

The Global Burden of Acquired Immune Deficiency Syndrome (AIDS) in Tuberculosis Infected Patients and Related Financial Aspects

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Dear Editor

The acquired immune deficiency syndrome (AIDS) is an infectious disease caused by human immunodeficiency virus (HIV). Approximately about 37 million people are infected by this virus with the rate of 1.2 million deaths per year. The mortality rate is high among HIV infected patients in the first 6 months of treatment.¹ Immune deficient cases are at the high risk of any opportunistic infection. AIDS has been closely linked with tuberculosis (TB) disease, so almost one third of total mortality is related to this co-infection. In this regard, tuberculosis is used as a diagnostic index for AIDS.² AIDS is not only associated with high mortality and morbidity, but it affects social life with related stresses and anxieties.³ Considering vast influence of HIV-TB over peoples' lives, the present study aimed to estimate direct global burden of HIV infection on the patients with TB in a one-year period in 2014.^{4,6}

The required data including HIV-TB incidence, mortality rate, and patients' details such as life expectancy in 2014 were collected from the World Health Organization data sheets.⁷ Countries' financial data such as gross domestic production (GDP) in 2014 was extracted from World Bank data center.⁸ The study was designed according to the ethical principles of Ethics Committee at Zabol University of Medical Sciences. Data were recorded in provided checklists for further analysis. Descriptive statistics tests such as frequencies were conducted using the SPSS software version 18.0. Furthermore, to calculate the burden, excel formula function was used.

The disability-adjusted life year (DALY) was considered for calculating disease burden. The DALY index is equal summation of 2 components called years of lost life (YLL) and years lost due to disability (YLD).⁹

$$DALY=YLL+YLD \quad (1)$$

The YLL comes from number of deaths (N) and related lost lives (L) and the YLD comes from the number of infected patients (I) and the time during which they were infected (d) and lost their usual abilities considering disability weight (DW).

$$YLL=N \times L \quad (2)$$

$$YLD=\sum 1 \times d \times DW \quad (3)$$

According to Global Burden of Disease (GBD) report, HIV disability weight was equal to 0.153.¹⁰ The economic burden was calculated by using GDP per capita.^{4,6}

$$\text{Economic Burden}=DALY \times \text{GDP} \quad (4)$$

The total number of newly diagnosed HIV infected patients was 1 502 600 worldwide with the average of 14,310 new cases per country in 2014. The total number of HIV-TB co-infected patients was 1 097 014 in the world with the average of 6377 per country in 2014. Almost 73% of new HIV patients were also infected with TB in 2014. Out of total 21 440 237 HIV-TB adjusted lost years, 167 843 years were related to disability and 21 272 394 years were related to mortality in 2014. The average lost years were 52 938 per country. Total financial loss was more than 70 billion USD worldwide with the average of 173 million USD per country. The first 10 countries with maximum burden were South Africa, Nigeria, Mozambique, India,

Indonesia, Zambia, Kenya, Cameroon, Malawi, and Uganda with the burdens of 4 570 110, 4 266 300, 2144205, 2 134 130, 1 529 839, 685 614, 519 660, 438540, 411007, and 398720 lost years, and financial losses of 29632136229, 13 666 238 790, 1 255 646 448, 3 375 126 595, 5342044804, 1 180 353 062, 705 854 178, 617 201 196, 104 806 785, and 284 925 312 USD, respectively. Detailed results are displayed in Table 1.

In a study by Winter et al in 2018, it was shown that the TB susceptibility was in relationship with HIV infection.

HIV infection is considered as a risk factor for latent TB. The early diagnosis of HIV infection is essential for the proper treatment of HIV-TB infected patients.¹¹ The study of Lawn et al demonstrated that HIV-TB incidence was approximately equal to 1.37 million worldwide in 2007. This co-infection included almost 15% of total global TB cases. It also encompassed 23% of total HIV related mortalities. Moreover, multidrug resistance was further seen in HIV-TB infected patients. One fourth of the world HIV-TB cases have been located in Africa with

Table 1. Global HIV-TB Burden in 2014

Country	GDP Per Capita	Life Expectancy in Both Sexes	Incidence in 2014	Mortality	YLL	(YLD	Burden (y)	Economic Burden (USD)
Afghanistan	633.6	60.5	320	87	5263.5	48.96	5312.46	3365975
Albania	4,564.40	77.80	3.50	10	778	0.5355	778.5355	3553547
Algeria	5,484.10	75.60	200.00	46	3477.6	30.6	3508.2	19239320
American Samoa	Data not available							
Andorra	Data not available	Data not available	9.20	0	0	1.4076	1.4076	0
Angola	Data not available	52.40	23,000.00	350	18340	3519	21859	0
Antigua and Barbuda	13,432.10	76.40	2.30	0	0	0.3519	0.3519	4726.756
Argentina	12,509.50	76.30	740.00	58	4425.4	113.22	4538.62	56775867
Armenia	3,873.50	74.80	80.00	12	897.6	12.24	909.84	3524265
Aruba	Data not available							
Australia	61,979.90	82.80	26.00	10	828	3.978	831.978	51565913
Austria	51,122.40	81.50	22.00	10	815	3.366	818.366	41836834
Azerbaijan	7,886.50	72.70	130.00	28	2035.6	19.89	2055.49	16210622
The Bahamas	22,217.50	76.10	0.44	10	761	0.06732	761.0673	16909013
Bahrain	24,855.20	76.90	9.30	0	0	1.4229	1.4229	35366.46
Bangladesh	1,086.80	71.8	570	180	12924	87.21	13011.21	14140583
Barbados	15,366.30	75.50	2.60	0	0	0.3978	0.3978	6112.714
Belarus	8,040.00	72.30	310.00	80	5784	47.43	5831.43	46884697
Belgium	47,327.60	81.10	72.00	10	811	11.016	822.016	38904044
Belize	4,831.20	70.10	24.00	10	701	3.672	704.672	3404411
Benin	903.5	60	1000	310	18600	153	18753	16943336
Bermuda	Data not available							
Bhutan	2,560.50	69.80	91.00	10	698	13.923	711.923	1822879
Bolivia	3,124.10	70.70	510.00	130	9191	78.03	9269.03	28957377
Bosnia and Herzegovina	4,851.70	77.40	2.80	0	0	0.4284	0.4284	2078.468
Botswana	7,123.30	65.70	4,500.00	1000	65700	688.5	66388.5	4.73E+08
Brazil	11,726.80	75.00	16,000.00	2400	180000	2448	182448	2.14E+09
Brunei Darussalam	40,979.60	77.70	0.18	0	0	0.02754	0.02754	1128.578
Bulgaria	7,851.30	74.50	4.10	0	0	0.6273	0.6273	4925.12
Burkina Faso	713.1	59.9	1200	470	28153	183.6	28336.6	20206829
Burundi	286	59.6	1900	690	41124	290.7	41414.7	11844604
Cabo Verde	3,641.10	73.30	66.00	26	1905.8	10.098	1915.898	6975976
Cambodia	1,094.60	68.7	1,800.00	820	56334	275.4	56609.4	61964649
Cameroon	1,407.40	57.30	20,000.00	7600	435480	3060	438540	6.17E+08
Canada	50,230.80	82.20	100.00	16	1315.2	15.3	1330.5	66832079
Cayman Islands	Data not available							
Central African Republic	358.5	52.5	7600	3100	162750	1162.8	163912.8	58762739
Chad	1,024.70	53.1	6000	2100	111510	918	112428	1.15E+08
Chile	14,528.30	82.50	130.00	10	825	19.89	844.89	12274815

Table 1. Continued

Country	GDP Per Capita	Life Expectancy in Both Sexes	Incidence in 2014	Mortality	YLL	(YLD	Burden (y)	Economic Burden (USD)
China	7,590.00	76.10	13,000.00	700	53270	1989	55259	4.19E+08
Colombia	7,903.90	74.80	3,400.00	400	29920	520.2	30440.2	2.41E+08
Comoros	810.1	63.5	8.5	0	0	1.3005	1.3005	1053.535
Congo, Dem. Rep.	442.3	64.7	5500	2500	161750	841.5	162591.5	71914220
Congo, Rep.	3,147.10	Data not available	34,000.00		0	5202	5202	16371214
Costa Rica	10,415.40	79.60	54.00	10	796	8.262	804.262	8376710
Cote d'Ivoire	1,545.90	53.30	Data not available	2400	127920	0	127920	1.98E+08
Croatia	13,475.30	78.00	4.00	0	0	0.612	0.612	8246.884
Cuba	Data not available	79.10	110.00	10	791	16.83	807.83	0
Curacao			Data not available					
Cyprus	27,194.40	80.50	0.13	0	0	0.01989	0.01989	540.8966
Czech Republic	19,502.40	78.80	4.20	0	0	0.6426	0.6426	12532.24
Denmark	60,718.40	80.60	12.00	10	806	1.836	807.836	49050509
Djibouti	1,813.60	63.50	540.00	140	8890	82.62	8972.62	16272744
Dominica	7,244.50	73.90	Data not available	0	0	0	0	0
Dominican Republic	6,163.60	73.90	1,700.00	190	14041	260.1	14301.1	88146260
Ecuador	6,345.80	76.20	1,100.00	310	23622	168.3	23790.3	1.51E+08
Egypt, Arab Rep.	3,365.70	70.90	35.00	43	3048.7	5.355	3054.055	10279033
El Salvador	4,120.00	73.50	240.00	31	2278.5	36.72	2315.22	9538706
Equatorial Guinea	18,918.30	58.20	670.00	49	2851.8	102.51	2954.31	55890523
Eritrea		64.7	250	100	6470	38.25	6508.25	0
Estonia	20,147.80	77.60	24.00	10	776	3.672	779.672	15708676
Ethiopia	573.6	64.8	19000	5500	356400	2907	359307	2.06E+08
Faroe Islands			Data not available					
Fiji	5,112.30	69.90	27.00	10	699	4.131	703.131	3594617
Finland	49,842.70	81.10	5.70	0	0	0.8721	0.8721	43467.82
France	42,725.70	82.40	340.00	62	5108.8	52.02	5160.82	2.2E+08
French Polynesia			Data not available					
Gabon	10,772.10	66.00	530.00	300	19800	81.09	19881.09	2.14E+08
Gambia, The	441.3	61.1	780	140	8554	119.34	8673.34	3827545
Georgia	4,435.20	74.40	160.00	17	1264.8	24.48	1289.28	5718215
Germany	47,773.90	81.00	120.00	11	891	18.36	909.36	43443674
Ghana	1,441.60	62.40	11,000.00	4200	262080	1683	263763	3.8E+08
Greece	21,672.70	81.00	16.00	10	810	2.448	812.448	17607942
Greenland	43,364.90	Data not available	Data not available	0	0	0	0	0
Grenada	8,573.70	73.60	0.12	0	0	0.01836	0.01836	157.4131
Guam			Data not available					
Guatemala	3,673.10	71.90	840.00	540	38826	128.52	38954.52	1.43E+08
Guinea	539.6	59	4700	1500	88500	719.1	89219.1	48142626
Guinea-Bissau	567.8	58.9	2900	1500	88350	443.7	88793.7	50417063
Guyana	4,053.90	66.20	170.00	42	2780.4	26.01	2806.41	11376905
Haiti	824.2	63.5	3700	770	48895	566.1	49461.1	40765839
Honduras	2,434.80	74.60	340.00	46	3431.6	52.02	3483.62	8481918
Hong Kong SAR, China	40,169.50	Data not available	Data not available		0	0	0	0
Hungary	14,026.60	75.90	11.00	10	759	1.683	760.683	10669796
Iceland	52,036.70	82.70	0.01	0	0	0.00153	0.00153	79.61615
India	1,581.50	68.30	110,000.00	31000	2117300	16830	2134130	3.38E+09
Indonesia	3,491.90	69.10	63,000.00	22000	1520200	9639	1529839	5.34E+09
Iran, Islamic Rep.	5,442.90	75.50	400.00	110	8305	61.2	8366.2	45536390
Iraq	6,420.10	68.90	3.10	0	0	0.4743	0.4743	3045.053

Table 1. Continued

Country	GDP Per Capita	Life Expectancy in Both Sexes	Incidence in 2014	Mortality	YLL	(YLD	Burden (y)	Economic Burden (USD)
Ireland	54,339.30	81.40	15.00	0	0	2.295	2.295	124708.7
Isle of Man			Data not available					
Israel	37,206.20	82.50	32.00	10	825	4.896	829.896	30877277
Italy	35,222.80	82.70	240.00	31	2563.7	36.72	2600.42	91594074
Jamaica	5,106.10	76.20	29.00	10	762	4.437	766.437	3913504
Japan	36,194.40	83.70	99.00	10	837	15.147	852.147	30842949
Jordan	5,422.60	74.10	0.41	0	0	0.06273	0.06273	340.1597
Kazakhstan	12,601.60	70.20	590.00	37	2597.4	90.27	2687.67	33868942
Kenya	1,358.30	63.40	40,000.00	8100	513540	6120	519660	7.06E+08
Kiribati	1,509.50	66.30	1.90	0	0	0.2907	0.2907	438.8117
Korea, Dem. People's Rep.			Data not available					
Korea, Rep.	27,970.50	Data not available	Data not available	10	0	0	0	0
Kuwait	43,593.70	74.70	5.30	0	0	0.8109	0.8109	35350.13
Kyrgyz Republic	1,268.90	71.10	Data not available	55	3910.5	0	3910.5	4962033
Lao PDR	1,793.50	65.70	500.00	280	18396	76.5	18472.5	33130429
Latvia	15,692.20	74.60	210.00	19	1417.4	32.13	1449.53	22746315
Lebanon	10,057.90	74.90	110.00	0	0	16.83	16.83	169274.5
Lesotho	1,034.20	53.70	12,000.00	4900	263130	1836	264966	2.74E+08
Liberia	457.9	61.4	2100	330	20262	321.3	20583.3	9425093
Libya	6,573.40	72.70	100.00	0	0	15.3	15.3	100573
Liechtenstein			Data not available					
Lithuania	16,489.70	73.60	57.00	20	1472	8.721	1480.721	24416645
Luxembourg		82.00	2.70	0	0	0.4131	0.4131	48172.79
Macao SAR, China	96,038.10	Data not available	Data not available	0	0	0	0	0
Macedonia, FYR	5,455.60	Data not available	Data not available		0	0	0	0
Madagascar	449.4	65.5	2200	480	31440	336.6	31776.6	14280404
Malawi	255	58.3	19000	7000	408100	2907	411007	1.05E+08
Malaysia	11,307.10	75.00	2,200.00	620	46500	336.6	46836.6	5.3E+08
Maldives	7,635.50	78.50	0.32	0	0	0.04896	0.04896	373.8341
Mali	704.5	58.2	710	400	23280	108.63	23388.63	16477290
Malta		81.70	2.20	0	0	0.3366	0.3366	0
Marshall Islands	3,529.70	Data not available	0.36	0	0	0.05508	0.05508	194.4159
Mauritania	1,275.00	63.10	410.00	26	1640.6	62.73	1703.33	2171746
Mauritius	10,016.60	74.60	42.00	10	746	6.426	752.426	7536750
Mexico	10,325.60	76.70	2,100.00	310	23777	321.3	24098.3	2.49E+08
Micronesia, Fed. Sts.	3,057.10	69.40	Data not available	0	0	0	0	0
Moldova	2,238.90	Data not available	Data not available	110	0	0	0	0
Monaco			Data not available					
Mongolia	4,129.40	68.80	11.00	10	688	1.683	689.683	2847977
Montenegro	7,378.30	76.10	0.18	0	0	0.02754	0.02754	203.1984
Morocco	3,190.30	74.30	770.00	120	8916	117.81	9033.81	28820564
Mozambique	585.6	57.6	85000	37000	2131200	13005	2144205	1.26E+09
Myanmar	1,203.80	66.6	19,000.00	4100	273060	2907	275967	3.32E+08
Namibia	5,408.20	65.80	5,600.00	1500	98700	856.8	99556.8	5.38E+08
Nepal	701.7	69.3	1500	380	26334	229.5	26563.5	18639608
Netherlands	52,138.70	81.90	52.00	10	819	7.956	826.956	43116411
New Caledonia				0	0	0	0	0
New Zealand	44,342.20	81.60	3.40	0	0	0.5202	0.5202	23066.81

Table 1. Continued

Country	GDP Per Capita	Life Expectancy in Both Sexes	Incidence in 2014	Mortality	YLL	(YLD	Burden (y)	Economic Burden (USD)
Nicaragua	1,963.10	74.80	140.00	22	1645.6	21.42	1667.02	3272527
Niger	427.4	61.8	1500	470	29046	229.5	29275.5	12512349
Nigeria	3,203.30	54.50	100,000.00	78000	4251000	15300	4266300	1.37E+10
Northern Mariana Islands	Data not available							
Norway	97,299.60	81.80	12.00	0	0	1.836	1.836	178642.1
Oman	19,309.60	76.60	4.50	10	766	0.6885	766.6885	14804448
Pakistan	1,316.60	66.40	6,400.00	1300	86320	979.2	87299.2	1.15E+08
Palau	11,879.70	Data not available	0.02	0	0	0.00306	0.00306	36.35188
Panama	11,948.90	77.80	180.00	46	3578.8	27.54	3606.34	43091796
Papua New Guinea	2,268.20	62.90	3,500.00	540	33966	535.5	34501.5	78256302
Paraguay	4,712.80	74.00	290.00	53	3922	44.37	3966.37	18692709
Peru	6,541.00	75.50	2,500.00	250	18875	382.5	19257.5	1.26E+08
Philippines	2,872.50	68.50	2,500.00	80	5480	382.5	5862.5	16840031
Poland	14,336.80	77.50	100.00	16	1240	15.3	1255.3	17996985
Portugal	22,124.40	81.10	370.00	38	3081.8	56.61	3138.41	69435438
Puerto Rico	Data not available							
Qatar	96,732.40	78.20	0.89	0	0	0.13617	0.13617	13172.05
Romania	10,000.00	75.00	510.00	54	4050	78.03	4128.03	41280300
Russian Federation	12,735.90	70.50	5,500.00	1100	77550	841.5	78391.5	9.98E+08
Rwanda	695.7	66.1	1800	310	20491	275.4	20766.4	14447184
Samoa	4,172.20	74.00	19.00	0	0	2.907	2.907	12128.59
San Marino	Data not available							
Sao Tome and Principe	1,810.70	67.50	38.00	10	675	5.814	680.814	1232750
Saudi Arabia	24,406.50	74.50	130.00	0	0	19.89	19.89	485445.3
Senegal	1,067.10	66.70	1,500.00	430	28681	229.5	28910.5	30850395
Serbia	6,152.90	75.60	17.00	0	0	2.601	2.601	16003.69
Seychelles	15,564.60	73.20	0.73	0	0	0.11169	0.11169	1738.41
Sierra Leone	766		2300	700	0	351.9	351.9	269555.4
Singapore	56,284.30	83.10	75.00	13	1080.3	11.475	1091.775	61449792
Sint Maarten (Dutch part)	Data not available							
Slovak Republic	18,500.70	76.70	Data not available	0	0	0	0	0
Slovenia	24,001.90	80.80	0.20	0	0	0.0306	0.0306	734.4581
Solomon Islands	2,024.20	69.20	Data not available	0	0	0	0	0
Somalia	542.6	55	2200	440	24200	336.6	24536.6	13313559
South Africa	6,483.90	62.90	270,000.00	72000	4528800	41310	4570110	2.96E+10
South Sudan	1,115.10	57.30	2,900.00	0	0	443.7	443.7	494769.9
Spain	29,721.60	82.80	310.00	61	5050.8	47.43	5098.23	1.52E+08
Sri Lanka	3,794.90	74.90	53.00	14	1048.6	8.109	1056.709	4010105
St. Kitts and Nevis	15,510.40	Data not available	Data not available		0	0	0	0
St. Lucia	7,647.50	Data not available	Data not available		0	0	0	0
St. Martin (French part)	Data not available							
St. Vincent and the Grenadines	6,668.90	Data not available	Data not available		0	0	0	0
Sudan	1,875.80	64.10	1,200.00	1000	64100	183.6	64283.6	1.21E+08
Suriname	9,680.10	71.60	64.00	11	787.6	9.792	797.392	7718834
Swaziland	3,477.10	58.90	5,900.00	1700	100130	902.7	101032.7	3.51E+08
Sweden	58,898.90	82.40	24.00	10	824	3.672	827.672	48748970

Table 1. Continued

Country	GDP Per Capita	Life Expectancy in Both Sexes	Incidence in 2014	Mortality	YLL	(YLD	Burden (y)	Economic Burden (USD)
Switzerland	85,616.60	83.40	37.00	10	834	5.661	839.661	71888920
Syrian Arab Republic	Data is not available	64.5	3.4	0	0	0.5202	0.5202	0
Tajikistan	1,114.00	69.7	230.00	55	3833.5	35.19	3868.69	4309721
Tanzania	955.1	Data not available	Data not available	28000	0	0	0	0
Thailand	5,977.40	74.90	15,000.00	4500	337050	2295	339345	2.03E+09
Timor-Leste	1,169.00	68.30	57.00	0	0	8.721	8.721	10194.85
Togo	635	59.9	830	300	17970	126.99	18096.99	11491589
Tonga	4,114.00	73.50	0.02	0	0	0.00306	0.00306	12.58884
Trinidad and Tobago	21,323.80	71.20	71.00	12	854.4	10.863	865.263	18450695
Tunisia	4,420.70	75.30	23.00	10	753	3.519	756.519	3344344
Turkey	10,515.00	75.80	45.00	10	758	6.885	764.885	8042766
Turkmenistan	9,031.50	66.30	Data not available	0	0	0	0	0
Turks and Caicos Islands	Data not available							
Tuvalu	3,826.90	Data not available	Data not available	0	0	0	0	0
Uganda	714.6	62.3	Data not available	6400	398720	0	398720	2.85E+08
Ukraine	3,082.50	71.30	8,100.00	1200	85560	1239.3	86799.3	2.68E+08
United Arab Emirates	43,962.70	77.10	5.70	0	0	0.8721	0.8721	38339.87
United Kingdom	46,297.00	81.20	390.00	13	1055.6	59.67	1115.27	51633655
United States	54,629.50	79.30	600.00	110	8723	91.8	8814.8	4.82E+08
Uruguay	16,806.80	77.00	160.00	24	1848	24.48	1872.48	31470397
Uzbekistan	2,036.70	69.40	830.00	160	11104	126.99	11230.99	22874157
Vanuatu	3,148.00	72.00	Data not available	0	0	0	0	0
Venezuela, RB		74.10	700	120	8892	107.1	8999.1	0
Vietnam	2,052.30	76.00	7,000.00	190	14440	1071	15511	31833225
Virgin Islands (U.S.)	Data not available							
West Bank and Gaza	2,965.90	Data not available	Data not available	10	0	0	0	0
Yemen, Rep.	Data not available	65.70	80.00	25	1642.5	12.24	1654.74	0
Zambia	1,721.60	61.80	38,000.00	11000	679800	5814	685614	1.18E+09
Zimbabwe	931.2	60.7	25000	5200	315640	3825	319465	2.97E+08

Abbreviations: GDP, gross domestic production; YLL, years of life lost; YLD, years lived with disability.

higher incidence in sub-Saharan region.¹² An updated report of global HIV-TB burden in 2014 is provided in Table 1.

In a survey on HIV infection by Dieleman for the years 1995-2015, middle income countries spent more on TB related health programs and had fastest per capita growth in comparison with high and low income countries.¹³ In a study by Filha et al on direct and indirect costs of TB-HIV infections, indirect costs were more than half of the total costs. The costs for TB-HIV infected patients were almost 8.5 times more than those for TB infected patients.¹⁴ Therefore the total cost of HIV-TB co-infection is more than what was reported as direct cost in this study.

Due to the lack of data associated with economy and health in some countries, the global burden was much lower than the actual burden in calculation. In our calculations, we did not add TB disability weight because

we tried to estimate HIV infection burden in TB infected subjects with a focus on HIV. However, even these underestimated values of burden were quite significant and no case could be ignored. More than 99% of lost years caused by HIV-TB co-infection were coinfection-related deaths; therefore, TB screening is strongly recommended in all new HIV cases to reduce related deaths.

Ethical Approval

Not applicable.

Competing Interests

Authors declare no competing interests.

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