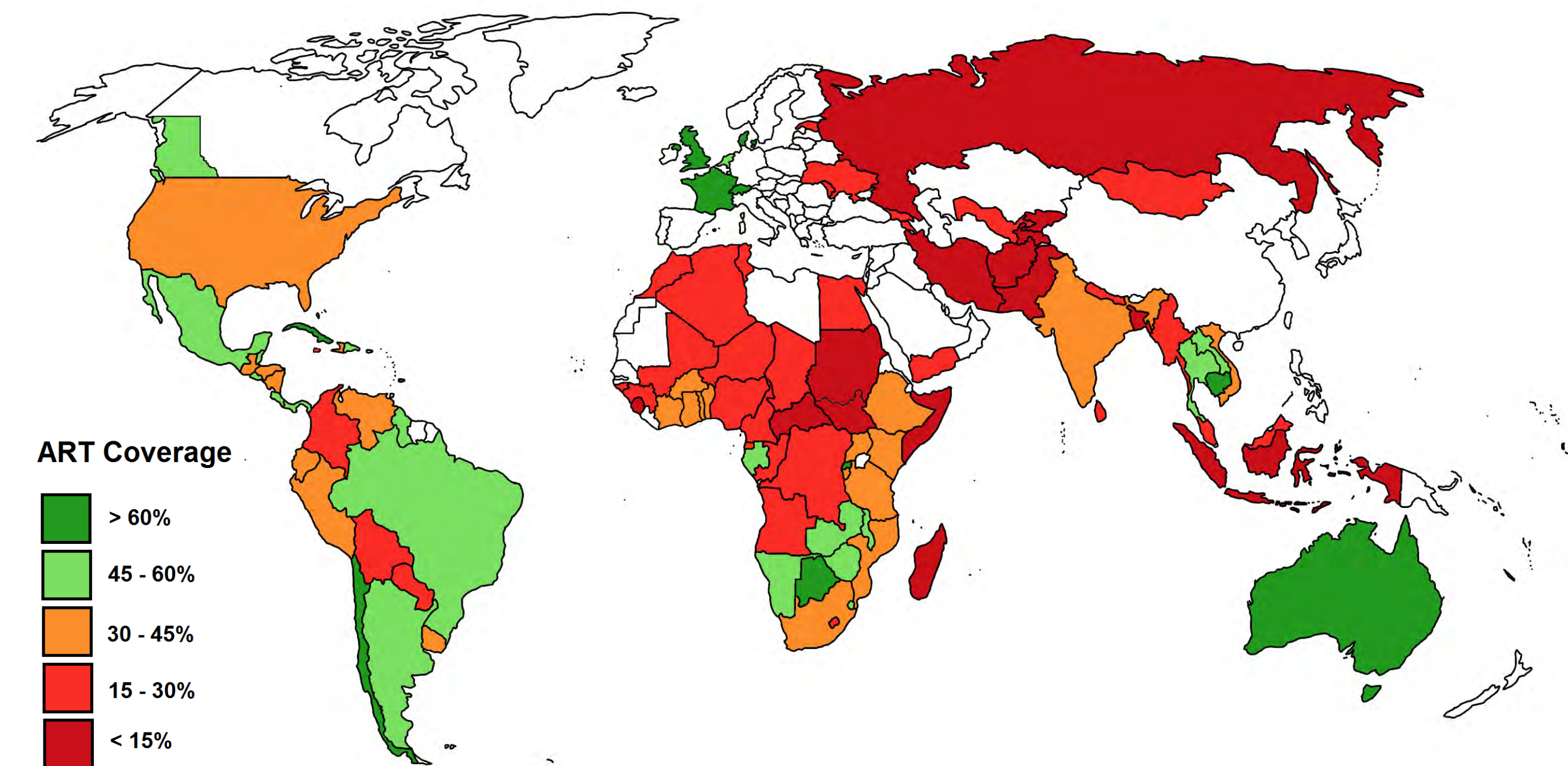
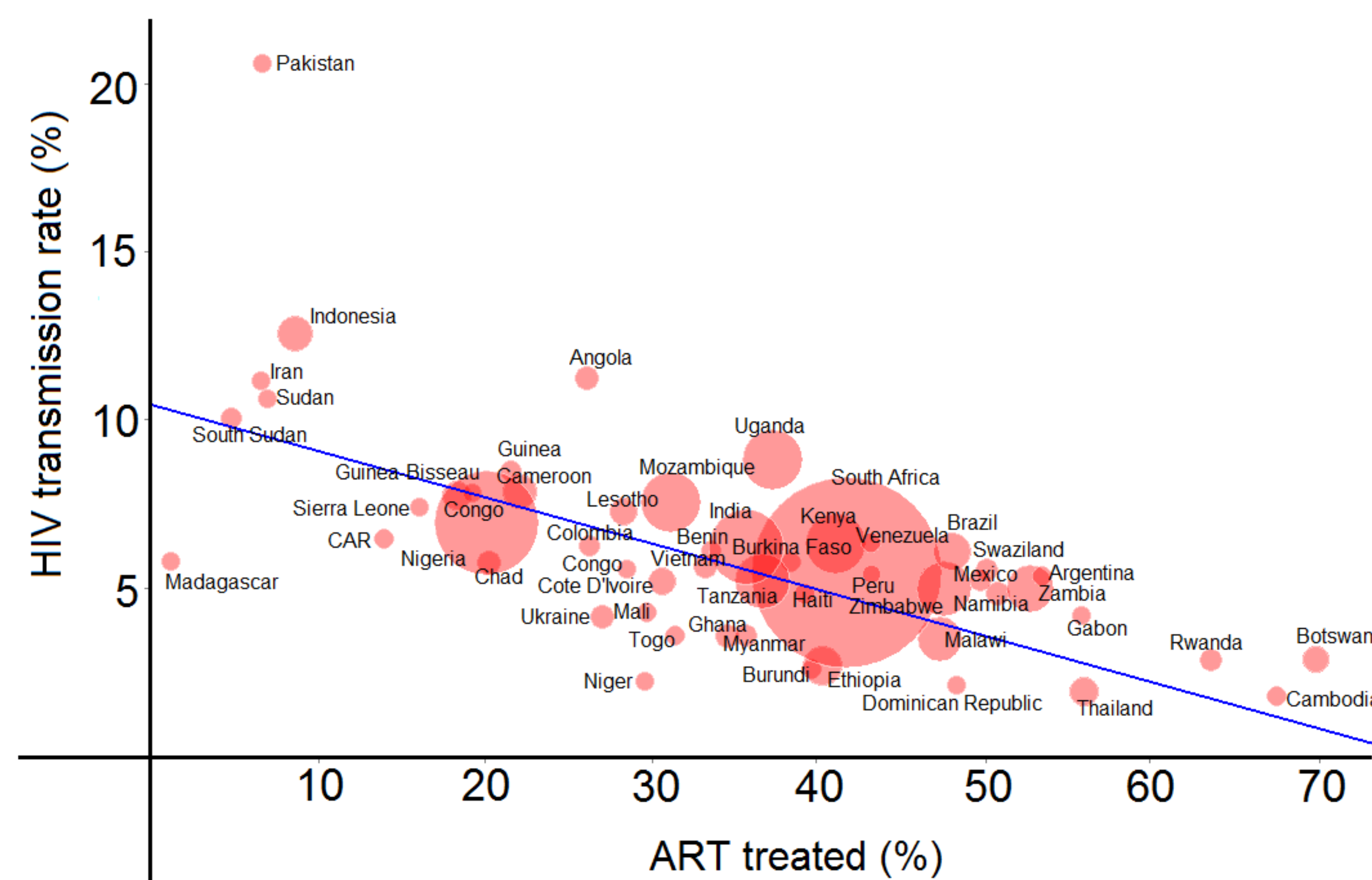


Figure 2: HIV transmission rate (new infections in 2013 / total HIV-infected people) versus ART coverage in 53 countries, weighted by epidemic size.



## Conclusions

**For the 53 low and middle income countries in this analysis, the mean percentage of HIV-infected people receiving antiretroviral treatment was 35% (range <1% in Madagascar to 70% in Botswana). Some low and middle-income countries have rates of antiretroviral treatment coverage higher than certain high-income countries (e.g. Botswana, Cambodia, Rwanda). However there are 8 low / middle income countries with very low ART coverage (<15%)**

**Low and middle income countries with higher rates of ART coverage had lower estimated rates of HIV transmission. However there is substantial variation around this correlation, which could reflect differences between countries in other preventative measures (e.g. HIV testing, condom use, needle exchange, male circumcision).**

Table 1. Number of people taking antiretroviral treatment and new HIV infections (2013 data) for 53 low and middle-income countries and 5 high income countries

Country	HIV positive	On ART (%)	New infections in 2013 (n, %)
Botswana	320,000	69.8%	9,100 (2.8%)
<b>UK [7]</b>	<b>107,800</b>	<b>68.0%</b>	
Cambodia	75,000	67.6%	1,300 (1.7%)
Rwanda	200,000	61.0%	5,600 (2.8%)
<b>France [5]</b>	<b>149,900</b>	<b>60.0%</b>	
Thailand	440,000	55.9%	8,200 (1.9%)
Gabon	41,000	55.7%	1,700 (4.1%)
Argentina	98,000	53.4%	5,200 (5.3%)
Zambia	1,100,000	52.7%	54,000 (4.9%)
<b>Canada [4]</b>	<b>72,000</b>	<b>51.0%</b>	
Namibia	250,000	50.8%	12,000 (4.8%)
Swaziland	200,000	50.1%	11,000 (5.5%)
Mexico	180,000	49.7%	9,300 (5.2%)
Dom. Repub	46,000	48.2%	950 (2.1%)
Brazil	730,000	48.0%	44,000 (6.0%)
Zimbabwe	1,400,000	47.5%	69,000 (4.9%)
Malawi	1,000,000	47.3%	34,000 (3.4%)
Peru	65,000	43.1%	3,500 (5.4%)
Venezuela	100,000	43.1%	6,300 (6.3%)
South Africa	6,300,000	41.6%	340,000 (5.4%)
Kenya	1,600,000	41.0%	100,000 (6.3%)
Ethiopia	790,000	40.2%	21,000 (2.7%)
Burundi	83,000	39.5%	2,100 (2.5%)
Haiti	140,000	39.1%	6,700 (4.8%)
Burkina Faso	110,000	38.3%	6,300 (5.7%)
Uganda	1,600,000	37.2%	140,000 (8.8%)
<b>USA [8]</b>	<b>1,201,100</b>	<b>36.8%</b>	
Tanzania	1,400,000	36.6%	72,000 (5.1%)
Myanmar	190,000	35.6%	6,700 (3.5%)
India	2,100,000	35.6%	130,000 (6.2%)
Ghana	220,000	34.4%	7,800 (3.5%)
Benin	74,000	33.5%	4,500 (6.1%)
Vietnam	250,000	33.1%	14,000 (5.6%)
Togo	110,000	31.3%	3,900 (3.5%)
Mozambique	1,600,000	31.1%	120,000 (7.5%)
C. d'Ivoire	370,000	30.5%	19,000 (5.1%)
Mali	97,000	29.6%	4,100 (4.2%)
Niger	41,000	29.4%	900 (2.2%)
Congo	69,000	28.4%	3,800 (5.5%)
Lesotho	360,000	28.2%	26,000 (7.2%)
Ukraine	210,000	26.9%	8,600 (4.1%)
Colombia	140,000	26.2%	8,700 (6.2%)
Angola	250,000	26.0%	28,000 (11.2%)
Cameroon	600,000	21.9%	47,000 (7.8%)
Guinea	130,000	21.4%	11,000 (8.5%)
Chad	210,000	20.1%	12,000 (5.7%)
Nigeria	3,200,000	20.0%	220,000 (6.9%)
Guinea-B	41,000	19.1%	3,200 (7.8%)
DR Congo	440,000	18.2%	34,000 (7.7%)
Sier. Leone	57,000	15.9%	4,200 (7.4%)
C Af Repub	120,000	13.8%	7,700 (6.4%)
<b>Russia [6]</b>	<b>1,363,330</b>	<b>11.0%</b>	
Sudan	49,000	6.5%	5,200 (10.6%)
Indonesia	640,000	8.5%	80,000 (12.5%)
Pakistan	68,000	6.5%	14,000 (20.6%)
Iran	70,000	6.4%	7,800 (11.1%)
S. Sudan	150,000	4.6%	15,000 (10.0%)
Madagascar	54,000	<1.0%	3,100 (5.7%)

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