Potential impact of the US PEPFAR on the tuberculosis, HIV co-epidemic in selected sub-Saharan African countries

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BACKGROUND

- (Mycobacterium) Tuberculosis (TB) is the most common opportunistic disease and the most frequent cause of death in individuals co-infected with HIV, especially in low and middle-income countries.

- Expansion of HAART programs could also contribute to decrease the TB burden. HAART suppresses viral activity and promotes the restoration of the immune system, thus lowering the risk of re-activating latent TB or of emerging opportunistic infections.

- Global funding to fight the HIV and TB epidemics increased dramatically in 2002 and 2003 with the launch of the Global Fund against AIDS, TB and Malaria and the U.S. President's Emergency Plan for AIDS Relief (PEPFAR).

- Both programs have focused on financing and developing partnerships at the country level to strengthen and implement effective TB/HIV control programs, and to rapidly accelerate access to HAART worldwide.

- Unfortunately, there is very limited longitudinal data measuring the impact of expanded HIV control activities on the TB epidemic at the country level. Such data would be critical to inform further steps needed to enhance the effectiveness of TB/HIV programs.

OBJECTIVES

To characterize:
- The TB incidence and mortality rates (HIV- and non HIV-related), before (1996-2002) and after (2004-2007) the launch of PEPFAR for a selected number of focus (**F**) and non-PEPFAR focus (or 'control [**C**]') countries in sub-Saharan Africa.

To compare:
- The rate of change in TB incidence relative to HIV prevalence over time, for both PEPFAR focus and control countries in sub-Saharan Africa.

METHODS

Countries
- 12 PEPFAR focus countries in sub-Saharan Africa – i.e. countries that received the greatest US government investments during the study period.

    o Botswana, Cote d'Ivoire, Ethiopia, Kenya, Mozambique, Namibia, Nigeria, Rwanda, South Africa, Uganda, United Republic of Tanzania, and Zambia.

- 29 PEPFAR control countries with a generalized HIV epidemic in sub-Saharan Africa – i.e. countries that received < 5 million annually of direct US government HIV support during the study period.

    o Angola, Benin, Burkina Faso, Burundi, Cameroon, Central African Republic, Chad, Congo, Democratic Republic of Congo, Djibouti, Eritrea, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Lesotho, Liberia, Madagascar, Malawi, Mali, Niger, Senegal, Sierra Leone, Somalia, Sudan, Swaziland, Togo, and Zimbabwe.

Data Source
- Incidence and mortality data on TB (all forms) for adults and children, PLWH and PnLWH, were obtained from the World Health Organization (WHO) Global Health Atlas.

- HIV prevalence data for adults and children were obtained from the Jointed United Nations Programme on HIV/AIDS (UNAIDS).

- Population estimates were obtained via the U.S. Census Bureau and used to calculate incidence, prevalence and mortality rates. We used the population at the mid-period to calculate these rates.

- Data were gathered from 1996 to 2007.

- We were not able to obtain TB mortality data for PLWH after the year 2007, since the WHO and UNAIDS have changed the way TB mortality rates are reported since 2008. These data are now included in the AIDS-related mortality cases.

Indicators
- Rate ratios for TB incidence and mortality rates (per 100,000 population) to compare the time periods before (1996-2002) and after (2004-2007) PEPFAR inception, and the PLWH and PnLWH population groups.

$$IRR_{PEPFAR}^{TB} = \frac{I_{TB}^{After\ PEPFAR}}{I_{TB}^{Before\ PEPFAR}} \text{ and } MRR_{PEPFAR}^{TB} = \frac{M_{TB}^{After\ PEPFAR}}{M_{TB}^{Before\ PEPFAR}}$$

$$IRR_{HIV}^{TB} = \frac{I_{TB}^{HIV-positive}}{I_{TB}^{HIV-negative}} \text{ and } MRR_{HIV}^{TB} = \frac{M_{TB}^{HIV-positive}}{M_{TB}^{HIV-negative}}$$

- A TB/HIV indicator* combining data from both HIV and TB. This indicator calculates the rate of change in TB incidence rate relative to the HIV prevalence rate. It allows comparisons across regions over time.

*Sânchez MS, Lloyd-Smith JO, Getz WM. Monitoring linked epidemics: the case of tuberculosis and HIV. PLoS One 2010; 5: e8796

RESULTS

Table 1. Relative Risks

Relative Risk	For TB Incidence				For TB Mortality			
	Focus		Control		Focus		Control	
	PLWH	PnLWH	PLWH	PnLWH	PLWH	PnLWH	PLWH	PnLWH
Median (25th-75th percentiles)	20 (18 - 25)	1 (-)	23 (18 - 25)	1 (-)	40 (32 - 45)	1 (-)	43 (33 - 51)	1 (-)
Worst Countries (above 75th percentile)	Rwanda, Kenya and Côte d'Ivoire		Madagascar, Senegal, Burkina Faso, Malawi, Guinea, Eritrea and Somalia		Rwanda, Kenya and Côte d'Ivoire		Madagascar, Senegal, Burkina Faso, Guinea, Benin, Malawi, Somalia and Gambia	

Relative Risk	For TB Incidence				For TB Mortality			
	Focus		Control		Focus		Control	
	Before PEPFAR's Inception	After PEPFAR's Inception	Before PEPFAR's Inception	After PEPFAR's Inception	Before PEPFAR's Inception	After PEPFAR's Inception	Before PEPFAR's Inception	After PEPFAR's Inception
Median (25th-75th percentiles)	1 (-)	0.75 (0.62 - 0.90)	1 (-)	0.88 (0.80 - 1.05)	1 (-)	0.76 (0.62 - 0.97)	1 (-)	0.79 (0.69 - 0.96)
Worst Countries (above 75th percentile)	South Africa and Mozambique		Angola, Chad, Gabon, Guinea, Madagascar, Sierra Leone, Senegal and Swaziland		Bostwana, Namibia and Mozambique		Chad, Djibouti, Guinea, Lesotho, Madagascar, Senegal and Sierra Leone	

Table 2. TB/HIV Indicators combining data from TB and HIV

A) Countries in which the TB incidence is increasing in a slower pace than the increase in HIV prevalence.

Group	Countries
C	Madagascar
C	Senegal
F	South Africa
C	Angola
C	Gambia
C	Niger
C	Guinea
C	Guinea-Bissau
C	Swaziland
C	Djibouti
C	Lesotho
C	Benin
C	Gabon
C	Sierra Leone
C	Eritrea
C	Togo
C	Sudan
C	Liberia

B) Countries in which the TB incidence is increasing while the HIV prevalence is decreasing .

Group	Countries
C	Zimbabwe

C) Countries in which the TB incidence is decreasing in a faster pace than the decrease in HIV prevalence.

Group	Countries
F	Kenya
F	United Republic of Tanzania
F	Côte d'Ivoire
F	Ethiopia

D) Countries in which the TB incidence is decreasing in a slower pace than the decrease in HIV prevalence

Group	Countries
C	Congo
F	Uganda
C	Burundi
F	Rwanda

E) Countries in which the TB incidence is decreasing while the HIV prevalence is increasing

Group	Countries
C	Somalia
F	Mozambique
F	Namibia
C	Mali
C	Chad
F	Nigeria
F	Botswana
C	Central African Republic
C	Malawi
C	Cameroon
F	Zambia
C	Burkina Faso
C	Ghana
C	Democratic Republic of the Congo

CONCLUSIONS

- We observed a general trend towards lower TB incidence rates In the African countries evaluated.

- PEPFAR focus countries showed a more consistent and substantial effect, highlighting the likely link between high-levels of HIV investment and broader effects on related diseases such as TB.

- Further operational research will be needed to fully and accurately characterize the relative impact of individual activities within these programs on the TB/HIV co-epidemic in the region.

- Such data will be critical to inform public policy and plan for future interventions in an attempt to accelerate the efforts to control the spread of both epidemics.

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