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# Trends of Zambia's tuberculosis burden over the past two decades

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**Summary**

OBJECTIVES To study trends in Zambia's TB notification rates between 1990 and 2010 and to ascertain progress made towards TB control.

METHODS Retrospective review of TB notification returns and TB programme reports for the period from 1990 to 2010.

RESULTS Two distinct TB trend periods were identified: a period of rising trends up to a peak between 1990 and 2004 and a period of moderately declining trends between 2004 and 2010. Treatment outcomes improved over the two decades. Data on trends in paediatric TB, TB in prisoners and TB in pregnant women remain scanty and unreliable owing to poor diagnostic capability. There were no data available on trends on drug-resistant TB because of the lack of laboratory services to perform drug sensitivity testing.

CONCLUSIONS The period of increasing TB between 1990 and 2000 coincided with an increase in HIV/AIDS. The period of slightly decreasing TB between 2004 and 2010 can be attributed to improved TB care, sustained DOTS implementation and improvement in TB diagnostic services. Newer diagnostics technologies for the rapid diagnosis of active TB cases and for drug-resistant testing, recently endorsed by the WHO, need to be implemented into the national TB programmes to detect more cases and to provide epidemiological and surveillance data from which to obtain an evidence base for guided investments for TB control. Alignment of TB and HIV services is required to achieve improved management outcomes.

**keywords** TB, Zambia, epidemiology, directly observed treatment short course, national TB Programme, control

## Introduction

WHO declared tuberculosis (TB) a global emergency in 1993 and recommended directly observed treatment short course (DOTS) in 1995 as a cost-effective strategy for TB control worldwide (WHO 1995). However, TB remains a major public health problem (WHO 2010a). The global burden of TB in 2009 was estimated to be approximately 9.4 million incident cases (equivalent to 137 cases per 100 000 population) and 1.7 million people died of TB. Women accounted for 35% of all cases (WHO 2010a). Approximately 80% of the TB cases notified worldwide were from the 22 high-burden countries (HBCs), and WHO concentrates mainly on these HBCs to show progress and programme performance.

In Zambia, a country with a population of 13 million people, TB continues to be among the big public health problems (Mulenga *et al.* 2010b), more than 40 years after launching the TB/Leprosy National Control Programme (NTP) (Bosman 2000). The burden of the disease is exacerbated by the high prevalence of HIV/AIDS, estimated to be approximately 13.5% (UNAIDS 2010); by widespread poverty (CSO 2011b); and by inadequate control strategies in congregate settings such as prisons that act as reservoirs for the disease (Todrys 2010; O'Grady *et al.* 2011a,b). However, Zambia is not currently listed as one of the 22 HBCs, presumably owing to its relatively small population, and does not receive the same support as the HBCs for TB control.

No TB data were reported to WHO from Zambia for the years 1997–1999 owing to the almost complete collapse of the NTP during healthcare reforms when vertical programmes were abolished and integrated with general health services (Bosman 2000; Mwaba *et al.* 2003). During this period, the TB burden in Zambia was as high as in some neighbouring countries included in the HBC group, such as Zimbabwe. It is possible that the non-reporting period may have resulted in Zambia not being identified as one of the HBCs (Mwaba *et al.* 2003).

TB diagnosis in Zambia is mainly through microscopy; the country has 158 diagnostic facilities and 1800 treatment facilities. Childhood TB data are not adequately captured because of problems with diagnosis and reporting; thus, available data may not reflect the true burden (Marais *et al.* 2006). Data on drug-resistant TB are not routinely collected by the NTP, and the burden of multiple drug-resistant TB (MDR-TB – *Mycobacterium tuberculosis* resistant to at least rifampicin and isoniazid) is estimated to be 1.8% of new TB cases by WHO (2010a). Approximately 67% of TB patients notified to the NTP are co-infected with HIV (CDC 2008, WHO 2010a).

In order to study trends in TB notification rates and to ascertain progress made towards TB control, we conducted a retrospective study looking at the period from 1990 to 2010. We discuss potential factors that have contributed to the changes in TB disease profile in the past decade, and make recommendations on improving current TB diagnostic services, drug resistance surveillance and recording and reporting of data that are important for achieving TB control in Zambia.

## Methods

A retrospective review and analysis of routine National TB surveillance data was performed using available data from 1990 to 2010. The data reviewed included all age groups and both genders; it was analysed in terms of aggregated national notifications, gender profiling and annual trends. Further desk reviews of in-country TB reports were also conducted to assess TB programme performance. Data available from published National TB programme review reports and other TB programme assessment reports were reviewed for the period 2000–2010. Case notification rates were calculated using the estimates of population from the central statistics office. Descriptive statistics were used to generate trends in notifications and selected treatment outcomes over the years. The sputum smear-negative cases were defined according to the National TB manual as adapted from the WHO guidelines as: 'Tuberculosis in a patient with three initial negative smear examinations by direct microscopy for Acid Fast Bacilli (AFB–) and non-response to a course of broad-spectrum antibiotics, and again three negative sputum smear examinations by direct microscopy, and X-ray abnormalities suggestive of active tuberculosis as determined by the treating Medical Doctor/Clinician' or 'Tuberculosis in a patient with three initial sputum smear examinations negative by direct microscopy but positive by culture for mycobacterium'. We used the Mann–Whitney *U*-test to assess the differences in TB prevalence between men and women.

## Results

### Total notifications

Over the past two decades, between 1990 and 2010, a total of 759 769 cases of all forms of TB were reported through health facilities in Zambia (Table 1). The average annual notification rate was 42 209 cases nationwide. The data can be divided into two distinct phases: pre- and post-2004 (Figure 1). TB case notifications increased steadily from 16 863 in 1990 to a peak of 58 070 in 2004. Thereafter, from 2004 to 2010, there has been a demonstrable decline in the absolute number of TB notifications countrywide.

**Table 1** Zambian TB case notifications and case notification rate per 100 000 population from 1990 to 2010

| Years | Total notification | Population | CNR (per 100 000 population) |
|---|---|---|---|
| 1990 | 16 863 | 7 817 803 | 216 |
| 1991 | 21 550 | 8 831 967 | 244 |
| 1992 | 25 448 | 8 235 599 | 309 |
| 1993 | 28 842 | 8 609 552 | 335 |
| 1994 | 33 492 | 8 860 317 | 378 |
| 1995 | 33 553 | 9 142 507 | 367 |
| 1996 | 38 863 | 9 501 956 | 409 |
| 1997 | *Not available | | N/A |
| 1998 | *Not available | | N/A |
| 1999 | *Not available | | N/A |
| 2000 | 49 806 | 9 885 591 | 504 |
| 2001 | 52 757 | 10 089 492 | 523 |
| 2002 | 45 836 | 10 409 441 | 440 |
| 2003 | 55 275 | 10 744 380 | 514 |
| 2004 | 58 070 | 11 089 691 | 524 |
| 2005 | 53 569 | 11 441 461 | 468 |
| 2006 | 51 179 | 11 798 678 | 434 |
| 2007 | 50 415 | 12 160 516 | 415 |
| 2008 | 47 333 | 12 525 791 | 378 |
| 2009 | 48 510 | 12 896 830 | 376 |
| 2010 | 48 408 | 13 272 553 | 365 |

CNR, case notification rate.
*Data not available because of donor insistence on removing the vertical programme and subsequent collapse of the TB programme.

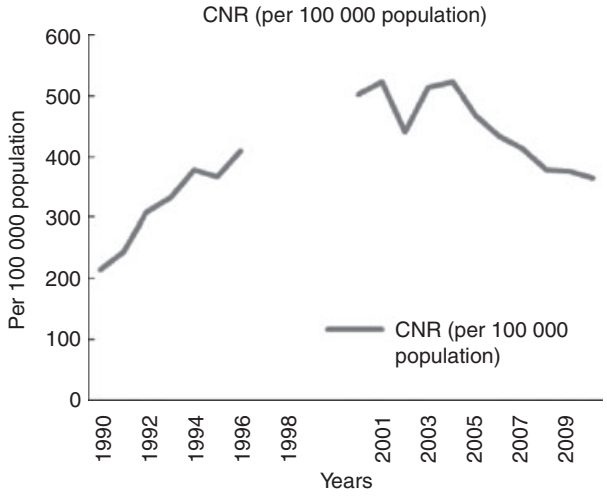


**Figure 1** Trends of TB case notification rate all forms (per 100 000 population), 1990–2010. Data not available for 1998–2000 because of donor insistence on removing the vertical NTB programme and integration of all health services. The NTP was re-instated in 2000.

The same trends are observed when the data are disaggregated by type of TB: sputum smear positive, smear negative, extrapulmonary TB and retreatment positives. There are consistently and significantly more smear-negative TB cases reported each year than smear-positive cases.

Data from years 1997, 1998 and 1999 were not available because of the collapse of the NTP owing to donor advice for the integration of all health services, thus removing the vertical NTP infrastructure. There was no specific funding for the TB programme until the year 2000 when the programme was resuscitated and reporting systems were re-activated.

### Tuberculosis trends by gender

The trends by gender are similar to the total notifications data (Figure 2). Generally, there are more male cases than female cases ($P = 0.035$) in spite of the fact that there are more females than males in the Zambian general population (CSO 2011a). However, this is consistent with global trends in TB by gender (WHO 2010a). Most of the notified cases are in the age range of 25–44. There is a significant difference in TB prevalence between children (<15 years) and adults ($P = 0.002$).

### Treatment outcomes

The cure rates almost doubled in the last decade, from 47% in 2000 to 82% in 2009 (Table 2). The treatment default rates declined from 19% in 2000 to 4% in 2009;

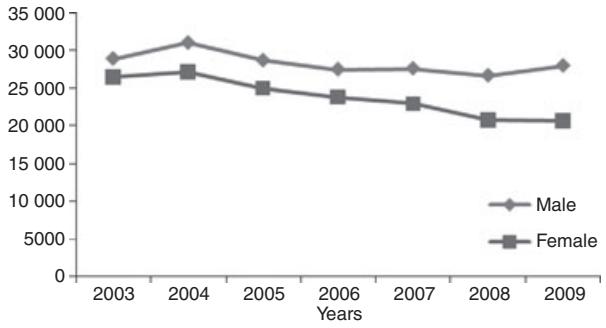


**Figure 2** TB notifications all forms by gender 2003–2009.

**Table 2** Treatment Outcomes Among Smear-Positive Cohorts from 2000 to 2009: Zambia

| Years | Cure rates (%) | Treatment default rate (%) | Treatment success rate (%) | Crude death rate (%) |
|---|---|---|---|---|
| 2000 | 47 | 19 | 66 | 7 |
| 2001 | 58 | 16 | 74 | 12 |
| 2002 | 67.7 | 11 | 78.7 | 10 |
| 2003 | 72.5 | 9 | 81.5 | 8.5 |
| 2004 | 75.6 | 6.5 | 82.1 | 8 |
| 2005 | 76 | 8 | 84 | 7.6 |
| 2006 | 77 | 8 | 85 | 6.6 |
| 2007 | 78 | 7 | 85 | 6.4 |
| 2008 | 82 | 4 | 86 | 5 |
| 2009 | 82 | 4 | 86 | 5 |

consequently, the treatment success rate increased from 66% in 2000 to 86% by the year 2009. The crude death rates from the national cohorts have also declined by more than half from 12% in 2001 to 5% in 2009. Only sporadic data were available from the NTP for cure rates, default rates, treatment success rates and crude death rates previous to 2000.

### Drug-resistant TB

No routine data are collected for drug-resistant TB by the Zambian NTP to date, although there have been cases of drug-resistant TB diagnosed at tertiary referral centres. No diagnosis of extensively drug-resistant TB (XDR-TB) has been reported to the NTP.

### Other data

Data on trends in paediatric TB, TB in prisoners and TB in pregnant women were not assessable as records were not available for these subgroups. Data on paediatric TB are

scarce and unreliable because of poor diagnostic capability and inappropriateness of current diagnostic algorithms.

## Discussion

Two distinct TB trends are seen in Zambia over the past 20 years: (i) a period of increasing TB between 1990 and 2000 which appears to have coincided with an increase in the prevalence of HIV/AIDS and (ii) a period of slightly decreasing TB between 2004 and 2010 which could be attributed to greater investments into the NTP by donors and the government and sustained DOTS implementation. However, under-reporting owing to poor record keeping is another possible reason for the decline.

Our study shows that the TB burden in Zambia remains high and continues to pose a serious public health challenge in spite of the implementation of the DOTS strategy as recommended by WHO (2010b). Whilst the decline in TB rates over the past decade is encouraging, more funding and investment is required for more effective diagnostic services and drug resistance testing and for enhancing DOTS implementation. Newer diagnostics technologies for the rapid diagnosis of active TB cases and for drug-resistant testing, recently endorsed by the WHO, need to be implemented into the national TB programmes so as to increase case detection and to provide epidemiological and surveillance data from which to obtain an evidence base for guided investments for TB control. Data are also required for assessing trends of TB in children and other vulnerable groups including pregnant women and prisoners.

The WHO estimates that Zambia has a case detection rate of approximately 80% (WHO 2010a), meaning that approximately 12 000 TB cases go undiagnosed each year. The public and semipublic sectors notify 90% of cases; the remainder is from a limited number of private sector facilities that collaborate with the NTP. There is therefore a likely discrepancy in the number of cases notified by the Zambia NTP and the TB cases diagnosed and treated in the country because of the private sector facilities that do not report to the NTP. It is unclear how many patients with TB use the informal health sector, such as traditional healers, in Zambia. There is a need to strengthen public–private partnerships to capture all TB cases and to ascertain the proportion of TB cases that the informal sector is attending to.

TB case notifications and rates increased dramatically from 1990 to 2004. This was a true increase because there was no expansion of NTP activities during this time. For 3 years (1997–1999), the NTP infrastructure collapsed. Reasons for the rise in TB during the period 1990–2004 include the growing HIV pandemic (UNAIDS 2010); the growing population (CSO 2011a); population urbanization leading to overcrowding and poor housing (CSO 2011a); and higher poverty levels. Since 2004, there have been modest reductions in case notifications and significant reductions in case notification rates (Table 1 and Figure 1). This could be attributed to the focus on TB control in Zambia over the last two decades and the implementation of DOTS, which possibly increased the number of TB cases reported in the first instance, followed by a reduction in the number of reported TB cases because of reduced transmission (Soltan *et al.* 2008). The rise in the number of facilities in all districts led to more service delivery points. Better financial support through sector-wide approaches (SWAPS) provided grounds for sustaining consistent DOTS implementation that consequently led to good treatment success rates, reaching 86% in 2009. The increase in financial resources to the programme through Global Health Initiatives such as PEPFAR, GFATM and other bilateral partners (DFID, CIDA-KNCV, TB CAP) may have subsequently improved programme performance through training and sensitization of health staff, more community involvement and sensitization of the general public leading to more people accessing TB services and a subsequent increase in notified cases (National Tuberculosis Programme 2011). The exact impact of these investments by donors is difficult to assess.

The community groups and community volunteers who try and ensure that patients with TB are supported and take their medication contribute to improving treatment outcomes that, over a sustained period, can contribute to the declining trends (Mulenga *et al.* 2010a). The declining trends cannot be attributed to the reduction in HIV prevalence (14.3% in 2001 to 13.5% in 2009), which has not dropped significantly (UNAIDS 2010).

More sputum smear-negative than smear-positive cases are notified every year, and 75% of the smear-positive cases are from the more urbanized areas such as Lusaka, the Northern Copper Belt region and Southern Provinces, which account for 40% of the total population (CSO 2011b). This is likely to be because there are more microscopy diagnostic facilities and medical human resources in urban than in rural provinces. Strengthening the healthcare system in more rural areas would lead to increased TB case detection and notification and government and donor funding for this purpose must be made a priority if TB is to be controlled in Zambia.

More male than female TB cases were notified to the NTP every year during the period under review, which is in contrast to the gender proportions in the general population. Also, there are more females than males with HIV/AIDS in Zambia (UNAIDS 2010), which is a major risk factor for susceptibility to TB (De Cock & Chaisson

1999; Corbett *et al.* 2006; Lawn & Zumla 2011). The reasons why men are more susceptible to TB than women in Zambia need to be explored further. Nonetheless, this gender disparity correlates with the global situation (WHO 2010a).

A greater percentage of TB cases are within the reproductive age group. Therefore, many patients with TB will either be pregnant or have young children. Current Zambian TB data do not record the pregnancy status of patients; hence, the burden of TB in pregnancy is poorly understood and needs to be defined. TB is an important cause of the maternal mortality from non-obstetric causes (Ahmed *et al.* 1999; Grange *et al.* 2010); hence, there is an urgent need to understand TB in pregnancy and intensify diagnosis and safe treatment for TB in expecting mothers.

The TB burden in children in Zambia remains undefined because of several reasons. TB is easily missed owing to difficulties in making an accurate diagnosis of TB in children and also owing to the problems in differentiating TB from other childhood respiratory infections (Chintu *et al.* 2002). Thus, childhood TB is not well documented within the NTP. TB is difficult to diagnose in children, especially in those under 5 years. The recent development of the Xpert MTB/RIF assay for the simultaneous detection of *M. tuberculosis* and rifampicin resistance is an important advance that requires evaluation in childhood TB (Nicol & Zar 2011), but because sputum is difficult to obtain from young children, this test may not provide all answers (Mwaba *et al.* 2011). More needs to be done to address childhood TB. Hospital childhood TB programmes should be separated from adult programmes, strengthened and should work closely with the NTP.

Treatment success and cure rates have improved significantly since 2000 in Zambia (Table 2). The treatment outcomes reflect the improvements in TB control. This may be an indication that the DOTS strategy has the potential to reduce the TB burden when sustained over time (Soltan *et al.* 2008). The high treatment success rates have contributed to the declining notification rates and may indicate that TB transmission in the general public may be decreasing. Being a low-income country, Zambia relies mainly on light microscopy for TB diagnostics, which is notoriously insensitive (Steingart *et al.* 2006). Current policies need to be improved upon if Zambia is to achieve TB control. Active case finding is an additional strategy for improving case detection rates as shown in Zimbabwe (Corbett *et al.* 2006). Improved case detection can be achieved using superior diagnostics. The recent WHO endorsement of Xpert MTB/RIF is an exciting development but research must be performed on how to appropriately implement such technology in Zambia. Financing the implementation of expensive molecular diagnostics technology for the rapid and accurate diagnosis of TB, and for detecting and defining the problem of drug-resistant TB, is also a major issue (Mwaba *et al.* 2011). Sufficient infrastructure does not currently exist in Zambia for the accurate diagnosis of drug-resistant TB and for its surveillance. Thus, the epidemiology and importance of drug-resistant TB in Zambia remains relatively undefined.

Two-thirds of Zambian TB patients notified to the NTP are co-infected with HIV (CDC 2008, WHO 2010a). It thus becomes very important to align and integrate TB and HIV services, so that more effective patient care can be established. Antiretroviral drugs only became available in Zambia in 2003 enabling HIV services in the public sector to be established. Antiretroviral therapy (ART) roll-out and HIV services are still lagging behind. There are now close to 400 facilities in Zambia at which ART is offered across the whole country with now approximately 400 000 people accessing ARVs. TB services, on the other hand, are offered in all 1800 facilities in the country. TB and HIV services are not yet integrated, although efforts are being made to achieve this.

It is prudent that advances in new technology are adopted and implemented into developing country programmes, improving the quality and effectiveness of TB services within their health systems. There should be concurrent investments into improved case detection and treatment for TB in children and other vulnerable groups like pregnant women, prisoners, homeless and HIV-infected people. This would contribute to the achievement of millennium development goal 6 and also goals 4 and 5 that address reduction in infant mortality and maternal mortality (UN 2010). Donors must focus their investments towards strengthening health services in sub-Saharan African countries to optimize TB and TB/HIV care.

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