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REVIEW

Tuberculosis in prisons in sub-Saharan Africa – the need for improved health services, surveillance and control

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SUMMARY

Prisons have long been associated with rapid transmission of infectious diseases. The HIV/AIDS epidemic in sub-Saharan Africa (SSA) has fuelled the spread of TB and HIV in prisons. The poor living conditions and ineffective health services in prisons in SSA are a major breeding ground of *Mycobacterium tuberculosis* (*Mtb*). The spread of TB between prisoners, prison staff and visitors and the emergence of drug-resistant TB in prisons now poses a threat to control efforts of national TB programmes in SSA. Accurate data required to develop appropriate interventions to tackle the ominous problem of TB in African prisons are scanty and unreliable. The health of prisoners is by default a neglected political issue. This article reviews the available literature on TB and drug-resistant TB in prisons from SSA countries, discusses the risk factors for acquiring TB and highlights the priorities for further translational research in prisons. Ethical issues pertaining to research on captive African populations are discussed. Scientific, political and funder attention is required urgently to improve prison health services.

1. Introduction and background

Tuberculosis (TB) and HIV/AIDS cause high morbidity and mortality rates in adults in sub-Saharan Africa (SSA). World Health Organisation (WHO) recommendations for TB control are focussed on the early diagnosis and supervised treatment of people in the community. The ex-South African President and Nobel Prize winner, Nelson Mandela, developed TB whilst a prisoner on Robben Island, Cape Town. Prisons have long been known to be associated with rapid transmission of bacterial, viral, fungal and parasitic infectious diseases of the skin, gut, genitals and respiratory system. Prisons are recognised as reservoirs for TB transmission, and surveillance data from Eastern European prisons show that TB causes significant morbidity and mortality in prison inmates and staff.[1–4]

In SSA, the average TB incidence and prevalence rates are 363/100,000 and 475/100,000[5] respectively. The HIV/AIDS epidemic is fuelling the spread of TB and up to 70% of adults with TB are co-infected with HIV in many SSA countries.[6] TB in prisons encompasses not only TB in prisoners, but TB in prison staff who ultimately interact directly with their families and community when they leave work. Emerging data show that multi-drug resistant TB (MDR-TB) is also increasingly being identified in prisoners and prison staff and poses a threat to National TB Programmes (NTPs).[7,8] While there have been many comprehensive reports of TB in prisons from USA and Europe, there has been a paucity of literature on TB in African prisons. Accurate data of TB in prisons in SSA countries are not readily available since surveillance and data reporting mechanisms are poor or non-existent. This review summarises the available literature on epidemiology, diagnosis, treatment and control of TB in prisons from SSA countries highlighting key priority areas for research and associated ethical issues. A case is made for increased research on priority issues and attracting political and funder attention and investment to address the neglected problem of TB in SSA prisons.

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2. Methods

A review of all relevant English language publications on TB in prisons in SSA was performed of PubMed and Google Scholar databases. The search used the key words 'tuberculosis (TB)', 'prisons', 'prisoners', 'inmates', 'drug resistance', and 'Africa' linked with the words 'epidemiology, treatment, TB control, transmission, management, conditions, ethics, and prevention'. The search covered the period July 1st, 1990 up to July 1st, 2010. Review articles for TB in prisons in general with no geographical restrictions were collected via a PubMed search using the key words 'tuberculosis' and 'prisons'. In addition, the US Centres for Disease Control and Prevention (CDC) and World Health Organisation (WHO) websites were searched for relevant information. There were inherent differences in the methods used to conduct the various studies and they also varied in emphasis, presentation of data and study variables.

3. Published studies on TB in SSA prisons

Data of TB in prisons from SSA countries show high prevalence rates affecting upto 5% of inmates. Reports from Zambia, Cameroon, Tanzania, Malawi, Botswana, and Ivory Coast suggest that the TB prevalence in prisons is several fold higher than that of TB in the general population (Table 1). A cross-sectional study of TB in thirteen Zambian prisons conducted between 2000 and 2001, enrolled 1080 of a total of 6118 prison inmates, of which 245 (22.7%) had active TB (prevalence = 4005 per 100,000 inmates). Similar results were obtained from studies of prisons from Douala, Cameroon. A retrospective cohort study of 501 prison inmates with active TB at Butimba prison, Mwanza, Tanzania[11] conducted between January 1994 and December 1997 showed a high mortality (16.8%) with 84 deaths, and 112 of 501 inmates (25.9%) were HIV positive. Three hundred and forty three of the 501 inmates (68.4%) were clinically classified as malnourished. The majority of inmates (42.1%) were diagnosed with TB between 1 and 2 years after incarceration.

In 1996 an active case finding study was performed in Zomba Central Prison, the largest prison in Malawi. Of 1315 inmates, 915 (70%) were screened for pulmonary TB of which 47 (5142 per 100,000 inmates) had active TB. Of 22 inmates with TB who agreed to have a HIV test, 16 (73%) were HIV positive. In most inmates the symptoms of TB had started after the study participant had entered prison.[15] This study led to policy change in Malawi and the Malawi National Tuberculosis Control Programme was empowered to develop a system that would lead to more accurate diagnosis and treatment of TB in prisons in the country.[16]

The USA Centres for Disease Control (CDC), in collaboration with Botswana government authorities, performed an active case finding study screening prison inmates and guards for TB at four prisons in Gaborone during 2002.[13] A total of 1027 (88%) of 1173 prison inmates and 263 (91%) of 288 guards were interviewed. Of a total of 509 (50%) prisoners that reported cough, 371 (73%) provided sputum samples of which 39 had TB - a point prevalence of TB of 3797 per 100,000 inmates (3.8%). Prisons guards had a point prevalence of 2662 cases per 100,000 ($n = 7/263$). Six out of 20 (30%) study participants, who agreed to be HIV tested, were positive. Several CDC recommendations resulted from this study, although these measures have been slow to be implemented.

A prospective study of TB in Bouake prison camp, Ivory Coast from 1990–1992.[14] showed the incidence of active TB to be 5803 per 100,000 inmates ($n = 108/1861$). In the majority of cases TB disease was associated with other conditions including malnutrition (75%), anaemia (70%) and dermatoses including scabies (64%). HIV co-infection was observed in 30% ($n = 9/30$) of the cases and alcohol and tobacco dependence in 50%. The 6-month treatment regimen was effective, with 97.6% of those who completed their treatment, cured.

4. Prisons – reservoirs of TB impacting on the general community

Prisons are regulated but not closed systems, due to the numbers of people who enter, leave and re-enter them. Prison health is a critical part of public health, as health problems within and outside prisons are interrelated.[17] This has major health implications regarding the epidemiology of TB and other transmittable diseases within the community.[18,19] Sub-standard health services and TB diagnostic and treatment practices in prisons compound the risk of MDR-/XDR-TB to the entire population.[18] Successful TB control, in any country, requires effective TB control in prisons. Failure to control TB in prisons has the potential to disrupt community TB control programmes.[18]

5. Drug resistant TB data from SSA prisons

The 2010 WHO MDR-TB and extensively drug-resistant TB (XDR-TB) report[20] estimates that 440,000 MDR-TB cases occurred in 2008 (3.6% of the total incidence of TB), of which 150,000 deaths occurred worldwide. Accurate data on drug-resistant TB from SSA

Table 1
Summary of TB in prison studies from sub-Saharan Africa.

Country	Reference	Study site(s) and year(s) of study	Main findings (TB prevalence, incidence and HIV co-infection)
Zambia	Habeenzu C *et al.*, 2007[9]	TB screening in 13 prisons across Zambia (2000–2001)	Minimum TB prevalence was 4005 per 100,000 based on a total prison population of 6118 (245/1080 recruited patients were positive for TB) and the authors speculate that true TB prevalence rates may approach 15–20%. Resistance to at least one anti-tuberculosis drug was detected for 40 (23.8%) isolates, while MDR-TB was identified for 16 (9.5%) isolates (MDR-TB prevalence of 262 per 100,000).
Cameroon	Noeske J *et al*, 2006[10]	TB screening in the central prison in Douala (2003–2004)	TB point prevalence of 3516 per 100,000 ($n = 87/2474$) with 6/24 (25%) of patients tested co-infected with HIV.
Tanzania	Rutta E *et al*, 2001[11]	TB patients in Butimba prison in Mwanza (1994–1997)	Of 501 TB patients, 40.7% were smear positive, 25% were co-infected with HIV and the majority of inmates were diagnosed with TB between 1 and 2 years after incarceration
Malawi	Banda H *et al*, 2009[12]	TB screening in 18 (of 22) prisons across Malawi (2005)	Average prevalence of smear-positive pulmonary TB was 705 per 100,000 ($n = 54/7661$) but prevalence was higher in large urban prisons (1080 per 100,000).
Botswana	CDC Report, 2003[13]	TB screening in 4 prisons in Gaborone (2002)	A point prevalence of TB of 3797 cases per 100,000 population ($n = 39/1024$) in prison inmates and 2662 cases per 100,000 ($n = 7/263$) in prison guards with 30% (6/30) of patients tested co-infected with HIV
Ivory Coast	Koffi N *et al*, 1997[14]	TB screening in Bouake prison camp (1990–1992)	Smear positive TB incidence of 5803 per 100,000 inmates ($n = 108/1861$) with HIV co-infection observed in 30% ($n = 9/30$) of cases.
Malawi	Nyangulu D *et al*, 1997[15]	TB screening in Zomba Central Prison (1996)	TB prevalence of 5142 per 100,000 inmates ($n = 47/914$) with 73% of those tested co-infected with HIV ($n = 46/62$).

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are scant with only approximately half of the countries reporting data that show <3% of new TB cases as MDR-TB.[7,20] The WHO estimated that 69,000 cases of MDR-TB emerged in 2008 in Africa, which is likely to be an underestimate due to lack of any significant laboratory infrastructure required to perform drug susceptibility testing on a routine basis. In a study based on data from 39 of the 46 countries in Africa, it was estimated that MDR-TB is likely to be more prevalent than previously recognised.[21] Recent surveys from Ethiopia (retreatment cases)[22], Nigeria (tertiary hospital)[23], Zambia (prison)[9] and Rwanda (retreatment cases)[24] report MDR-TB prevalence rates of 26%, 54%, 9.5% and 9.4%, respectively. These data indicate that MDR-TB prevalence rates are higher than reported by the WHO.[7]

Prisons can be an important source of spread for drug-resistant TB.[19] The WHO status report on TB in prisons released in 2007 states that there is an urgent need to ensure effective and efficient diagnosis and treatment of drug-resistant forms of TB in prisons.[25] Many SSA countries simply do not have the resources or organised health systems for screening, diagnosis and treatment of prison inmates for TB. For those that are tested for TB, routine drug-susceptibility testing is not performed. This illustrates the large gap between what is recommended by the WHO and the real situation on the ground in SSA prisons. Barriers to implementation of TB control in prisons include: inadequate TB and TB/HIV health services and medical staff for prisons; lack of laboratory support; inadequate infection control measures and lack of resources to implement them; inadequate discharge planning, contact tracing and followup after discharge; lack of proper data collection and surveillance procedures; low priority for national governments resulting in poor resource allocation.

6. Risk factors for transmission and development of active TB within prisons

Table 2 lists the factors that promote transmission and development of active TB in prisons. In SSA prisons the most important risk factors are HIV, poor ventilation, overcrowding and malnutrition. Prisons provide ideal conditions for the rapid and effective transmission of respiratory tract, skin, gastrointestinal and sexually transmitted diseases.[26] According to the WHO, TB propagates in prisons because of several reasons: prisons receive TB through prisoners and staff with active TB; prisons concentrate TB; prisons disseminate TB; prisons make TB worse; and prisons export TB.[25] It is well established that TB is a disease associated with malnutrition, stress, immunosuppression, overcrowding, poor housing and ventilation, factors which are prevalent in prisons. TB thrived in the UK a hundred years ago, in Victorian times, when these conditions prevailed.

A recent article in the Lancet titled 'Death and disease in Zimbabwe's prisons' describes the appalling conditions faced by prisoners in SSA.[27] Ex-prison inmates described how the sick and the healthy slept side by side, coughing at each other and how the dead and the living often competed for space. An assessment of Zambia's prisons, regarding TB and HIV, published by Human Rights Watch in April this year[28] revealed similar findings. In October 2009, the Zambia Prisons Service employed only 14 health staff, including only one physician, to serve its 15,300 prisoners and only 15 of 86 prisons had a health clinic or sick bay.[28,29]

Table 2
Risk factors for transmission and development of active TB within prisons.

Environmental risk factors	Host risk factors
Poor ventilation in prison cells and congregate settings within the prisons	Poor nutrition and micronutrient deficiencies
Close contact between prisoners due to restricted prison compounds	Stress and anxiety
Close contact between prisoners and prison staff	Immunosuppression eg HIV infection
Overcrowded sleeping quarters (many prisoners per cell)	Smoking, Alcohol, and Chronic obstructive airways disease
Close contact between prisoners and visitors	Addictive drugs
Poor prison health services	Lack of sunshine and vitamin D deficiency

7. Achieving TB control in prisons

The prevalence of TB in prisons ultimately reflects the efficiency and quality of the country's NTP. The WHO has viewed TB in prisons as an important control issue and published guidelines on TB for national government TB programmes a decade ago.[19] These are similar to *Mtb* infection prevention and control measures recommended by the CDC and include: early identification of inmates with latent TB infection (LTBI) and active TB; prompt isolation of contagious inmates; appropriate use of infection control methods; swift performance of contact investigations; and successful completion of treatment for latent and active TB.[30,31]

In Malawi, the National TB Programme (NTP) and the Prison Medical Services have effectively worked together to improve the diagnosis and treatment of TB in prison inmates since 1996.[16] Prison inmates are screened for TB on admission and at intervals during their incarceration. Inmates are treated for TB according to NTP guidelines. A study, performed in 2005, of 18 prisons in Malawi showed a prevalence rate of smear-positive TB of 0.7%, which, while high compared with that of the general population, is lower than prevalence rates from other prison surveys in Africa, indicating some measure of programme success.[12]

8. Overcoming risk factors for TB in prisons

8.1. Living conditions including overcrowding and ventilation

Living conditions in prisons throughout the world are poor. SSA prisons are among the most overcrowded in the world.[28] The Human Rights Watch report's recommendations to address TB in prisons include "improving immediately the ventilation, sunlight, and cleaning of TB isolation cells in line with international standards".[28] All SSA country governments are faced with competing investment needs and prisoner healthcare drops down the list of priorities.

8.2. HIV screening and treatment

Due to the high prevalence of TB and HIV/AIDS in the local community, and amongst prisoners in SSA, parallel screening for TB and HIV is necessary and should be performed regularly in all prisoners. HIV positive inmates and staff should be provided with counselling, testing, appropriate treatment and, if necessary, parallel management of TB and HIV.

8.3. Nutritional status, immunity and TB

Malnutrition and associated poor immunity is associated with an increased risk of reactivation of latent to active TB and increased risk of re-infection because of the negative impact of micro and macronutrient deficiencies on the cell-mediated immune system.[32] Several studies in various populations have associated vitamin D deficiency with increased risk of TB.[33–38] Lack of funding, massive overcrowding and mismanagement of meagre resources are primary drivers of malnutrition, increased risk of disease and death in most SSA prisons.[27]

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8.4. Improving health services

Prison health services are insufficient, in all SSA countries, due to competing priorities for limited health care funds.[25,39] Access to adequate health care for inmates is therefore limited because of lack of resources, accommodation, equipment, transport, staff and infrastructure and consumables such as diagnostic materials and medicines.[19] Prisons have no isolation facilities to treat MDR-/XDR-TB. These facilities are also absent in teaching hospitals in SSA. Many MDR-/XDR-TB patients are untreatable, which poses the question: where should we house prison inmates with MDR-/XDR-TB and what will happen to them?

8.5. Screening and diagnosis of TB

TB diagnostic methods, if available at prison point-of-care health services, are often poorly applied.[19] Screening of prison inmates on entry into prison should be made a priority and will play an important role in early case detection and control of TB.[40,41] An inexpensive, accurate, rapid point-of-care TB screening method is urgently required for active case finding if the problem of TB in prisons is to be effectively controlled. A promising new diagnostics system developed recently is the Xpert MTB/RIF Assay which is a fully automated closed system that performs both sputum sample preparation and real-time PCR, producing results in less than 2 h. The Xpert MTB/RIF Assay, is capable of detecting the *Mtb* complex while simultaneously detecting rifampicin resistance. Analytical sensitivity and specificity is 100% according to a recent study using rifampicin resistant and sensitive *Mtb* isolates and non-tuberculosis bacteria, fungi and viruses.[42] In a recent multi centre evaluation study published in the New England Journal of Medicine the Xpert MTB/RIF Assay was 98.2% and 72.5% sensitive on smear-positive and smear-negative TB patients respectively and was 99.2% specific.[43] There is a need for this assay to be evaluated and tested at prisons in Africa and, if appropriate, to be installed for use at point-of-care in prison clinics. However, the high costs associated with newer diagnostics technologies such as the Xpert MTB/RIF Assay will prevent their widespread introduction by SSA countries' NTPs. However, an important issue is that while rifampicin resistance is relatively easily identified, due to the fact that resistance is limited to a few point mutations within the rpoB gene, resistance testing of other TB drugs is much less straightforward. Until rifampicin or rifampicin with non-INH drug combinations are universally recommended for the treatment of latent TB, drug-susceptibility testing will still rely on the slower culture-based methods. Rapid methods for detection of resistance to INH and second line TB drugs are currently being developed.

8.6. Infection control, isolation and treatment

The standard recommendations for infection control, isolation of patients and protection of medical staff apply to all institutions. However, these are not implemented in most SSA countries prisons. This becomes a major issue when prisoners have to be taken to a central health facility by prison guards for medical assessment. Those with drug-resistant TB pose a major threat to those involved in looking after them. The WHO directly observed treatment short course (DOTS) treatment strategy is well known and, in theory, should be relatively easy to implement in the captive population of the prison environment. Paradoxically, however, the prevalence of drug-resistant TB is often higher in prison populations than in the civilian population. Those with drug-resistant TB should be treated according to the latest WHO guidelines.[44] Future successes in TB control will also depend on the development of new anti-tuberculosis drugs used in treatment regimens that are shorter to enable prison inmate compliance[45]. Several new TB drugs are currently in the clinical development which could be effective against MDR-TB, including the diarylquinolone, TMC-207, which targets mycobacterial ATP synthase[46], and Nitroimidazoles, such as PA-824 and OPC-67683, which are equally active against drug susceptible and drug-resistant TB and are also being evaluated in clinical trials[45]. As they are active against both replicating and non-replicating organisms, they could potentially shorten treatment of active disease and provide activity against latent TB infection. Evaluation of the use of moxifloxacin and TMC-207 in treatment regimens to shorten the duration of chemotherapy are also ongoing.[45]

8.7. Isoniazid preventative therapy (IPT) for those with latent TB or HIV

In an ideal world, all prison inmates should be screened for both latent and active TB. Whilst IPT is recommended for those with latent TB infection[47] the controversies surrounding the use of a single drug to which the tubercle bacillus may be resistant to, and the absence of an accurate test that can distinguish between latent and active TB, especially in high TB and HIV endemic areas, it is advisable not to use single drug prophylaxis or treatment for prisoners suspected of having latent TB infection. The whole issue of IPT and *Mtb* latency is currently being debated and single drug treatment should be avoided.[48]

8.8. Information and education

Education and training are integral parts of TB and HIV control programmes in prisons, according to the WHO,[19] the aim of which are to increase awareness and knowledge. Such training should have a positive impact on attitudes and behaviour of individuals likely to be affected by TB such as inmates, family, prison personnel and visitors. Less than 60% of countries surveyed in Europe provided appropriate health education for TB control in prisons[17] and no countries in SSA provide this type of education.

9. Priorities and ethical considerations for research on TB in prison

Table 3 lists some of the priority unanswered questions regarding TB in prisons in SSA. The scientific community need to focus more attention on the neglected issue of TB in prisons and the size of the problem needs urgent definition for both drug-sensitive and drug-resistant TB. Priorities for research must be identified and developed in consultation with local politicians and international donors. This will provide an evidence base which can help SSA governments allocate appropriate and adequate funding for improving prison health care services.

Performing research studies on prisoners (who, by the nature of their incarceration, are disadvantaged populations that lose many of their human rights) raises many ethical issues[49,50] and lessons from unethical studies, such as those highly quoted from the USA, need to be learnt.[51,52] SSA countries should develop their own ethical criteria for research into prisoners and local ethics committees should be educated on protection of 'vulnerable individuals' and the special role for ethical review committees.[53,54] Other ethical questions arise: a) Should improved surveillance be classed as research when it is already international policy as stated by the WHO? b) Should implementation of 'proven' TB control measures be delayed while operational research is undertaken? c) Would research on the dynamics of TB transmission be ethical if infection control measures were not already in place? Prison inmates, belonging to undervalued social groups such as immigrants, social minorities and refugees, can easily be deprived of their legal rights.[4] A careful ethical review should take these points

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Table 3
Unanswered questions regarding TB in SSA prisons.

What is the actual size of the TB and TB/HIV problem (both drug-sensitive and drug-resistant) in African country prisons?	- Need to establish quality data recording and reporting system - Need better quality TB diagnostic, treatment and followup services - Need point of care rapid diagnostic tests for same day identification of active TB cases - Need point of care raid screening for drug-resistant TB
What resources are required to aim towards control of TB in prisons?	- Cost of establishing proper health services for prisoners and staff - Cost of improving/redesigning prison buildings and ventilation of cells - Cost of better prison food and prison living conditions - Cost of drug treatment for HIV and drug-resistant TB - Cost of prison staff developing active TB
What are the priorities that need focussing upon to improve TB control in prisons?	- Improve and integrate TB/HIV/STD/other health services for prisoners and prison staff - Define the magnitude of TB and TB/HIV in prison staff and prisoners - Define the problem of drug-resistant TB in prisons - Improve prison conditions (cell size, ventilation, food) - Reduce overcrowding of prisons - Focus governmental and funder attention on problem of TB in prisons - Define optimal and cost-effective ways to diagnose TB in prisons - Define the optimal screening method for prisoners and staff
What are the transmission dynamics of *Mtb* in the prison environment?	- Define how many new prisoners have active TB on entry to prison - Define prevalence rates of active TB in existing prisoners and prison staff - Define the prevalence of MDR-/XDR-TB in prisoners and prison staff - How long it takes before an HIV-infected or uninfected prisoner develops active TB? - Define TB transmission to the community by prisoners released after serving their sentence - Ascertain treatment completion and followup rates of prisoners with active TB released from prison

into consideration and African country governments must allow ethical research to be conducted in prison settings to obtain information for introducing appropriate healthcare interventions. Furthermore, under research conditions, inmates will receive the benefit of supervised healthcare management. It is the responsibility of the state and society to ensure that the human right to health is properly addressed.

10. Political support and appropriate financing essential for TB control

It is apparent that TB control will not be achieved until action is taken by governments at all fronts of the TB problem[55]. TB, within confined institutions like prisons, needs to be included in all planning and investment for TB control. Article 6 of the International Covenant on Civil and Political Rights treaty of the United Nations General Assembly states clearly that "Every human being has the inherent right to life. This right shall be protected by law. No-one shall be arbitrarily deprived of it." Thus governments have a moral duty to protect prisoners from harm by disease. Joint political, scientific and NTP commitment is required if the TB epidemic in prisons is to be effectively combated.

11. Conclusions

TB in prisons is a neglected area in SSA countries and an increasing prevalence of active TB is being seen in prisons in SSA. Apart from HIV, several other preventable factors are driving the spread of TB within prisons. Drug-resistant TB is increasingly being detected in SSA prisons and basic epidemiological data on MDR-/XDR-TB is urgently required. There is a growing concern in the international community and human rights groups that prisoners do not have access to good quality medical care and living conditions. All SSA governments need to focus NTPs into improving prison health services and establishing improved data collection and surveillance methods. The problem of TB in prisons needs to be defined through properly designed, ethically conducted research studies. Only when reliable data is available, can a case for specific investments from donor governments and international funding agencies be made, to bring TB in prisons under control.

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