

National and Regional Time-Series Estimates of HIV Incidence 1991-2007

Summary

HIV incidence, which measures the annual rate of new HIV infection, provides the best measure of progress in preventing new HIV infections. Incidence is difficult to measure directly, but estimates made using published UNAIDS data closely approximate recently published estimates calculated from Demographic Health Surveys in five countries. The estimates using UNAIDS data for 1991-2007 are easy to prepare, but depend on the accuracy of the UNAIDS data. At the global level these estimates show incidence increasing until the late 1990s then decreasing steadily. At the individual regional level, Sub-Saharan Africa incidence peaks in 1994. Some regions decline from 1991, while others peak on either side of 2000 and others yet are relatively flat for the time series period. By 2000 the estimates of incidence cover roughly 95 per cent of the world population. National data shows all but a few countries with declining incidence, with incidence in some 30 mainly sub-Saharan African countries still above the low levels achieved in high income countries and other regions. At the global level the decline appears to be flattening out from 2004. There is not enough information to determine whether the major cause of the decrease was due to prevention or the epidemic running its course. Despite the progress, some 2.5 million new HIV infections still occur globally every year. At the policy level this suggests that Millennium Development Goal 6, target 6A to “have halted by 2015 and begun to reverse the spread of HIV/AIDS” was achieved in the late 1990s. A new MDG 6A target based on this new information would be appropriate. The data also suggests that with declining levels of foreign aid available, the available funding should be concentrated on Sub-Saharan Africa.

Introduction

HIV incidence and HIV/AIDS prevalence are two measures of the severity of the pandemic which are often confused. HIV/AIDS prevalence measures the proportion of a selected population that are HIV positive at a specific point of time, and includes those that have developed full blown AIDS and those that are receiving Anti-Retroviral Therapy (ART). Incidence measures the rate of new HIV infections for the defined population for a specific time period. Of the two, time series data on incidence is the most important for measuring the progress of the epidemic—a drop in incidence indicates new infections are declining. Increases or decreases in prevalence are ambiguous and require information on AIDS deaths and ART treatment for interpretation of the data.

Considerable progress has been made in estimating prevalence, due mainly to a large number of Demographic Health Surveys which include HIV testing¹. Direct calculation of incidence is, however, very difficult and is discussed briefly in another working paper². This paper uses estimates of incidence calculated from UNAIDS data on People Living With HIV/AIDS (PLWHA) and AIDS deaths as well as population data from the World Bank. The formula is new HIV infections divided by population at risk, where new infections = PLWHA (t)-PLWHA (t-1) + AIDS deaths and population at risk = Total Population (t)-PLWHA (t). The formula was used to calculate annual time series data for 1991 to 2007 for all

countries for which there is UNAIDS data as well as world regions, as defined by the World Bank. The estimated incidence is for the total population and does not account for age or sex.

The accuracy of the estimates depends completely on the accuracy of UNAIDS data. There are very few estimates of incidence available, particularly for countries with serious epidemics, however Hallett et al³ calculated incidence for five countries, the Dominican Republic, Mali, Niger, Tanzania and Zambia using DHS prevalence data—the Hallett et al estimates are for population aged 15 to 24. This paper uses UNAIDS data to estimate incidence for the total population of these countries for the same time periods. Table 1 shows that the two methodologies generate very similar results.

Table 1 – Estimates of HIV Incidence per 1,000 population.

Country	Years	Hallett	Model
Dominican Republic	2002-2007	0.5	0.5
Mali	2001-2006	1.1	0.8
Niger	2002-2006	0.6	0.5
Tanzania	2004-2008	3.4	3.0*
Zambia	2002-2007	11.2	10.5

Source: Hallett et al and author's calculations. *2004-2007

It has been possible to calculate partial time-series for 142 countries. Coverage is more complete for later years. Table 2 shows the proportion of population covered for each of the World Bank regions⁴. The regional codes will be used through this paper and are:

- EAP—East Asia and Pacific
- ECA—Europe and Central Asia
- HI—High Income Countries
- LAC—Latin America and the Caribbean
- MNA—Middle East and North Africa
- SAS—South Asia
- SSA—Sub-Saharan Africa
- WLD—World Total

Table 2--HIV Incidence, Population covered by region (%), 1991, 1995, 2000 and 2007

Year	EAP	ECA	HIC	LAC	MNA	SAS	SSA	WLD
1991	87.4%	22.0%	87.3%	92.9%	65.1%	88.0%	99.9%	81.6%
1995	83.2%	70.0%	92.0%	95.3%	75.1%	88.0%	99.9%	86.9%
2000	98.5%	77.7%	91.8%	95.2%	74.0%	87.9%	99.9%	92.2%
2007	98.6%	73.2%	92.0%	95.0%	72.4%	98.1%	99.7%	94.3%

Source: Calculated by author

By 2007, coverage was more than 94 per cent at the global level, although coverage for the MNA and ECA regions was just under 75 per cent. The next sections will first examine the regional estimates followed by an overview of the national estimates. An Excel Table (Version 97-2003 for compatibility)

with detailed HIV incidence time-series data for 1991-2007 at the national and regional levels is available at http://www.gri.ca/WorkingPapers/incidence_countries_2007.xls .

Regional/Global HIV Incidence

Estimates of HIV incidence at the global level show that HIV incidence peaked in 1997. At the regional level, incidence for SSA peaked in 1994, for SAS in 1997 and for EAP in 2002. Incidence has been declining for both EAP and LAC from the start of the time series in 1991. Both MNA and HI have low levels of incidence which have varied from year to year, probably due to the impact of small errors in data in these relatively low total population areas. Annual estimates of HIV incidence as a percentage are shown in table 3.

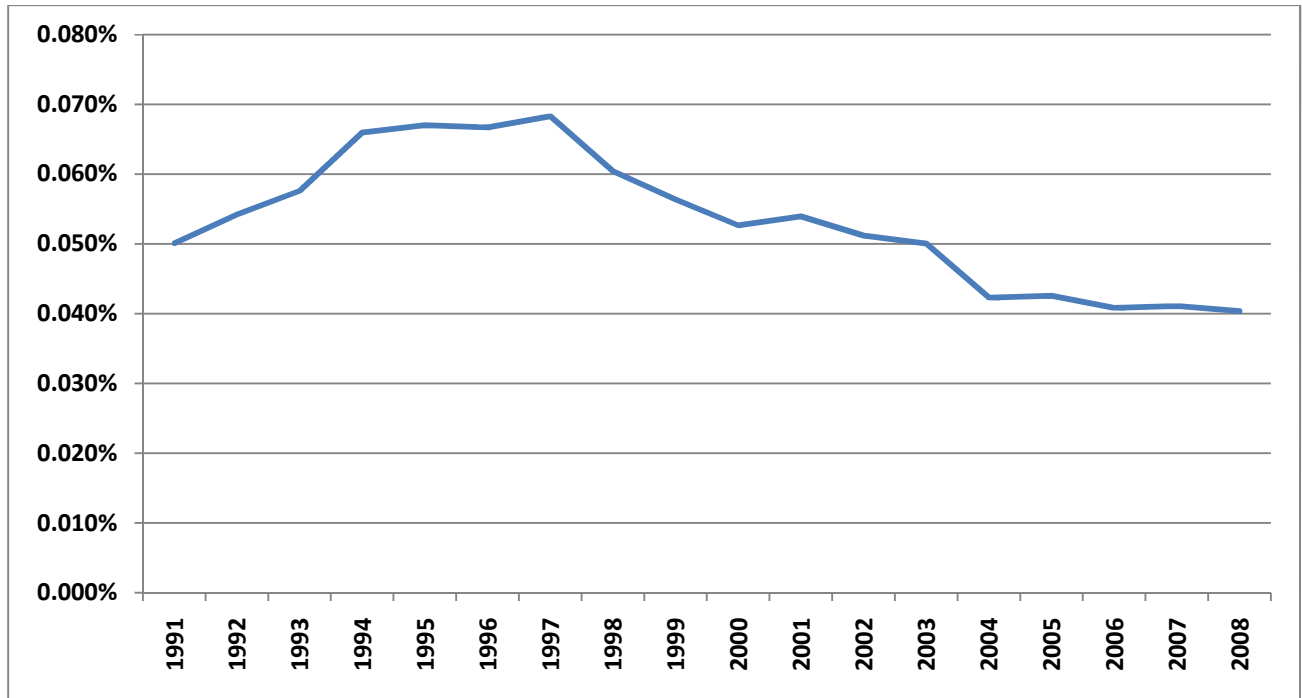
Table 3 REGIONAL HIV INCIDENCE--1991-2008--(Percent)

Year	EAP	ECA	LAC	MNA	SAS	SSA	HI	WLD
1991	0.015%	0.003%	0.035%	0.001%	0.006%	0.313%	0.017%	0.050%
1992	0.014%	0.003%	0.035%	0.002%	0.012%	0.344%	0.015%	0.054%
1993	0.012%	0.002%	0.032%	0.002%	0.020%	0.375%	0.016%	0.058%
1994	0.012%	0.002%	0.032%	0.003%	0.033%	0.417%	0.016%	0.066%
1995	0.010%	0.005%	0.029%	0.004%	0.049%	0.409%	0.014%	0.067%
1996	0.011%	0.013%	0.031%	0.004%	0.052%	0.390%	0.012%	0.067%
1997	0.013%	0.021%	0.026%	0.006%	0.053%	0.396%	0.010%	0.068%
1998	0.011%	0.023%	0.029%	0.007%	0.037%	0.362%	0.007%	0.060%
1999	0.013%	0.030%	0.024%	0.007%	0.021%	0.359%	0.010%	0.056%
2000	0.013%	0.042%	0.023%	0.009%	0.021%	0.321%	0.009%	0.053%
2001	0.013%	0.064%	0.025%	0.009%	0.014%	0.332%	0.007%	0.054%
2002	0.013%	0.077%	0.021%	0.009%	0.014%	0.312%	0.007%	0.051%
2003	0.012%	0.069%	0.021%	0.008%	0.014%	0.291%	0.016%	0.050%
2004	0.012%	0.055%	0.019%	0.008%	0.007%	0.258%	0.006%	0.042%
2005	0.011%	0.043%	0.025%	0.007%	0.007%	0.260%	0.007%	0.043%
2006	0.012%	0.032%	0.016%	0.008%	0.013%	0.243%	0.005%	0.041%
2007	0.010%	0.032%	0.024%	0.007%	0.005%	0.241%	0.017%	0.041%
2008								0.040%

Source: Calculated by author from adjusted UNAIDS data

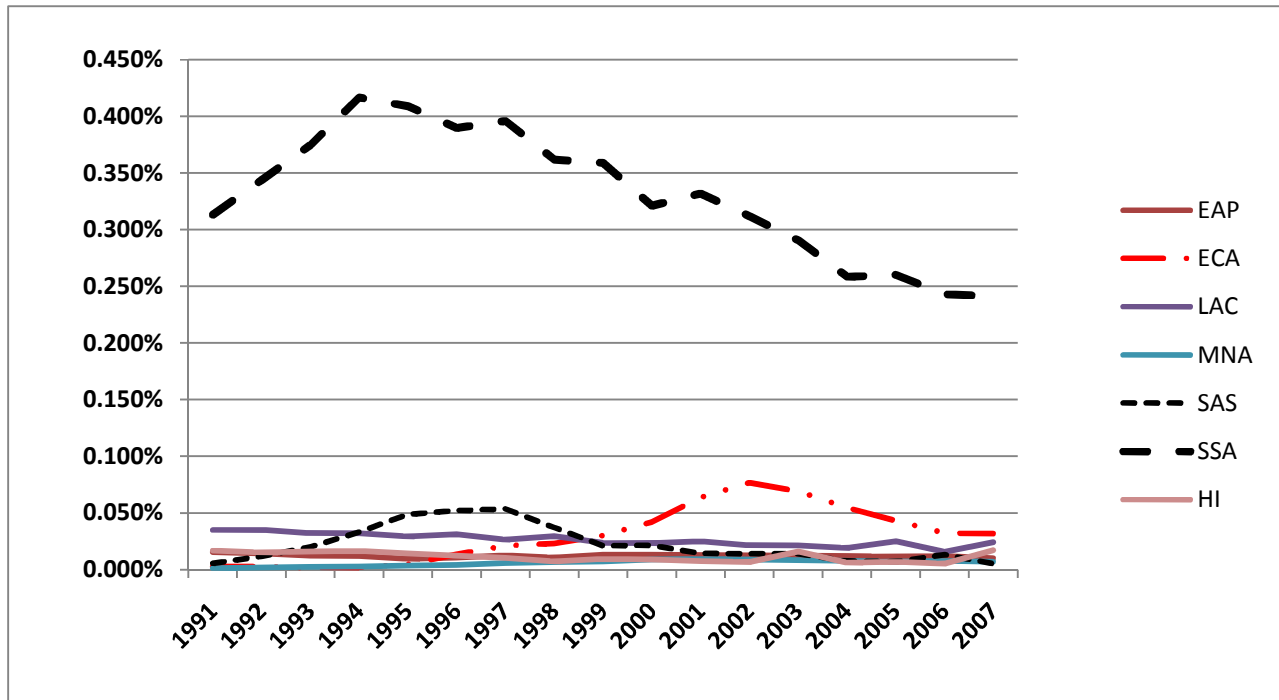
Chart 1 shows the time series for HIV incidence at the global level. Both Table 3 and Chart 1 suggest that the decline in HIV incidence may have begun to slow down in 2004, but a longer data series is necessary to reach a firm judgement. Chart 2 shows the relationship between HIV incidence time series in the different regions. The chart shows clearly the different behaviour of the epidemic in SSA and in the other regions. While incidence in SSA is declining, by 2007 it was still at about 0.24 percent, while incidence for all the other regions had converged at less than 0.035 percent.

Chart 1 – World HIV Incidence in Per Cent 1991-2007



Source: Calculated by author from UNAIDS data

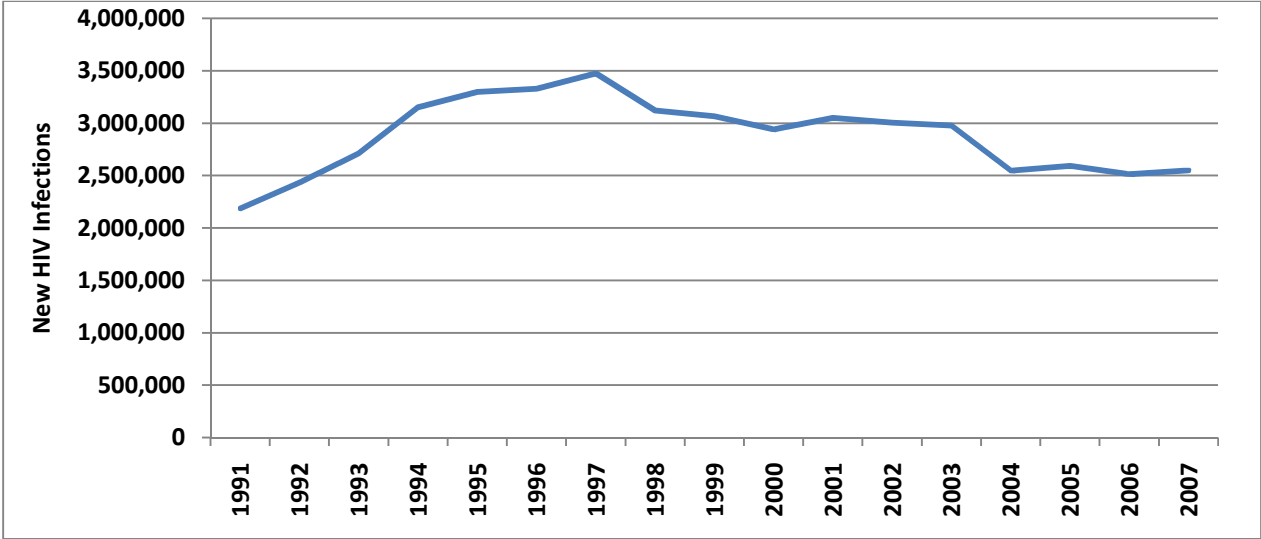
Chart 2—Regional HIV Incidence as Percent –1991-2007



Source: Calculated by author from UNAIDS data

While the decline in incidence is encouraging, it represents the ratio between declining levels of new HIV infections divided by an increasing total population. World population increased from about 4.4 billion in 1991 to 6.2 billion in 2007. Chart 3 shows that while new HIV infections are also declining overall, the curve is much flatter than the incidence curve. This curve provides results of roughly the same magnitude as an estimate of total new infections by Hecht et al⁵. Overall new infections peaked at about 3.5 million a year in 1997 declining to about 2.5 million in 2007. This is a significant decline, but also indicates that, while slowed, the epidemic is still not beaten

Chart 3: Global New HIV Infections



Source: Calculated by author from UNAIDS data

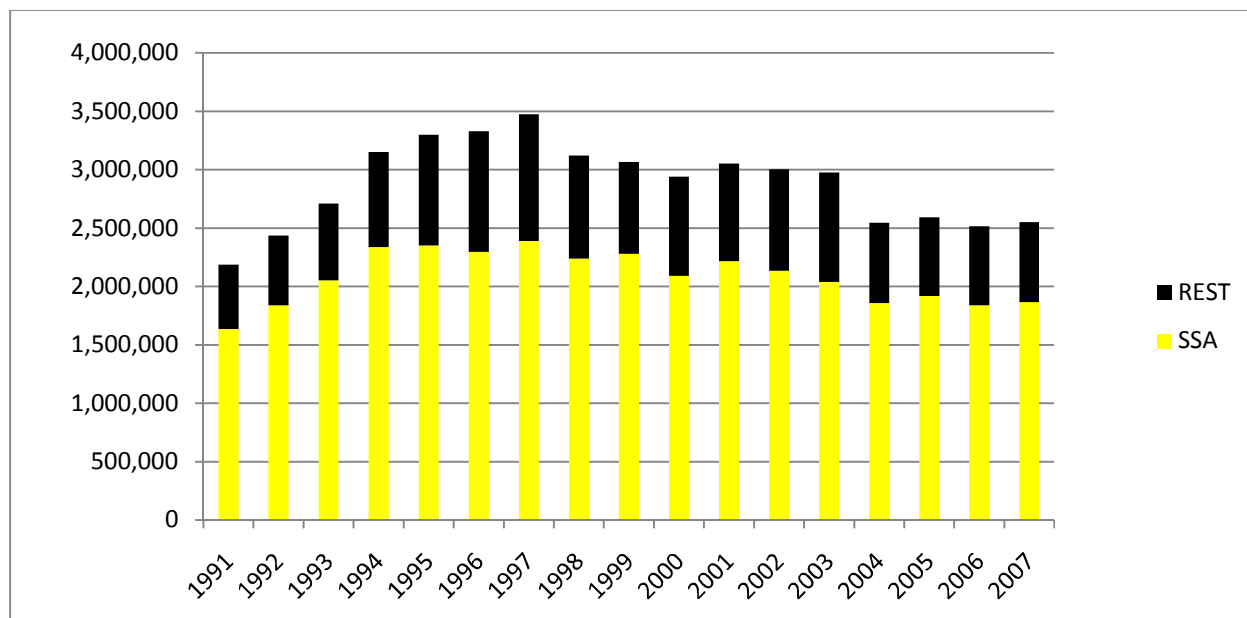
Table 4 gives estimates of new HIV infections by World Bank region for 1991 to 2007. A number of apparent anomalies in the data are highlighted in gray. These appear to be due to rounding errors—UNAIDS rounds its estimates in some of the larger countries to the nearest 100,000 and to the nearest 10,000 in some medium sized countries. Overlooking the rounding errors, the table shows a consistent decline in new HIV infections in recent years. As with incidence, new HIV infections in Sub-Saharan Africa dominate the numbers, being responsible for from 68 to 75 per cent of all new infections depending upon the year. This domination by SSA is shown graphically in Chart 4.

Table 4 -- New HIV Infections by Region--1991-2007

Year	EAP	ECA	LAC	MNA	SAS	SSA	HI	WLD
1991	208,100	2,500	143,100	2,000	56,526	1,634,750	139,950	2,186,926
1992	194,200	4,100	147,300	2,700	121,997	1,839,100	125,150	2,434,547
1993	169,900	4,700	136,500	3,600	209,221	2,053,100	134,200	2,711,221
1994	168,600	6,000	138,400	4,500	355,545	2,338,000	139,200	3,150,245
1995	136,800	14,100	128,600	6,700	532,900	2,351,000	128,800	3,298,900
1996	153,700	41,300	140,000	8,000	578,871	2,295,400	112,000	3,329,271
1997	182,800	71,000	119,700	11,500	605,525	2,389,700	94,000	3,474,225
1998	156,200	78,000	138,900	13,200	428,489	2,239,450	66,700	3,120,939
1999	222,000	102,800	113,600	14,900	247,037	2,278,400	88,200	3,066,937
2000	234,900	143,600	113,800	18,400	256,529	2,090,000	82,700	2,939,929
2001	231,700	216,500	123,600	19,800	174,445	2,215,800	70,000	3,051,845
2002	230,000	260,400	105,900	18,900	193,287	2,133,800	62,000	3,004,287
2003	223,300	239,200	108,500	18,100	197,600	2,039,100	150,500	2,976,300
2004	220,700	188,400	98,000	17,500	105,267	1,858,700	57,800	2,546,367
2005	213,250	148,700	129,300	15,900	99,800	1,918,600	67,500	2,593,050
2006	222,800	111,300	81,700	17,500	192,977	1,837,600	51,000	2,514,877
2007	191,600	102,600	128,200	16,100	78,323	1,867,100	166,800	2,550,723

Source: Calculated by author from UNAIDS data

Chart 4: New HIV Infections -- SSA as a Share of Total



Source: Calculated by author from UNAIDS data

National HIV Incidence

Estimates of 1991-2007 HIV incidence and new HIV infections have been calculated for 142 countries. Of these, 27 have gaps of one year or more in the data, although only two are missing data for 2007.

Annual incidence and new infection data at the country level for the 1991-2007 series are available in a downloadable spreadsheet at <http://www.gri.ca/workingp.html>. No attempt will be made to examine the situation in each of the individual countries. Instead the paper will:

- Identify the 20 most important countries by incidence and by new infections,
- Examine the distribution by incidence for all countries with data for a few selected years.

Countries with highest HIV Incidence-- The list of the 20 countries with the highest level of incidence in Table 5, illustrates a number of characteristics of the epidemic. For many countries there has been a dramatic decrease in incidence from their peak levels, although for some of the countries with lower rates there has been little change. During their peak periods 10 of the countries had peaks of 1 percent incidence or higher, but by 2007 only three countries had levels above 1 per cent. Strikingly 17 of the 20 countries, including the 13 with the highest rates, are in Sub-Saharan Africa while one more is in North Africa. All countries in the list have relatively small populations; South Africa with nearly 48 million population is the largest. Total population for the 20 countries is 269 million with an average population of 13.5 million.

Table 5--20 Countries with Highest HIV Incidence --2007

Country	Population	Region	Income group	Incidence	Peak
Swaziland	1,151,399	SSA	Lower middle income	2.1%	3.4%
Zambia	12,313,942	SSA	Low income	1.4%	1.8%
Lesotho	2,031,676	SSA	Lower middle income	1.0%	2.9%
Mozambique	21,869,362	SSA	Low income	0.9%	0.9%
South Africa	47,850,700	SSA	Upper middle income	0.8%	2.0%
Namibia	2,088,671	SSA	Upper middle income	0.8%	1.5%
Botswana	1,892,426	SSA	Upper middle income	0.7%	2.7%
Malawi	14,439,496	SSA	Low income	0.7%	1.4%
Kenya	37,754,701	SSA	Low income	0.6%	1.1%
Central African Republic	4,257,403	SSA	Low income	0.5%	0.6%
Zimbabwe	12,449,219	SSA	Low income	0.4%	2.8%
Gabon	1,421,882	SSA	Upper middle income	0.3%	0.5%
Togo	6,300,495	SSA	Low income	0.3%	0.3%
Guyana	764,100	LAC	Lower middle income	0.3%	0.5%
Djibouti	834,291	MNA	Lower middle income	0.3%	0.3%
Tanzania	41,276,209	SSA	Low income	0.2%	0.6%
Chad	10,622,922	SSA	Low income	0.2%	0.3%
Cameroon	18,659,938	SSA	Lower middle income	0.2%	0.6%
Suriname	510,366	LAC	Upper middle income	0.2%	0.2%
Uganda	30,637,544	SSA	Low income	0.2%	1.0%

Source: Calculated by author from UNAIDS data

Countries with highest levels of new infections-- The list of countries with the most new HIV infections approaches the problem from another perspective. There is an overlap of nine countries between the two lists, all in Sub-Saharan Africa. Many of the countries in this list have large populations, but relatively low levels of incidence. Twelve of the countries are in Sub-Saharan Africa, including two with populations of over 50 million which did not figure in the incidence list. But in this list we also find the United States, the four BRIC countries (Brazil, Russia, India and China), Vietnam, the Ukraine and Indonesia. These eight countries have low levels of incidence; the Ukrainian rate at 0.08 per cent is the highest of the eight. Total population for the 20 countries is 3.9 billion, with an average population of 197.9 million. Total new infections for 2007 were 1.98 million or 77.6 per cent of the total estimated global new infections of 2.55 million.

Table 6 -- 20 Countries with Highest New HIV Infections -- 2007

Country	Population	Region	Income group	New Infections	Incidence
South Africa	47,850,700	SSA	Upper middle income	350,000	0.83%
Kenya	37,754,701	SSA	Low income	207,500	0.58%
Mozambique	21,869,362	SSA	Low income	181,000	0.89%
Nigeria	147,721,843	SSA	Lower middle income	170,000	0.12%
Zambia	12,313,942	SSA	Low income	156,000	1.39%
United States	301,290,000	HI	High income: OECD	122,000	0.04%
Ethiopia	78,646,128	SSA	Low income	117,000	0.15%
Tanzania	41,276,209	SSA	Low income	96,000	0.24%
Malawi	14,439,496	SSA	Low income	88,000	0.65%
Uganda	30,637,544	SSA	Low income	57,000	0.19%
India	1,124,786,997	SAS	Lower middle income	56,923	0.01%
Russian Federation	142,100,000	ECA	Upper middle income	50,000	0.04%
China	1,317,885,000	EAP	Lower middle income	49,000	0.00%
Vietnam	85,154,900	EAP	Low income	44,000	0.05%
Congo, Dem. Rep.	62,522,787	SSA	Low income	44,000	0.07%
Zimbabwe	12,449,219	SSA	Low income	40,000	0.36%
Ukraine	46,509,350	ECA	Lower middle income	39,000	0.08%
Cameroon	18,659,938	SSA	Lower middle income	39,000	0.22%
Indonesia	224,669,595	EAP	Lower middle income	38,700	0.02%
Brazil	190,119,995	LAC	Upper middle income	35,000	0.02%

Source: Calculated by author from UNAIDS data

Combined Tables 5 and 6 – Combining tables 5 and 6, gives of total of 31 countries with 11 on the list for high incidence only, 11 for high new infections only and nine for both high incidence and high levels of new infections. Combining Djibouti into Sub-Saharan Africa (for practical purposes) gives us three basic lists. There are 21 Sub-Saharan African countries on the list (of which 9 are on both lists), two Latin American/Caribbean countries (Guyana and Suriname) which are on the high incidence list and eight industrialized or rapidly growing economies on the high level of infections group. This latter group should be expected to set their own HIV/AIDS priorities and deal with their own epidemics – new

infections for this group total 434,000 or only 17 percent of total new infections in 2007-- 63.5 percent of all new infections in countries other than those in Sub-Saharan Africa. The 21 selected Sub-Saharan African countries have total new infections of 1.68 million in 2007 or 90 per cent of the total new infections in Sub-Saharan Africa in 2007 and 66 per cent of global new infections.

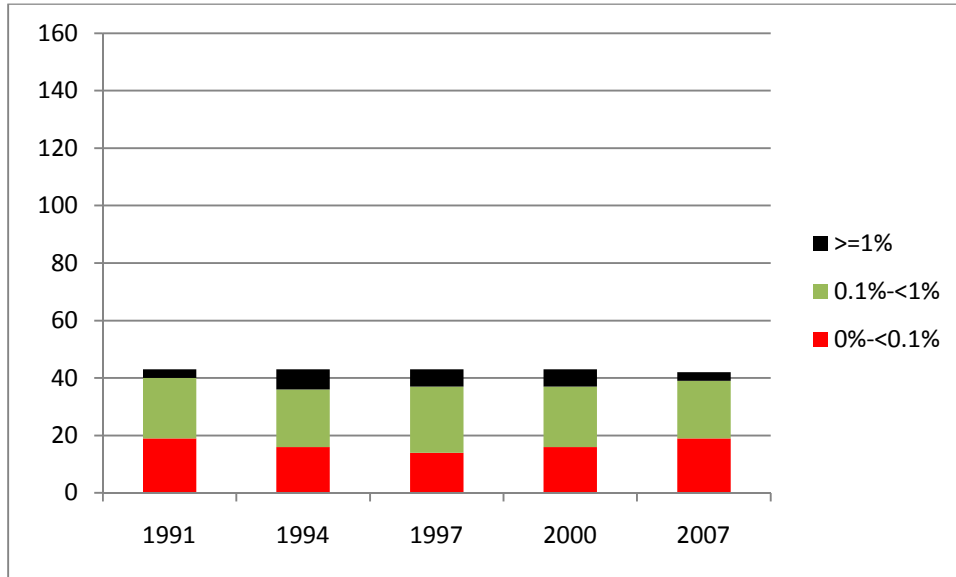
Distribution of Incidence – Table 7 shows the distribution of HIV incidence for individual countries for five selected years, 1991 which is the first year for which there is data, 1994 which was the year incidence peaked in SSA, 1997 the year incidence peaked globally, 2000 and 2007 the final year for which there is data. The data is divided into three levels, low --below 0.1 per cent, medium-- between 0.1 and below 1.0 per cent and high where incidence is larger than or equal to one per cent. For the years in question SSA is the only region for which countries have had incidence in the high range in the selected years. The number of countries with this high incidence dropped from 7 in 1994 to 3 in 2007. By 2007 there were 27 countries in the medium range, 20 in SSA and 7 in the rest of the world while only 19 countries in SSA were in the low range compared to 110 in the rest of the world. Because the number of countries for which data has become available outside of SSA has increased, this data must be treated carefully, but Table 7 and Charts 5, 6 and 7 clearly demonstrate the difference between the rates of incidence in SSA and the rest of the world. In both broad areas, the proportion of countries with high and medium rates of incidence is declining, but in SSA the number of high and medium countries makes up more than 50 per cent of total countries in 2007 compared to 7 per cent in the rest of the world.

Table 7 -- Distribution of annual HIV Incidence--Selected Years

Sub-Saharan Africa					
	1991	1994	1997	2000	2007
0%-<0.1%	19	16	14	16	19
0.1%-<1%	21	20	23	21	20
>=1%	3	7	6	6	3
Total	43	43	43	43	42
Rest of the World					
	1991	1994	1997	2000	2007
0%-<0.1%	64	69	77	84	91
0.1%-<1%	9	10	9	9	7
>=1%	0	0	0	0	0
Total	73	79	86	93	98
World Total					
	1991	1994	1997	2000	2007
0%-<0.1%	83	85	91	100	110
0.1%-<1%	30	30	32	30	27
>=1%	3	7	6	6	3
Total	116	122	129	136	140

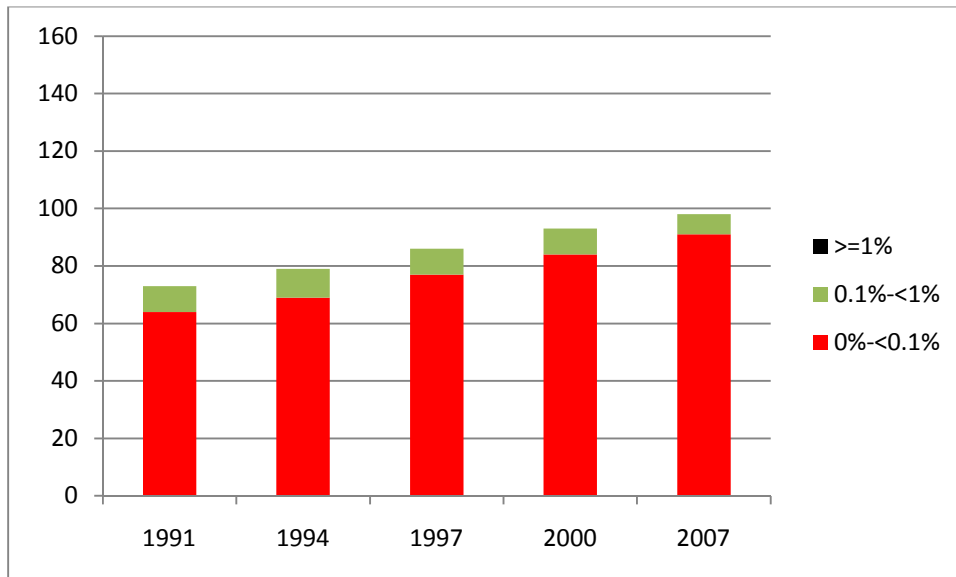
Source: Calculated by author from UNAIDS data

Chart 5 – HIV Incidence in Sub-Saharan Africa – Selected Years



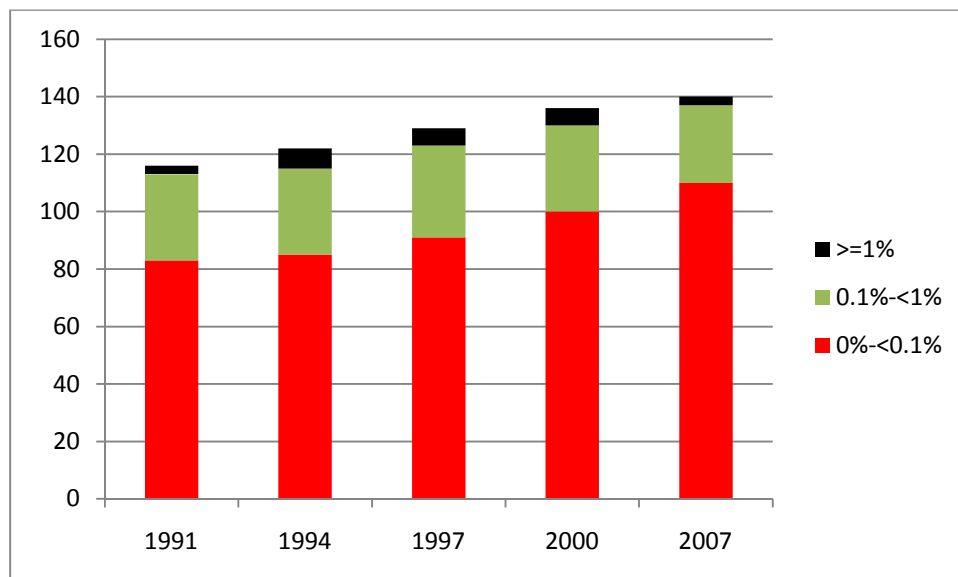
Source: Calculated by author from UNAIDS data

Chart 6 – HIV Incidence the Rest of the World – Selected Years



Source: Calculated by author from UNAIDS data

Chart 6 – HIV Incidence the Rest of the World – Selected Years



Source: Calculated by author from UNAIDS data

Policy Implications/Conclusions

Too much must not be read into the data, which depends entirely on the accuracy of estimates made by UNAIDS. However, a number of tentative conclusions and recommendations are possible with respect to Millennium development goal targets (MDG6) and targeting the use of donor funds in the fight against HIV/AIDS.

MDG6—Based on the available data, Millennium Development Goal 6, target 6a to “have halted by 2015 and begun to reverse the spread of HIV/AIDS” was achieved in the late 1990s, a few years before it was even formally accepted. The global peak of HIV incidence in 1997 marked the turning point. There is not enough information to determine whether the major cause of the reverse in the HIV incidence trend was due to prevention or the epidemic running its course. However, despite the progress some 2.5 million new HIV infections still occur globally every year. A revised and more meaningful target is required – one which specifies target levels for defined dates.

The fight against HIV/AIDS – HIV incidence and new HIV infections have been declining for more than 10 years, both at the regional level and for the vast majority of countries. Many developing countries now have incidence rates similar to those of the major industrialized countries. While more analysis will be needed to reach firm conclusions at the country level, with financial resources in short supply, the results suggest that UNAIDS activities should concentrate on Sub-Saharan Africa where countries are challenged by both high incidence and high levels of new infections.

¹ Measure DHS: Demographic and Health Surveys, available at <http://www.measuredhs.com/> . Accessed 28 June 2010.

² Gordon, John G., 2010, "Calculating HIV Incidence", available at <http://www.gri.ca/workingp.html> <http://www.gri.ca/workingp.html>. Accessed 30 June 2010

³ Hallett et al, "Estimates of HIV incidence from household-based prevalence surveys", AIDS: 2 January 2010 - Volume 24 - Issue 1 - p 147-152

⁴ World Bank Regions definitions at country and lending groups; <http://data.worldbank.org/about/country-classifications/country-and-lending-groups> . Accessed 30 June 2010. There is a link to download the file near the bottom of the page.

⁵ Hecht et al, 2009, "Critical Choices In Financing The Response To The Global HIV/AIDS Pandemic", *Health Affairs*.2009; 28: 1591-1605