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Kelsey A. Stevenson Date

Epidemiology of HIV and tuberculosis in five South African correctional facilities

By

Kelsey A. Stevenson
Master of Public Health

Global Health

_____
Kenneth G. Castro, MD, FIDSA
Committee Chair

_____
Carlos del Rio, MD, FIDSA
Committee Member

_____
Laura J. Podewils, MS, PhD
Committee Member

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By

Kelsey A. Stevenson

Bachelor of Science
University of Wisconsin – La Crosse
2011

Thesis Committee Chair:
Kenneth G. Castro, MD, FIDSA

An abstract of
A thesis submitted to the Faculty of the
Rollins School of Public Health of Emory University
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Abstract

Epidemiology of HIV and tuberculosis in five South African correctional facilities
By Kelsey A. Stevenson

Background:
South Africa is home to the world's largest HIV epidemic, and has one of the highest TB incidence rates in the world. An estimated 73% of TB patients in South Africa are coinfected with HIV. Throughout the world, prisoners are more susceptible to HIV and TB than the general public because of both the congregate nature of the prison setting, and the prevalence of high-risk behaviors among prisoners.

Objectives:
This analysis aimed to compare actual practices for the HIV and TB cascades of with the official policy for screening, care, treatment, and retention of HIV and TB in correctional facilities; to determine the prevalence and proportion of persons living with HIV, TB, and HIV/TB coinfection within five facilities; and to evaluate the cross-sectional prevalence of HIV, TB, and HIV/TB coinfection, as well as any associations between demographic and clinical risk factors.

Methods:
Programmatic data was collected from five South African prisons during the implementation of a program for TB screening and HIV counseling and testing. Crude associations between HIV infection, TB, HIV/TB coinfection and each independent variable were identified, and descriptive statistics were used to determine the proportion of HIV infection, TB, and HIV/TB coinfection. Logistic regression models were created to determine factors associated with HIV, TB, and coinfection.

Results:
Retention in the TB cascade of care was better than that in the HIV cascade, but both cascades lost a proportion of those eligible at each step. Overall prevalence for HIV was found to be 17.1%, and TB prevalence was 0.5% with variability across facilities. Logistic models demonstrated associations between risk factors at varied on the basis of known disease status.

Conclusion:
Due to the amount of previously undiagnosed HIV and TB detected through this screening program, routine screening is recommended for all prisoners upon entry and routinely throughout the period of incarceration. Incarceration can be a valuable opportunity for identifying and treating patients that would otherwise be difficult to reach. This is key, as failing to address these infections in prison is a risk not only to the health of prisoners and prison workers, but to the broader public.

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INTRODUCTION AND OVERVIEW

Human Immunodeficiency Virus (HIV), tuberculosis (TB), and HIV/TB coinfection are all substantial global threats to health. Globally there are approximately 37 million people living with HIV and 1.5 million AIDS-related deaths per year.[1] In 2015, 10.4 million people developed TB disease, 1.4 million died of TB, and one-third of HIV-related deaths were due to TB.[2] It is estimated that among people living with HIV (PLHIV), the risk of developing TB is between 26 and 31 times greater than among those without HIV infection.[3] Persons co-infected with HIV and *Mycobacterium tuberculosis*, have also been shown to experience advanced HIV progression and declining immune function, leading to death if left untreated with available antiretroviral treatment (ART) regimens.[4]

South Africa is home to the world's largest HIV epidemic, with an estimated 7 million people living with HIV (PLHIV) and 180,000 deaths due to AIDS in 2015.[5,6] South Africa also has one of the highest TB incidence rates in the world (834 per 100,000)[2], and an estimated 73% of TB patients in South Africa are coinfected with HIV.[7]

Throughout the world, prisoners are more susceptible to HIV and TB than the general public because of both the congregate nature of the prison setting, and the prevalence of high-risk behaviors among prisoners, such as unprotected sex and intravenous-drug use.[8] Limited data suggest these global trends are mirrored in sub-Saharan Africa, with both HIV and TB prevalence among prisoner and detainee populations being greater than that found among non-incarcerated populations.[9]

The rate of imprisonment in South Africa is estimated at 413 per 100,000.[5,6] Understanding the status of these epidemics in the context of South African prisons is especially crucial, due to this high rate of imprisonment, and the current lack of high-quality data for HIV and TB in the region.[10] The sub-optimal conditions that facilitate the transmission of both diseases, such as overcrowding, and poor nutritional support, are present in prison settings throughout sub-Saharan Africa.[10] Rapid prisoner turnover means that uncontrolled epidemics of HIV and TB are a threat not just to prisoners, but their communities as well. Improved data on the status of HIV and TB in correctional facilities are key for informing programmatic planning, policy development, and implementation.[11]

Limited data are available on the status of screening, diagnosis, treatment, and management (the cascade of care) for both HIV and TB in prison settings throughout the region.[11] A 2014 systematic review of the HIV cascade of care in low- and middle-income settings demonstrates a relative dearth of information, particularly in correctional settings. The paucity of data appear to contribute to suboptimal planning by prison officials, who often fail to provide or ensure the continuity of screening, care, and treatment of individuals upon detention, throughout incarceration, and following release.[12,13] It is this dearth of knowledge that the following analysis hopes to address by providing a more thorough understanding of the state of HIV and TB screening and care, the burden of HIV and HIV/TB infection, and factors associated with HIV and HIV/TB in the context of five South African correctional facilities.

BACKGROUND

HIV, globally and in sub-Saharan Africa

Human immunodeficiency virus (HIV) is an incurable but treatable life-long infection in which the immune function is weakened, impairing the body's ability to fight other infections and cancers that those with healthy immune systems can typically overcome. HIV infection may develop into acquired immunodeficiency syndrome (AIDS) if left untreated, which will result in death.

Since its identification in 1983, HIV/AIDS has been responsible for the deaths of over 35 million people.[14] There are nearly 37 million people living with HIV globally as of 2015; 25.5 million of whom live the world's most affected region, sub-Saharan Africa.[1] In 2015, 1.1 million people died of AIDS-related causes. An estimated 800,000 of these deaths occurred in sub-Saharan Africa, accounting for 72% of the global total, despite AIDS-related deaths falling 47% in the region between 2005 and 2015.

In 2015, people living with HIV/AIDS (PLWHA) in sub-Saharan Africa comprised nearly 70% of the global HIV burden.[1] Many countries in the region have substantial generalized epidemics, but significant variation in prevalence exists, from 0.5% in Senegal, to 28.8% in Swaziland.[15,16]

An estimated 27% of those living with HIV in the region are in South Africa.[1,5] Home to the world's largest HIV epidemic, 16% of global AIDS-related deaths occurred here during 2015. South Africa is also home the largest HIV treatment program in the world, with an estimated 3.4 million people on ART as of 2015.

In 2014, the Joint United Nations Programme on HIV/AIDS (UNAIDS) released new, ambitious target goals for diagnosis, treatment, and viral suppression of HIV.[17] By 2020, the aim is that:

- 90% of all people living with HIV will know their HIV status;
- 90% of all people with diagnosed HIV infection will be receiving sustained antiretroviral therapy; and
- 90% of all people receiving antiretroviral therapy will have viral suppression.

If these targets are met and the anticipated advances in medical technology relating to HIV care occur, it is projected that there will be a 90% reduction in AIDS-related deaths by 2030.[17] Even with no improvements to current diagnostic and treatment technologies, if these targets are met, AIDS-related deaths are projected to fall by 80%. Achievement of these targets, coupled with the rapid scale-up of prevention programs, has the potential to reduce the annual number of new infections by almost 90%, effectively ending the status of HIV/AIDS as a major global public health problem by 2030.

In the decades since the beginning of the HIV epidemic, the development of effective antiretroviral therapy (ART) has dramatically reduced the number of HIV-related deaths.[1] Global ART coverage has scaled up to 46%, with southern and eastern Africa experiencing the greatest expansion in coverage, going from 24% in 2010 to 54% by the end of 2015.

This reduction in HIV-related mortality has occurred faster than the reduction of new infections, leading to a gradually increasing global HIV prevalence, as more PLHIV have

access to care and treatment and subsequently live longer, and a declining global HIV incidence, as access to ART and effective prevention reduces the risk of transmission in many at-risk populations. This global trend is reflected in sub-Saharan Africa. Recent evidence demonstrates that if current levels of HIV prevention and treatment are merely maintained, rather than improved upon, progress towards ending the epidemic will not only stall, but will move backwards, with an increase in the number of AIDS-related deaths and HIV infections by 2020.[18]

Tuberculosis, globally and in sub-Saharan Africa

TB is a preventable, curable infectious disease caused by *Mycobacterium tuberculosis*. In 2015, TB caused 1.8 million deaths in 2015, and ranked among the top ten global causes of death, surpassing HIV as the leading cause of death due to infectious diseases for the second year in a row.[2] Approximately 400,000 of these deaths occurred in persons with HIV coinfection.

Most TB infections are asymptomatic. In approximately 10% of cases, latent tuberculosis infection (LTBI) progresses into symptomatic, active disease.[19] Active TB disease is typically pulmonary, affecting the lungs. Less common among otherwise healthy individuals is extrapulmonary TB, which occurs when the disease develops outside the lungs.[20] Previous estimates suggest that approximately one-third of the global population was infected with *Mycobacterium tuberculosis*, and over 95% of cases of active TB and death occur in the developing world.[19] However, more recent updated estimates suggest that in 2014, approximately 23% of the global population is believed to be infected with *Mycobacterium tuberculosis*, and over 95% of cases of active TB and

death occur in developing countries.[19, 21] Without treatment, the progression of active TB disease will result in death in 70% of cases.[22]

While TB occurs throughout the world, the epidemic manifests differently in different regions.[23] In many Western, high-income nations, the bulk of the epidemic is attributed to foreign-borne populations. The multidrug-resistant form of tuberculosis (MDR-TB), which lacks susceptibility to the two first-line TB antibiotics (isoniazid and rifampin), and extensively drug-resistant TB (XDR-TB), which is MDR-TB with additional resistance to the most effective second-line TB treatments available, are substantial threats to progress towards reducing the global burden of TB.[24] Drug-resistant TB appears throughout the world, but in 2015, 60% of the estimated global MDR-TB cases occurred in five countries: Brazil, China, India, the Russian Federation, and South Africa.[2, 25] Routine drug-susceptibility testing results from South Africa have also demonstrated a growing incidence of resistance.[26]

Between 1990 and 2015, TB mortality rate fell by 47%, and TB prevalence fell by 42%.[2] The Global Plan to End TB 2016-2020 presents a framework for continued means of lowering both incidence and mortality, focused the following overarching areas of improvement[27]:

- Integrated, patient-centered care and prevention;
- Bold policies and supportive systems; and
- Intensified research and innovation.

In order to advance toward the Global Plan's overarching vision of a world free of death and disease due to TB, borrowing from UNAID's 90-90-90 target concept, sets the 90-(90)-90 targets for TB as:

- Reach at least 90% of those requiring TB treatment,
    - Including 90% of key populations; those most vulnerable, underserved, and at risk of developing TB; and
- Achieve at least 90% treatment success.

Reaching these targets by 2020 will lay the groundwork for meeting the ambitious goals of a 90% reduction in TB incidence, and a 95% reduction in TB deaths between 2015 and 2035.

Approximately 26% of all global TB cases occurring in 2015 were in the World Health Organization (WHO) African Region, and the proportion of HIV/TB coinfected cases was highest in countries in this region, exceeding 50% in parts of Southern Africa.[2] South Africa in particular has the highest rates of TB in the world, driven by the HIV burden.[27]

In 2015, people living with HIV accounted for 11% (1.2 million) of all new TB cases, and globally, over one-third of HIV-related deaths were attributed to HIV.[2] A 1995 study found that both the incidence of new AIDS-defining opportunistic infections and mortality rates associated with those infections have been shown to be higher when PLHIV are coinfected with TB.[28] Further challenges exist in identifying TB among PLHIV, as extrapulmonary TB and smear-negative pulmonary TB is more common in this population, regardless of CD4+ count.[29] These obstacles, coupled with a lack of accurate and rapid diagnostic tools for TB, and an absence of standardized symptom-based screening strategies have posed a challenge to accelerating TB case finding for PLHIV, particularly in resource-limited settings.[30]

These two epidemics are inextricably linked, and 80% of HIV/TB coinfections occur in sub-Saharan Africa.[31] As in all settings throughout the world, risk is magnified for in key populations. For HIV, these key populations include commercial sex workers, men who have sex with men, injection drug users, and prisoners. Recently, the Stop TB Partnership has released a series of briefs outlining key populations at risk of TB. These include miners, mobile populations, healthcare workers, PLHIV, and prisoners. Any attempts to curtail this co-epidemic must address these key populations.

HIV and tuberculosis in correctional settings

Evidence suggests that the prevalence of both HIV and TB among prisoners throughout the world exceeds that found in the general population.[9, 32, 33] Globally, 30 million people move through correctional facilities each year, and 10 million people are incarcerated at any given time. The majority of these people will return to their communities, many as soon as a few months to a year, meaning that health in correctional facilities is closely linked to broader public health.[33]

Key populations at increased risk of HIV, such as sex workers, and people who inject drugs, are often overrepresented in incarcerated populations, and absent or inadequate prevention measures allow for transmission within facilities.[34] Unique challenges exist when developing prevention programs for HIV in this context, as the provision of condoms, lubricant, or sterile needles are often forbidden. Access to HIV counseling, testing, and treatment is an additional challenge intensified in correctional settings. Even when HIV counseling and testing is available, prison health systems may face obstacles in meeting the clinical and laboratory needs of incarcerated HIV patients, including collaboration with community HIV programs to ensure continuity of care

beyond release. This can be particularly challenging, as health programs in prisons often fall under the purview of the national department of corrections, rather than national or local public health programs.[32]

The importance of implementing HIV interventions in correctional settings was recognized early in the epidemic.[35] As incarceration often concentrates individuals that participate in risky behavior, such as needle-sharing, prison health officials must be prepared to confront institutional impediments such as moral or legal opposition to certain harm reduction measures.[36, 37]

The increased prevalence of TB in prisons appears to be influenced by both the concentration of risk factors of TB among the incarcerated population, such as HIV infection, injection drug use, and the potential for transmission of this airborne disease. Prison settings often increase the risk of TB transmission through overcrowding, poor ventilation, inadequate healthcare infrastructure, and poor case detection.[34]

There is a substantial need to develop collaborative HIV/TB programs in prisons.[34] Prisoners should have access to the same prevention and treatment activities implemented within the community, and HIV/TB programs at local and district health levels should include prison health programs under their oversight.

Limited information exists about the status of HIV and TB within African prisons. One study in a Zambian prison suggests that rates of TB and HIV are substantially higher than the average for Zambian non-incarcerated population, with a trend towards concentration and potential transmission of both diseases within the facility and to the

general population.[38] While many sub-Saharan African prisons create nearly ideal circumstances for accelerated transmission of both HIV and TB, true prevalence within correctional facilities is often unknown. This is problematic, as this baseline information is critical not only for understanding these joint burdens, but also for determining the proportion of disease acquired within prison.

HIV and tuberculosis in South African correctional settings

An estimated 162,000 people are incarcerated in South Africa.[39] With rate of 291 prisoners per 100,000 people, South Africa has one of the highest rates of imprisonment in Africa, and facilities are frequently overcrowded. There is relatively limited information regarding the state of HIV and TB in South African correctional settings.[40] Available information suggests that prevalence of both HIV and tuberculosis is substantially higher than that found within the general population in South Africa, as is the case in the global context.[41] As in correctional settings throughout the world, overcrowding and the amplified risk of violence while imprisoned exacerbate prisoners' vulnerability to HIV and tuberculosis, and high levels of HIV risk behavior are common in prisons. A systematic review completed in 2014 found an HIV prevalence of 24.2% in one prison, with over three times the odds of undiagnosed TB found among prisoners with HIV.[40] This review also highlighted the significant need for further studies to best understand the epidemiology of HIV and TB among prisons in South Africa and best inform programmatic response. Control of HIV and TB within correctional facilities is critical not only to maintain the human rights of prisoners, but also as a public health measure to protect the wider community.

Current HIV and tuberculosis testing and care algorithms in South African correctional facilities

In spite of the limited information available regarding the status of HIV and TB within South African prisons, the South Africa Department of Health has developed fairly comprehensive guidelines for the management of HIV, TB, and sexually transmitted infections (STIs) within correctional facilities.[42] These guidelines recommend that voluntary HIV counseling and testing (HCT) must be offered to all inmates at entry, during incarceration, as per request by inmate, as part of routine screening campaigns, as part of integrated primary health care services, and upon release, and that symptom-based TB screening must be conducted on all inmates at entry, as part of routine screening campaigns, if self- or peer-referred, if a TB contact, as part of integrated primary health care services, at least bi-annually, and upon release. Universal STI screening is to be conducted for all prisoners, with regular screening for PLWHA.

In the case of HIV screening, prisoners consenting to testing are given a rapid HIV test. If the test is positive, a confirmatory rapid test is conducted. If this second rapid test is also positive, the prisoner is considered HIV-positive. In the case of indeterminate or discordant results, a blood sample is collected and sent for enzyme-linked immunosorbent assay (ELISA) analysis, which is used to determine the final HIV result. If HIV-positive, prisoners are to receive CD4+ testing and be assessed for TB infection and disease.

Prisoners living with HIV that have not initiated ART are to receive repeat CD4+ testing every six months (and initiation of ART if CD4+ falls below 350 cells/μL), as well as TB

symptom (cough, fever, unexplained weight loss, drenching night sweats)) and sexually-transmitted infection (STI) screening (with special focus on gonorrhea, syphilis, and chlamydia) during every encounter with a healthcare professional. These inmates are also to receive, in addition to isoniazid preventative therapy (IPT), and cotrimoxazole to prevent other common HIV-associated opportunistic diseases. If a prisoner living with HIV is diagnosed with TB, ART must begin immediately, and screening for cryptococcal disease is to occur if CD4+ <200 cells/μL.

The guidelines mandate that symptom-based TB screening be conducted on all inmates within six hours of entry, as part of routine screening campaigns, if self- or peer-referred, if a TB contact, as part of integrated primary health care services, at least bi-annually, and upon release.[42] For inmates presenting with TB symptoms, an investigation must be initiated within twenty-four hours, including a history of previous TB, family history, contact, and exploration of other underlying risk factors. Symptomatic prisoners will also be given a medical examination, including a chest x-ray and submission of a sputum specimen for bacteriological analysis with GeneXpert MTB/Rif® (Xpert).

For PLWHA, assessment for TB infection includes a physical examination, and providing a chest x-ray (CXR). All prisoners with CD4+ <350 cells/μL are to initiate ART, and all HIV-positive prisoners are to be prescribed isoniazid preventative therapy (IPT) for the duration of their incarceration, so long as they are not currently on TB treatment, are asymptomatic for TB, and have no significant contraindications to IPT.

If a prisoner has positive Xpert results, a spot sputum is to be collected for baseline microscopy. In the case of a positive Xpert result, or smear positivity, TB treatment is commenced. If both specimens are negative, prisoners without HIV will receive antibiotic treatment for five days, then be reassessed. Prisoners living with HIV, however, are referred for further assessment, including chest x-ray and TB culture.

It is recommended that prisoners found to have pulmonary TB be admitted to the health facility and isolated for two weeks. Smear- or culture-positive and Xpert-positive rifampicin-sensitive patients are to be treated according to the National TB Management Guidelines. Xpert-positive rifampicin-resistant (RIF-R) patients should be referred to an MDR-TB unit for further management. For prisoners with TB, consideration of hospitalization is to be considered in cases of diabetes, liver disease, respiratory insufficiency, hemoptysis, serious adverse reactions to therapy, or severe extra pulmonary disease.

Engagement in the long-term treatment regimens required for both HIV and TB treatment can be challenging to maintain for patients and caretakers. For both HIV and TB treatment in DCS facilities, adherence to treatment is to be supported through the provision of information regarding the treatment regimen and the need for long-term treatment, as well as information about possible side effects of therapy. This education must emphasize the importance to taking treatment exactly as prescribed, and should adherence should be supported by nurses, care workers, and treatment support, as well as pill counts.

The spectrum of engagement in care, or cascade of care for HIV consists of screening for HIV, followed by linkage to care, retention in care, commencement of ART, adherence to ART, and eventual viral suppression and maintenance.[43] The cascade of care for TB is similar, in that it includes screening, linkage to care and treatment, and adherence to the treatment regimen until its completion.[44] In order to assure treatment regimens for HIV and TB that begin in prison are not discontinued upon release or transfer, the Department of Health guidelines recommend that all transferred and released prisoners have appropriate medical referral letters and supporting documentation to best facilitation continuity of care between facilities.

Prior to release, an entry-into-care plan should be created by DCS healthcare staff with the prisoner, in order to make their transition into care outside of prison as seamless as possible. In the development of this plan, DCS staff should determine the expectations and concerns the patient has about seeking care and treatment post-release, and work together to identify ways to mitigate any perceived or actual barriers the may impede the patient's ability to seek care following their release. Whenever possible and applicable, patients are to be provided a 30-day supply of medication upon release. Prior to release, prisoners should also be provided with a list of nearby health facilities in addition to their referral facility, and whenever possible, staff at the referral facility are to be notified of the referral. Follow up should occur between DCS with both staff at the healthcare facilities where the patient was referred, as well as the patient themselves when possible.

Objective and aims

The current study aimed to provide a more thorough understanding of the state of HIV and TB screening and care, the burden of HIV and HIV/TB infection, and factors associated with HIV and HIV/TB in the context of five South African correctional facilities.

The specific aims of this study were to:

1. Compare actual practices for the HIV and TB cascades of care in five South African correctional facilities with the Department of Health policy for screening, care, treatment, and retention of HIV and TB in correctional facilities;
2. Determine the prevalence and proportion of persons living with HIV, TB, and HIV/TB coinfection within five South African correctional facilities, both overall, and by facility;
3. Evaluate the cross-sectional prevalence of HIV, TB, and HIV/TB coinfection, as well as any associations between demographic and clinical risk factors (e.g., age, gender, duration of incarceration, and presence and duration of fever, night sweats, and weight loss).

Findings from this evaluation will be disseminated to the South African Department of Health and the Department of Correctional Services in order to better inform health policy planning.

METHODS

Data source

Programmatic data was collected from five South African correctional facilities by The Aurum Institute (Aurum) between January 1, 2014 and January 31, 2015 during the implementation of a Global Fund-supported program entitled, "TB Screening, Detection and Management in Identified Health Facilities of the Department of Correctional Services (DCS)."[45] Prisoners throughout the country were screened for tuberculosis using digital chest x-ray in conjunction with TB symptom screening. Those with symptoms of TB or chest x-ray abnormalities were asked to provide a sputum sample for further TB investigation using the GeneXpert MTB/RIF (Cepheid).

Additionally, an HIV counseling and testing program (HTC) was conducted concurrently with the TB screening project at five sites. Funded by a Right to Care Global Fund grant, the program offered all prisoners at these five facilities HCT.

The protocol to evaluate the TB screening and HCT program was approved by the South African University of the Witwatersrand's Medical Human Research Ethics Committee and the South African DCS.

The specific goals of the project were to introduce GeneXpert machines in South Africa's correctional facilities in order to build capacity to do point-of-care TB testing in the correctional environment and to provide HCT services to offenders. Aurum is also a sub-sub recipient of another Global Fund grant under the National Department of Health. This grant provided mass TB screening via digital chest x-ray to all incarcerated persons in the country, as well as HCT.

The current secondary analysis utilizing the programmatic information was reviewed and approved by the Emory Institutional Review Board and by the Centers for Disease Control and Prevention.

Study population

The study population for this analysis was comprised of male and female adult prisoners incarcerated or entering a correctional facility during the implementation of the TB screening program. All prisoners eighteen years of age or older at the time of screening were considered eligible for inclusion in this analysis (N=30571). As all prisoners were screened for TB, but had the option to opt out of HCT, results were further refined to include only those consenting to HCT in the analysis of HIV prevalence, proportion, and HIV-related variables.

Sampling frame

Participants eligible for inclusion in the analysis were identified from a deidentified dataset collected and made available by The Aurum Institute. This dataset is comprised of adults that were currently incarcerated or entering one of the five correctional facilities included in this analysis during the implementation of the TB screening and HCT programs.

Data collection

Data collection at these five facilities occurred between January 14, 2014 and January 30, 2015. Demographic and symptom variables were collected via self-report using the Stevenson

attached questionnaires (Appendix 1). Clinical data regarding diagnostics, and treatment initiation for both TB and HIV were collected from TrakCare and patient charts. The included information on the HIV cascade of care such as CD4+ cell counts, viral load counts, HIV treatment initiation, and post-release referrals to care.

All prisoners were screened for tuberculosis using digital chest x-ray in conjunction with TB symptom screening. Those with symptoms of TB or chest x-ray abnormalities were asked to provide a sputum sample for further TB investigation using Xpert MTB/RIF. TB status was determined on the basis of chest x-ray or Xpert results.
All persons willing to undergo HIV testing had a finger prick sample collected and screened for HIV using the UniGold (Trinity Biotech) point-of-care rapid HIV test kit. Screening tests with an HIV-positive result were confirmed using the Abon (Alere) point-of-care rapid test kit. In the case of discordant results (a positive, reactive screening test result, but a negative, non-reactive confirmatory test), a venous blood sample was collected for enzyme-linked immunosorbent assay (ELISA), and the ELISA result was interpreted as the final outcome for the HIV test.

Data cleaning and management

Original program data was collected in the field by Aurum. Data forms were checked for completeness and accuracy prior to their entry into an Excel database. The data for this current secondary analysis was provided in the form of a compiled Excel dataset.

The original dataset was downloaded in Microsoft Excel (Microsoft Excel for Mac: Version 15.7. 2016) format, and was converted into a SAS (Version 9.4. 2013) database for analysis.

The original dataset received from Aurum was split into five separate facility-specific datasets for preparation and cleaning. These datasets were sorted on the basis of mutually-exclusive disease status (HIV, TB, HIV/TB coinfection, and no disease), and all five site-specific datasets were concatenated into a single SAS dataset for the current analysis.

Data analysis

While original data were verified by Aurum data capturers, further preparation was required prior to analysis. Following concatenation in SAS, data was deduplicated on the basis of prisoner number, screening enrollment date, age, gender, and site. A separate dataset of potential duplicates was generated and examined. True duplicates were removed from the analysis, and in the case of records matching on the aforementioned variables but varying in completeness of the record, the most relevant record to the analysis was retained, on the basis of a scoring variable. The scoring variable was developed by assigning value to variables of interest, such as diagnosis of HIV or TB, presence of HIV testing data, and symptom report and retaining the record with the highest score out of the remaining variables for observations matched by prisoner number and site.

An exploratory analysis was then conducted in order to determine whether outliers or illogical values existed in the dataset. When these were encountered, they were set to missing. As it is not possible to return to the source data, any values not easily validated were set to missing due to the level of uncertainty when they could not be triangulated or imputed by other data.

Outcome variables and covariates

The primary outcomes of interest in this analysis were HIV, TB, and HIV/TB coinfection. Each observation was coded as a binary variable to one of four mutually exclusive categories: HIV only, TB only, coinfection, or presence of neither disease. Prisoners known to be HIV-positive upon entry to the facility were coded as a binary variable (knownpos=1) that was created for this analysis.

Bivariate and multivariate analyses were used to explore the unadjusted (crude) association between HIV infection and each independent variable, as well as TB and each independent variable. A multivariable analysis was done to determine the association between demographic and clinical risk factors for HIV/TB coinfection. Actual measured treatment, retention, and referral practices in South African correctional facilities were examined.

The subset of prisoners that consented to HIV screening was measured using a variable capturing a first HIV test result, coded as positive (1), negative (2), inconclusive (3) or refused (4). Any patient whose result was not missing or HCT refusal was considered consenting to HCT screening. For the subset of prisoners that both consented to an HIV test and had an HIV_Only or Coinfection value of 1, pre-ART initiation was coded as Pre-ART=1 for all prisoners that received initiation. HIV treatment initiation was coded HIVtx=1 for those that have initiated treatment, and IPT=1 for those on isoniazid preventative therapy. When available, CD4+ (cells/μL) results, and viral load (viral copies/mL) results were captured as continuous variables. Each of the aforementioned variables are affiliated with the date the of initiation or test result. Presence of a post-

release referral was denoted by PostReleaseRef=1. The dataset also included dates corresponding with the date the prisoner was determined HIV-positive and the date HIV-status was reported to DCS.

Per Department of Health guidelines, all prisoners were to be screened for TB. Reason for TB screening was documented and coded as: new admissions (1), currently incarcerated prisoners (2), those referred by ART/TB clinic (3), referred by a prisoner (4), or those referred for other reasons (9), which included an option for free text entry. Symptom screening for TB was performed for all prisoners by assessing presence of cough, fever, night sweats, and/or weight loss, each of which was coded as 1=present and 0=absent. When symptoms were present, duration of symptoms was coded as 1=less than 1 week, 2=1-2 weeks, or 3=more than 2 weeks. Department of Health guidelines consider a symptom screen positive when a patient reports cough, fever, or night sweats lasting over two weeks, or weight loss of 1.5 kilograms or more occur in one month. Any report of cough, fever, or night sweats lasting over two weeks were coded as presumptive TB cases for this analysis. Because weight loss was reported by week, but not by weight, any patient reporting weight loss was recoded as being presumptive for TB. A variable capturing the number of presumptive TB symptoms per observation was created to aid in this analysis.

For those with TB_Only=1 or Coinfection =1 that had submitted a sputum sample, the presence of rifampicin-resistance, determined via GeneXpert testing, was coded as 1=present, 0=absent. The database also included dates associated with TB diagnoses and DCS notification of TB.

Additional variables included in this analysis were gender (coded 1=male, 2=female), age, race, duration of incarceration, and DCS facility. While age was recorded as a continuous variable in the original data, for this analysis it was recoded into quintiles of 18-24 years (1), 25-34 years (2), 35-44 years (3), 45-54 years (4), and 55 years and older (5). Race was self-reported and coded as black (1), mixed race (2), Indian/Asian (3), white (4), and other (9), including the option for free text entry. Duration of incarceration was recorded in years, as a continuous variable, but was recoded into five categories: less than one year, 1-2 years, 3-4 years, 5-9 years, and ten or more years. Facility was deindentified prior to this analysis and coded A-E.

Descriptive, bivariate, and multiple logistic regression

Descriptive statistics were used to determine the proportion of HIV infection, TB, and HIV/TB coinfection, both overall and by facility. Potential associations between demographic and clinical factors were evaluated by bivariate analysis, examining these factors separately in relation to HIV infection, tuberculosis disease, and coinfection. Duration of incarceration was further collapsed into larger categories for the bivariate and multivariate analyses, as well as the logistic regression. Duration was recoded for those imprisoned less than one year, 1-2 years, and three or more years. Following the bivariate analyses, factors demonstrating a significant association based on a p-value less than or equal to 0.2, factors previously demonstrated to be significant in the literature, or biologically plausible factors were included in the final multivariable logistic regression analyses to examine their interrelationships and overall effect on the outcomes of each HIV, TB, and HIV/TB coinfection. The final models contained independent factors that had an association with the outcome of interest ($p \leq$ equal to 0.05) and, where appropriate, were adjusted for age.

Ethical considerations

Because this study included human subjects and their personal health information, Institutional Review Board (IRB) approval was required. The original study protocol and research instruments were reviewed and approved by the Emory University Institutional Review Board (IRB). This analytic plan was also reviewed and approved by the U.S. Centers for Disease Control, and the source study was reviewed and approved by the Human Research Ethics Committee at the University of Witwatersrand in Johannesburg, South Africa.

RESULTS

The original study from which the dataset for this analysis is derived took place between January 14, 2014 and January 30, 2015. Following deduplication, a sample of 30571 unique observations was available.

Cascades of care

HIV cascade

South Africa National Department of Health guidelines (Figures 1 and 2) require that HIV counseling and testing be made available to all prisoners upon entry, biannually, and upon release.[42] Overall, when excluding the 375 prisoners known (based on self-report of HIV positivity or currently on ART) to be HIV-positive upon entry, 98.8% (30196) of the sample of prisoners were eligible for HCT (Figure 3). Of these, 17284 (57.2%) consented to HIV screening during the parent study. 2404 (13.9 %) of the consenting patients had an initial HIV positive test result. A second, confirmatory rapid diagnostic test was positive for 2199 (91.5%) of prisoners with initial positive test results. 51 (2.1%) of those with initially positive test results had a negative result on

their second confirmatory test (6.4% of those with an initial positive test had either inconclusive results, or refused follow up testing). 21 (41.2%) of those with discordant initial and secondary rapid diagnostic tests had their diagnoses confirmed via ELISA. In total, 2220 persons were found to be HIV-positive through this HCT program.

Out of the total known HIV-positive population (N=3017), 50.9% (N=1537) had CD4+ cell count results, and 5.4% (163) had a reported viral load count in their clinical records (Figure 4). 4.6% (N=140) of the HIV-positive population had initiated isoniazid preventative therapy. 682 prisoners (22.6% of HIV+) met the criteria for ART initiation per Department of Health guidelines (by either having a CD4+ result <350 cells/μL, being found to have TB, or both), and 46.8% (N=319) had treatment initiation documented. Though we did not have documentation of the total number of HIV-positive patients who were released from incarceration, less than 1% (0.7%; N=21) of the total number of HIV-positive patients were recorded as having received a post-release referral to care.

TB cascade

The parent study for this analysis was a TB screening program in which all participants were assessed by use of symptom screening and CXR, as outlined the source study protocol. Per the Department of Health guidelines (Figures 5 and 6), any prisoner reporting the presence of fever, night sweats, or cough lasting over two weeks or weight loss of over 1.5 kilograms per month were to have sputum collected and assessed using GeneXpert. 16.6% (N=5061) of the prisoners in this sample reported symptoms lasting more than two weeks, or reported weight loss of any duration (as amount of weight lost was not recorded in this sample). Of those reporting TB symptoms lasting more than

two weeks, or weight loss (presumptive TB), 77.7% (N=3932) had sputum collected (Figure 7). TB diagnosis was reported among a total of 144 prisoners in the sample, 116 (80.6%) of whom had a sputum-confirmed diagnosis. Among the 116 prisoners with TB confirmed via sputum samples, 8.6% (N=10) of cases were found to be rifampicin resistant. 81.9% (N=118) of the 144 total prisoners with a recorded TB diagnosis had treatment initiation dates recorded. TB treatment outcome data was not available for this analysis.

HIV/TB coinfection cascade

Department of Health guidelines require individuals with HIV-positive status to be screened for TB at diagnosis. All prisoners suspected of TB on the basis of a positive symptom screen or abnormal CXR result are to be offered HIV screening. Of the 32 prisoners with known HIV/TB coinfection, 18.8% (N=6) were receiving ART and 84.4% (N=27) were receiving TB treatment. 75% (N=24) had a recorded CD4+ result, and 12.5% (N=4) had a viral load count.

HIV, TB, and HIV/TB coinfection prevalence and proportion

The overall prevalence of HIV in the study population, including those with both known HIV and newly diagnosed HIV, was 17.1% (N=3017), but facility prevalence varied between 7.2% and 22.0% (Tables 1, 2; Figure 8). Overall TB prevalence was 0.5% (N=144) among the 30571 prisoners screened for TB within the aggregate sample. Facility prevalence of TB varied between 0.3% and 0.6%. HIV/TB coinfection prevalence ranged from 0% to 0.5%, and the overall aggregate prevalence of HIV/TB coinfection across the five facilities was 0.1% (N=32).

Demographic and clinical characteristics of the study population

The majority (94.5%; N=28894) of the total study population (N=30571) was male, and 45.8% (14016) of the sample was between the ages of 25 and 34 (Table 3). 94.3% (N=28818) of the study population was black African, and 70.3% (N=21488) of those in the sample had been incarcerated for less than a year.

The majority (N=25510; 83.4%) of prisoners reported experiencing no TB symptoms. Among those that did report symptoms (N=5061), cough was the most common, with 18.4% (N=5634) of the sample reporting experiencing coughing within the past two weeks. Of those reporting symptoms for presumptive TB (cough, fever or night sweats ≥2 weeks or any weight loss), 10.8% (N=3294) reported experiencing only one symptom, and 5.8% (N=1767) reporting two or more symptoms.

Associations between HIV, TB, and HIV/TB coinfection and demographic and clinical factors

In order to assess for potential associations between outcome and possible risk variables, bivariate analyses and subsequent logistic regressions were conducted for each outcome of interest (Tables 4, 5). Upon evaluation, bivariate associations between risk factors for HIV were different between those with known TB, and those with negative or unknown TB status (Tables 6, 8). Due to this observation that the association between factors and HIV was different in these groups, suggesting effect modification by TB status, subsequent multivariable analyses were conducted separately by TB status strata. Similarly, differences in risk factors for TB were observed when assessing those with HIV and those with negative or unknown HIV

status (Tables 10, 12); multivariable analyses for the outcome of TB were performed in each HIV strata.

Associations between HIV and demographic and clinical factors

HIV among those with known TB

As can be seen in Table 7, a bivariate analysis demonstrated that among those with known TB, a patient had nearly three times the odds of HIV with report of a fever lasting over two weeks (OR 2.73, 95% CI: 1.09 – 6.82), and this association was statistically significant (p=0.03). Since no other factors were significant, the final age adjusted model only included fever as significantly increasing the odds for HIV positivity (OR 2.66, 95% CI: 1.06 - 6.67; p=0.03).

HIV among those with negative or unknown TB status

A bivariate analysis among those with an unknown or negative TB status illustrated a 1.92 – 4.55 increase in the odds of HIV associated with all other facilities when compared to Facility D, and each of these findings were statistically significant at a p-value of less than 0.0001 (Table 8). For women in this same subset, the odds of HIV were 2.04 (95% CI: 1.78 – 2.33) when compared to men, and this association was statistically significant (p<0.0001). The odds of HIV increased among those between the ages of 25 and 54 years when compared to those over the age of 55, but among those 18 – 24 years of age, HIV was 44% less likely when compared that same reference group (OR 0.66, 95% CI: 0.56 – 0.78, p<0.0001). Prisoners that were black African were found to have 2.85 the odds of HIV (95% CI: 2.22 – 3.67, p<0.0001) when compared to those of any other racial or ethnic group.

A multivariable logistic regression focused on HIV as an outcome among those with unknown or negative TB status found associations in which the odds of HIV increased among all sites when compared to Facility D (Table 9). The odds of HIV among women remained (OR 1.70, 95% CI: 1. .48 – 1.97, p<0.0001) significantly increased as compared to men's (Table 9). Age was statistically significant in this model, with the odds of HIV increasing by 1.03 (95% CI: 1.03 – 1.03, p<0.0001) for each year of age. Black African race was associated with 4.15 times the odds of HIV (95% CI: 3.22 – 5.36, p<0.0001), and duration of incarceration of under one year was significantly associated with increased odds of HIV when compared to those incarcerated over three years (OR 2.72, 95% CI: 2.34 – 3.15, p<0.0001). Similarly, those incarcerated one to two years versus those incarcerated for three or more years were at 1.66 times the odds of having HIV (95% CI: 1.38 – 2.00, p<0.0001). The multivariable regression also indicated an association between HIV and the number of presumptive TB symptoms reported. Compared with those reporting no symptoms, those with a single symptom were at 1.53 times the odds of being HIV-positive (95% CI: 1.36 – 1.73, p<0.0001), and those reporting two or more symptoms were at 1.95 times the odds (95% CI: 1.67 – 2.27, p<0.0001).

Associations between TB and demographic and clinical factors

The original bivariate analysis for TB outcome found significant differences between HIV outcomes by site, with increased odds of HIV among all other sites when compared with Facility E (Table 5). Women were at an increased risk of TB (OR 2.07, 95% CI: 1.21 – 3.54, p<0.0001), as were prisoners over the age of 24. Odds of TB were also increased among those incarcerated less than two years, when compared to those incarcerated three or more years. Because a significant association between HIV diagnosis and TB

was observed in the original bivariate analysis, additional bivariate analyses were conducted on the basis of HIV status.

TB among those with known HIV

Among those with known HIV, a bivariate analysis demonstrated associations between TB as an outcome and the report of each individual TB symptom, including cough, fever, night sweats, and weight loss, as well as the summary number of reported TB symptoms, with the odds of TB increasing 15.25 times (95% CI: 6.17 – 37.68, p<0.0001) among those reporting two or more symptoms when compared to those reporting no symptoms (Table 10).

A logistic regression model (Table 11) found the number of TB symptoms to be most significantly associated with TB among those with HIV, with 9.50 times the odds of TB among with a single symptom (95% CI: 3.86 – 23.41, p<0.0001) and 15.06 times the odds of TB among those with two or more symptoms (95% CI: 6.09 – 37.22, p<0.0001) compared to persons who did not report any symptoms of presumptive TB.

TB among those with negative or unknown HIV status

The bivariate analysis conducted for those with negative or unknown HIV status regarding TB as an outcome found that the odds of TB increased 2.13 times for women (95% CI: 1.14 – 3.37, p=0.02), but found that for those under the age of 55, the odds of TB decreased when compared to those above the age of 55. TB symptoms (Table 12). TB symptoms were all individually associated with TB, as were the number of reported TB symptoms.

A multivariable analysis (Table 13) found that women were 2.85 times more likely to have TB (95% CI: 1.50 – 5.42, p=0.001). The odds of TB also increased 1.03 times for each year of age (95% CI: 1.01 – 1.05, p=0.0007), and for those experiencing two or more TB symptoms, the odds of TB were 12.83 (95% CI: 7.67 – 21.48, p<0.0001).

Associations between HIV/TB coinfection and demographic and clinical factors

The analysis for the outcome of coinfection with potential risk factors was conducted by comparing two separate comparisons: those with only HIV to those with neither HIV nor TB and those with HIV/TB coinfection to those with neither HIV nor TB (Table 14). Factors originally considered associated with coinfection were each of the TB symptoms, and the number of TB symptoms reported.

The multivariable logistic regression for coinfection (vs. no infection with either TB nor HIV) demonstrated that women were at an increased odds of coinfection when compared to men (OR = 3.53, 95% CI: 1.22 – 10.21; p=0.02), and that persons with more TB symptoms (vs. none: OR 13.12, 95% CI: 5.34 – 32.20, p<0.0001 for >1 symptom and OR 26.68 95% CI: 10.79 – 65.98, p<0.0001 for 2 or more symptoms). The model also adjusted for duration of incarceration, which was not significantly associated with coinfection (less than 1 year vs. 3 or more years, OR 3.69, 95% CI: 0.86; p=0.08) but was independently and significantly associated with the odds of 1 disease (HIV or TB) (Table 15).

DISCUSSION

The demographic breakdown of this sample is similar to that of the broader South African prison population – the population of the prisons involved in this analysis were

mostly men, and this is also the case throughout the prisons in the DCS.[46] The distribution of age also reflects that found in the broader prisons system, though unfortunately no information on HIV, TB, or HIV/TB coinfection is available from DCS. Demographics of this sample are also reflective of the of South Africa's majority black African general population.[47]

Assessment of the cascades of care

Over half of the eligible prisoners opted to partake in HCT (57.2%), which is similar to the rates of opt-in HCT observed in a recent study conducted in North Carolina prisons and jails which reported average opt-in HCT uptake rates of about 60%.[48]

Treatment initiation for qualifying patients varied between HIV and TB. Less than half (46.8%) of qualifying patients with HIV initiated ART in accordance with Department of Health guidelines, in comparison with over 80% (81.9%) of TB patients having initiated treatment. Both cascades demonstrated a loss in the proportion of qualified patients at most steps. This attrition is well-documented in the HIV cascade of care; even in non-correctional settings, a proportion of patients retained in the cascade of HIV care is lost at each subsequent "step" in the cascade, from diagnosis, to linkage to care, retention in care, and viral suppression.[49]

As patients may transition in and out of care, incarceration is a valuable opportunity for linkage to care for those that have interrupted treatment, as well as for those requiring diagnosis and treatment initiation.[50] A 2015 systematic review of the cascade of care for HIV in prisons found that compared to the time prior to and following incarceration, all levels of the HIV cascade of care improved during the period of incarceration,

sometimes even above those seen in the general population, but these gains were often lost following release, giving incarceration a net negative impact on HIV treatment. The extent to which referrals for post-release care were being made was unable to be assessed, as eligibility for post-release referrals was not included in this dataset. Due to reports of high levels of turnover and large numbers of remand prisoners, we may expect that a larger proportion of those who were HIV-positive were released from incarceration during the time of the evaluation than were documented as having a post-release referral to care.[46]

There is little information available on the TB cascade of care, particularly in correctional settings. This may be in part due to TB screening being the primary focus of the programmatic intervention. Similar to what was observed in the HIV cascade of care, there was some loss of qualifying patients at each successive step in the cascade, though overall this loss was less than that found in the HIV cascade. As is the case with HIV, TB screening and treatment in prisons offers an opportunity to intervene in the cycle of transmission by diagnosing and treating patients that may otherwise be difficult to reach.

There is need for both the Department of Health and DCS to assess how the cascades of care for both HIV and TB could be bolstered. It is critical to understand not only what is currently responsible for the failure to retain patients at each step on the cascade, but also to identify ways of facilitating re-entry and re-engagement into the cascade for patients that may have not been retained prior to or during their incarceration. The current guidelines for management of HIV and TB outline clear practices for identifying and treating those with both diseases, but this analysis demonstrates that in at least five

facilities, practices are falling short of meeting these guidelines. Regular monitoring and evaluation of the activities recommended in these guidelines should exist, and assessments into whether or not the necessary staff is available to carry out these guidelines should be conducted.

Prevalence and proportion of HIV, TB, and HIV/TB coinfection

The prevalence of HIV in the aggregate sample of these five examined facilities was 17.1%, slightly lower than South African general population's HIV prevalence of 19.2% among those between 15 to 49 years of age.[5] However, variability exists between facilities, with up to 22.0% HIV prevalence in some facilities.

Similarly, variability exists between sites regarding TB prevalence, with a range between 0.3% and 0.6% and a rate per 100,000 ranging between approximately 335 and 490. This recorded prevalence is lower than the 3.5% observed in a 2014 TB study done in a South African prison, and is a departure from the most recently available TB incidence rate of 834 per 100,000 persons in the general South Africa population.[2, 51]

It is possible these lower observed prevalence rates for both HIV and TB reflect the face of a changing epidemic, but errors in screening sensitivity must also be considered in the case of this analysis.

Associations between HIV, TB, and HIV/TB coinfection with demographic and clinical factors

Associations discovered in this analysis could provide a means of better identifying those with the greatest odds of having HIV or TB, allowing for more targeted screening efforts, resulting in more identified cases and the opportunity to intervene in the progression of illness.

In the case of HIV outcomes among those with unknown or negative TB status, there is an increased odds of HIV associated with being at any site as compared to Facility D, being female, being between the ages of 25 and 54 (as compared to those 55 years of age or old). There is also a significant increase in the odds of HIV associated with being black, being in prison for less than three years, or experiencing two or more TB symptoms. In a practical sense, those responsible for screening would benefit from recognizing these risk groups with respect to screening.

These risk factors change when the patient in question is known to have TB. In that case, the presence of fever for over two weeks ends up being the only factor significantly associated with a positive HIV outcome. Because someone with a TB diagnosis has their odds of being HIV-positive increased over 2-fold, those responsible for HIV screening in prison should focus their attention on different clinical and demographic factors with respect to HIV, depending on their patients' TB status.

Among those with unknown or negative HIV status, factors associated with increased odds of TB included female sex, increasing age, and the number of reported TB symptoms. By contrast, for those with HIV, only the number of TB symptoms were significantly associated with TB. This reflects what is known and recommended for

symptom screening of TB among those with HIV having utility in identifying TB cases, particularly when it is possible to combine symptom screening with CXR.[52]
Making use of the information provided by these models can assist in better identifying individuals with increased odds of TB, allowing health workers to prioritize their screening, subsequently identifying more cases and potentially beginning more people treatment.

In attempting to make these high risk groups, for HIV, TB, or HIV/TB coinfection more easily identifiable, it is the hope that screening campaigns can be better targeted, allowing for more optimal use of constrained resources.

Limitations

Despite these findings, this study is not without limitations. Programmatic data was used for this analysis. As this data was not intended for research purposes, it required fairly intensive cleaning prior to use. Source data was also inaccessible, so information that could not be triangulated using other data was set to missing. The generation of missing values, as well as the deduplication process used, which in the final stages erred towards maintaining a more complete record, may bias the sample. This is, however, reflective of programmatic data in general, and it is believed that in spite of these limitations, the sample size and inclusion of multiple facilities allows these conclusions to be reflective and representative of the actual status of HIV, TB, and HIV/TB coinfection screening, diagnosis, and treatment in these five facilities. Acknowledging the difficulty of symptom screening, it could be helpful to expand questionnaires in order to capture known HIV and TB risk factors, including drug use, marital status, and known exposure.

During this externally-supported screening campaign, all prisoners were screened for TB, and HCT uptake was good, but it is uncertain how reflective this is of routine practice within DCS. The analysis examining cascades of care was also dependent upon recorded values. It is possible there were parts of care that were carried out, but not captured.

The generalizability of this analysis to correctional facilities elsewhere is limited, as the study includes only South African correctional facility data. Based on available demographic information from DCS, it does appear that the analysis is generalizable to facilities in South Africa.

The dataset also lacks any information about risk factors for HIV and TB such as a history of prior incarceration, marital status, occupation, smoking status, or substance use. TB symptoms were self-reported, making them subject exaggeration, falsification, or forgetfulness. While TB screening was compulsory, prisoners had the option to opt out of HCT, resulting in the analysis of HIV and HIV-related variables being restricted only to those that consented to HCT.

It is possible that HIV prevalence may be underestimated, due to 42.8% (N=12912) of the eligible population not consenting to HCT. The data accessible for this analysis did not allow for the evaluation of all stages of the cascade of care. Missing information included TST results, meaningful viral load data, cotrimaxazole initiation and crytpococcal screening among those living with HIV, and indication whether the person was eligible for release. For those with TB, CXR results, TB treatment outcomes, and post-release referral information were also unavailable. TB was also diagnosed on the

basis of Xpert, rather than culture, which could underestimate prevalence, though combining the use of Xpert and CXR helps mitigate this risk.

This analysis was restricted to five prisons, and while it is unknown how representative these findings are to prisons not included in this analysis, the demographics in this sample reflect those found throughout DCS.[46] Further, DCS population estimates provided were averages, and the number screened for TB exceeded these estimates at multiple sites (Table 1). This is likely attributed to high turnover, which reinforces the importance of addressing prison health measures with as much urgency as broader public health measures.

Despite these limitations, this analysis included over 30000 incarcerated persons who were screened for TB and HIV. We examined the cascade of care in this setting which can help directly guide program activities to improve retention in the cascade and subsequently, treatment outcomes for both HIV and TB.

RECOMMENDATIONS AND CONCLUSION

DCS and the South African Department of Health are provided a unique opportunity to diagnose and treat a population that may otherwise be difficult to reach. In order to best improve upon the HIV management system in place, there should be a focus on improving the capture of CD4+ cell count and viral load measures. Expansion of continuity of care efforts is also necessary, especially with respect to post-release referrals to care. There should be an assessment by DCS or the Department of Health into the causes of the reduction in proportion of patients at each level of the cascade of

care for both HIV and TB in order to begin working with DCS healthcare providers towards correcting these losses. Special attention should be paid to diagnosing HIV and TB among prisoners within the identified high risk groups discussed in this analysis – for example, special attention should be given to women, in the case of HIV among those with no TB, and TB among those with unknown or negative HIV-status, and HIV/TB coinfection. The aspects of the current TB cascade of care available for analysis are functioning quite well when compared to the HIV cascades of care. Assessments should be made to evaluate how to best improve retention in the cascade, as well as developing better ways of allowing for reentry into the cascade. To this end, routine HIV and TB screening should be made available to all prisoners, and linkage to care, both during the period of incarceration as well as following release, should be improved. As retention in care is critical to treatment success for both HIV and TB, post-release referrals are of critical importance in order to assure that those who have been started on treatment continue on treatment once they leave DCS supervision.

The externally-supported HIV and TB screening campaigns that form the basis for this analysis found a significant amount of previously-undiagnosed HIV and TB, with 87.6% of the HIV-positive population in the sample were undiagnosed prior to screening. These results underline both the value and necessity of routine screening offered upon entry and throughout incarceration. As the majority of those with HIV and TB were incarcerated for less than a year, screening upon entry for both diseases is especially important.

Efforts must also be made to ensure that all persons with HIV are being routinely screened for TB, due to the significant increased risk of developing TB among those

living with HIV. Special attention should be given to the previously-identified high risk groups for HIV and TB if widespread routine screening cannot take place. Targeted screening campaigns offering HCT to women in conjunction with any routine female health visits should be considered due to the increased odds of HIV among this sub-population. In persons with presumptive TB symptoms in which active TB has been ruled out, further HCT should be offered.

DCS reports a large number of remand prisoners, and a large proportion of this sample was incarcerated for less than a year.[45] This means that any failures to appropriately screen and diagnose those with HIV and TB is not only creating an unnecessary risk of transmission to other prisoners and prison workers, but also the general public. It would be a worthwhile exercise for DCS or the Department of Health to assess actual rates of turnover in order to identify the most optimal screening frequency for both HIV and TB. DCS may also consider adopting some sort of electronic medical system in order to better routinely monitor and evaluate the health of their population.

All of these recommendations align directly with those outlined in the 2013 Guidelines for TB and HIV Control in Correctional Facilities. Because such a large proportion of the sample population reports being imprisoned less than one year, an investment in prisoner health has the potential to dramatically improve public health. HIV and TB are both diseases that require the attention of DCS and the Department of Health. TB is curable, and measures can be put in place to minimize transmission within facilities so long as prompt diagnosis and treatment initiation are available. HIV is treatable, and earlier diagnosis and treatment initiation is associated with improved outcomes.[53] Incarceration can be a valuable opportunity for identifying and treating patients that would otherwise be difficult to reach. This is key, as failing to address these infections in

prison is a risk not only to the health of prisoners and prison workers, but to the broader public.

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FIGURES

Figure 1. Department of Health Guidelines for HIV Screening in Correctional Facilities

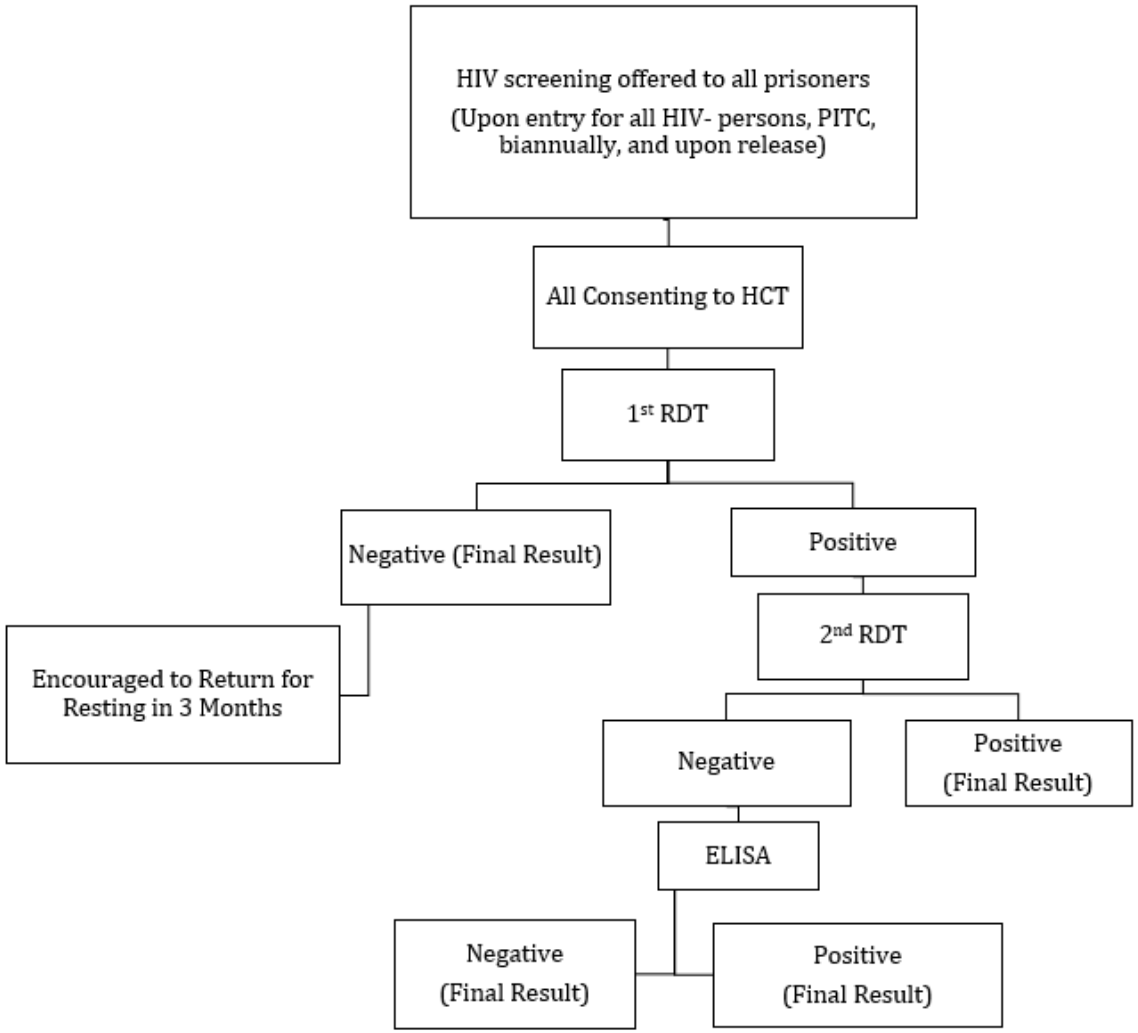


Figure 2. Department of Health Guidelines for Guidelines for the Management of HIV in Correctional Facilities

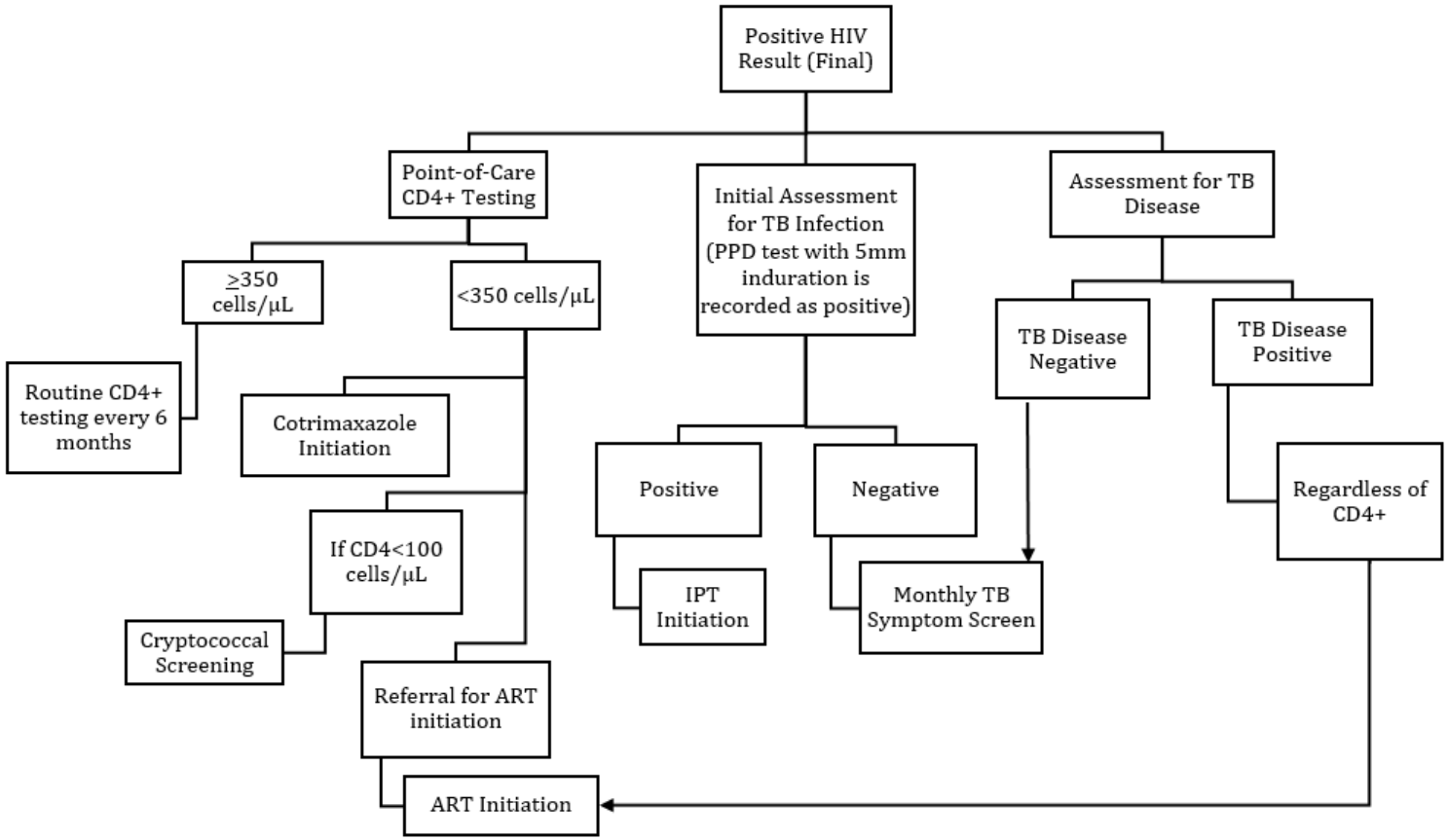


Figure 3. HIV Screening in five South African correctional facilities

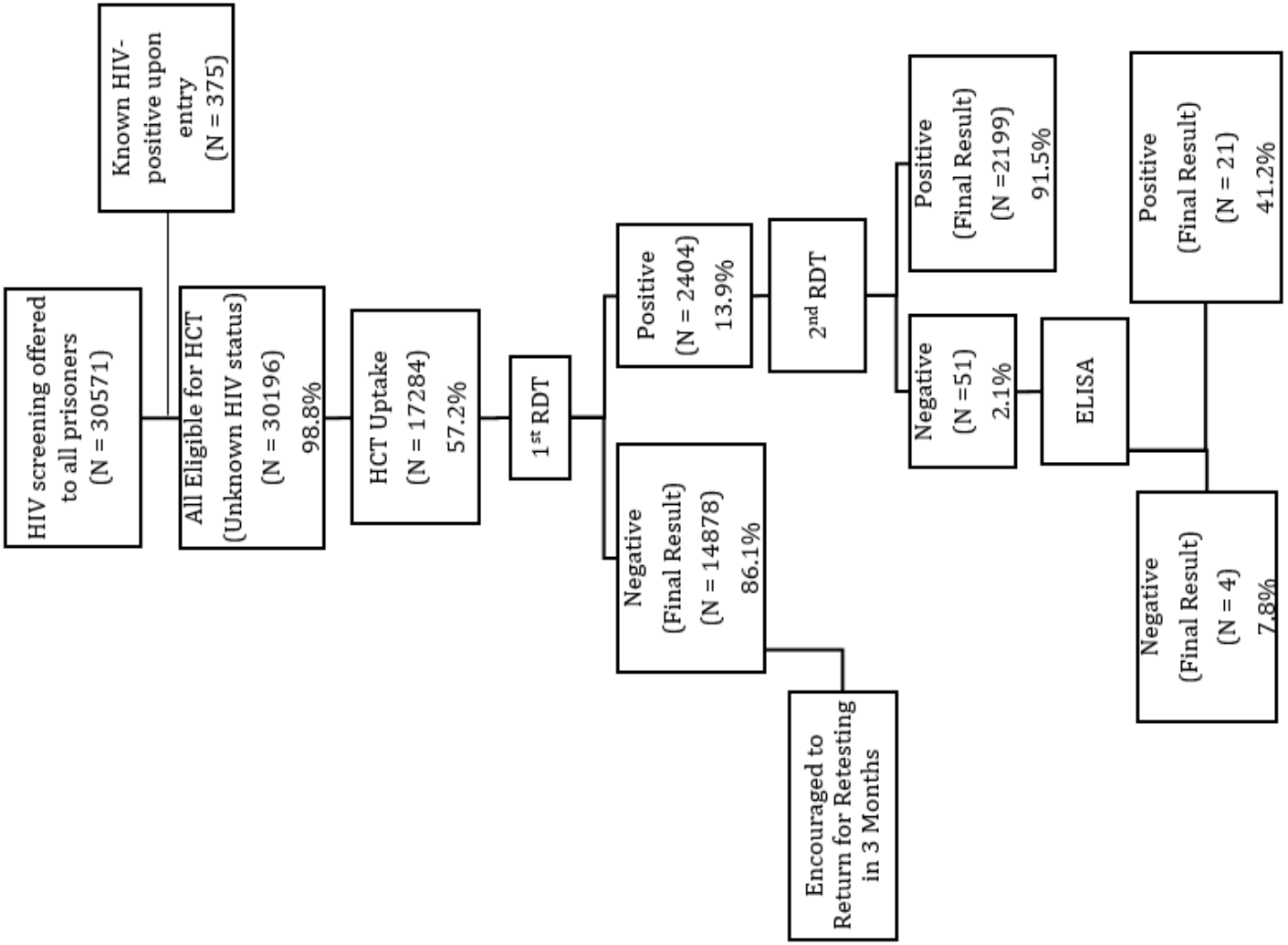


Figure 4. HIV management in five South African correctional facilities

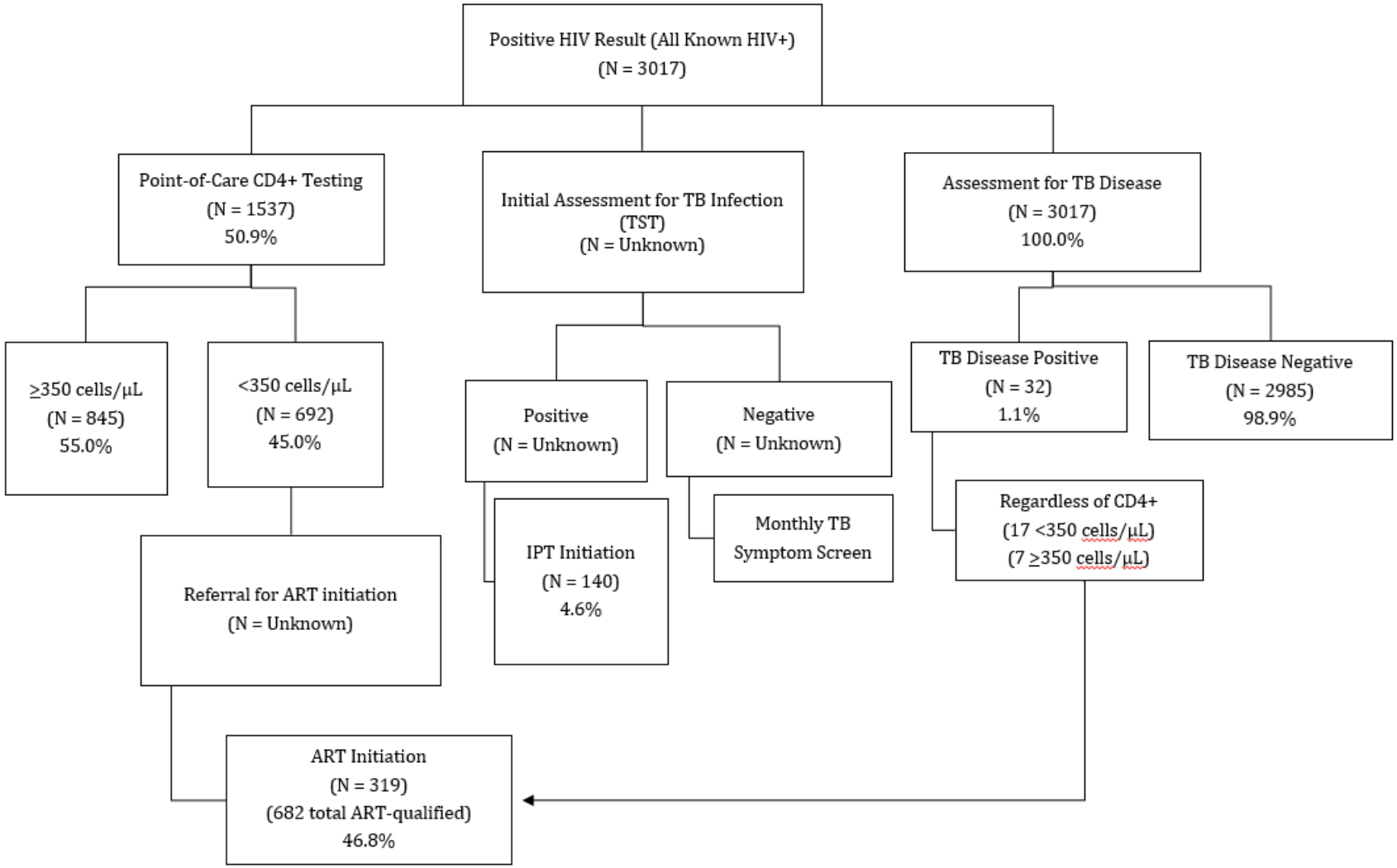


Figure 5. Department of Health Guidelines for Guidelines for TB Screening in Correctional Facilities

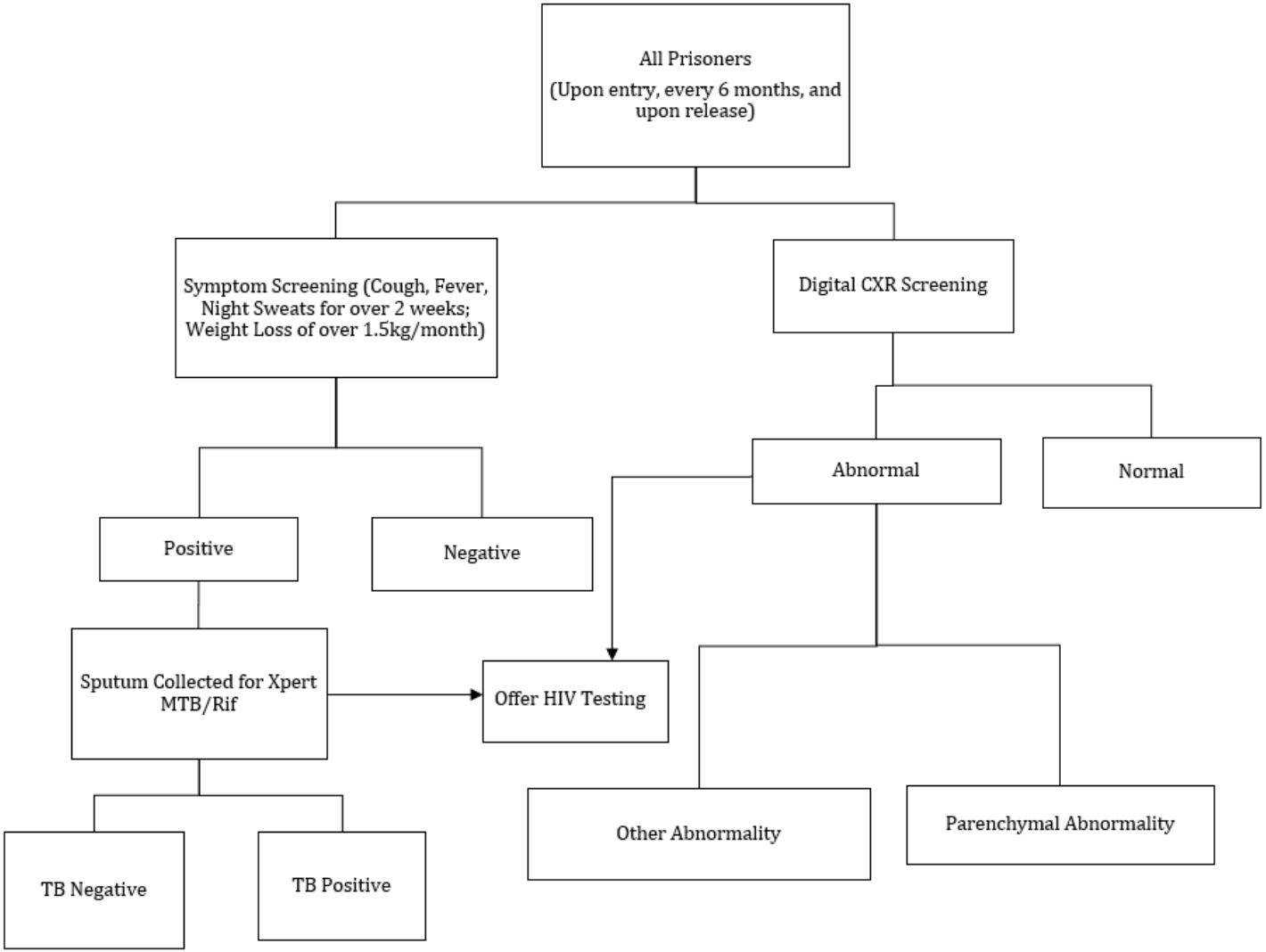


Figure 6. Department of Health Guidelines for Guidelines for TB Management in Correctional Facilities

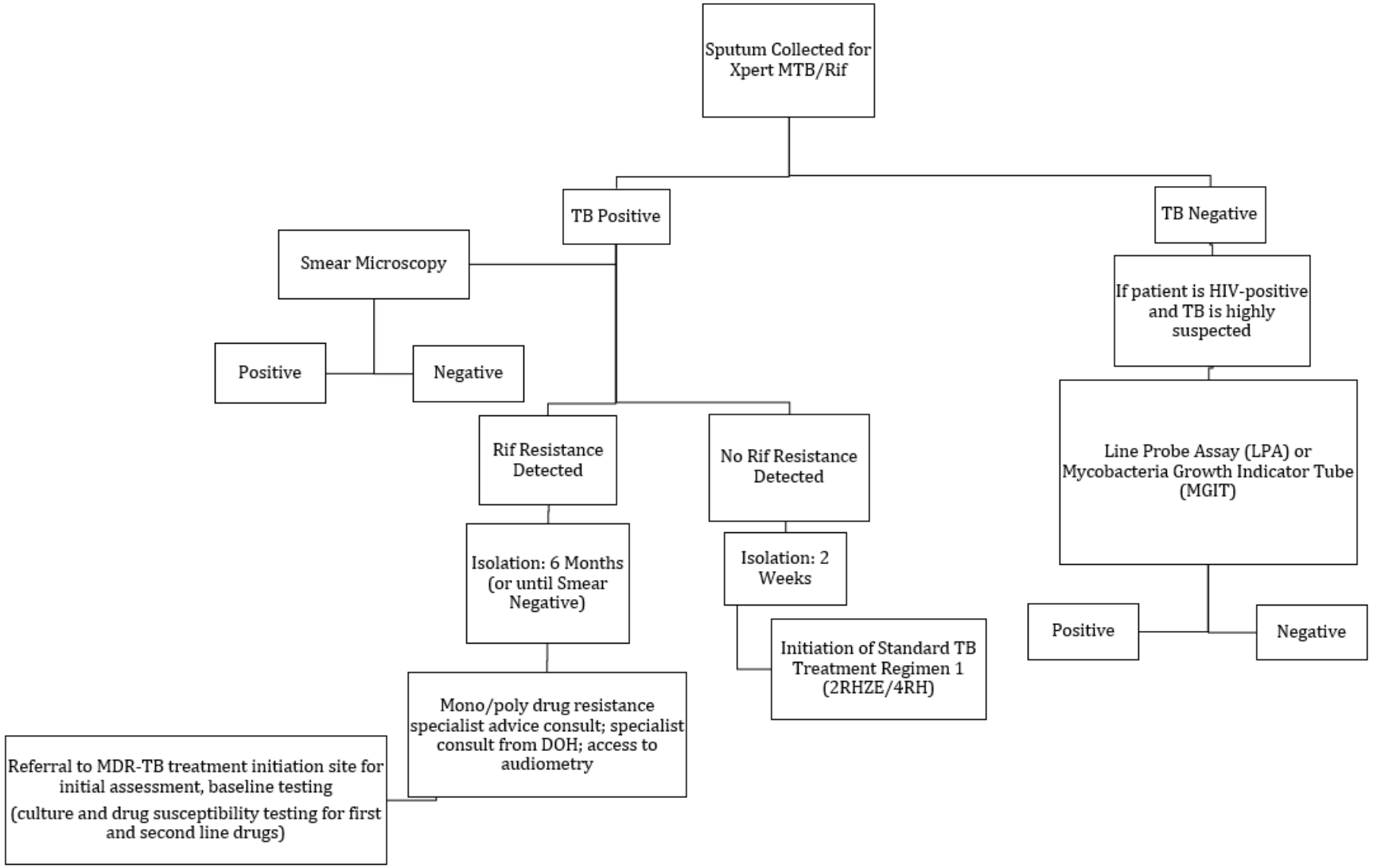


Figure 7. TB screening and management in five South African correctional facilities

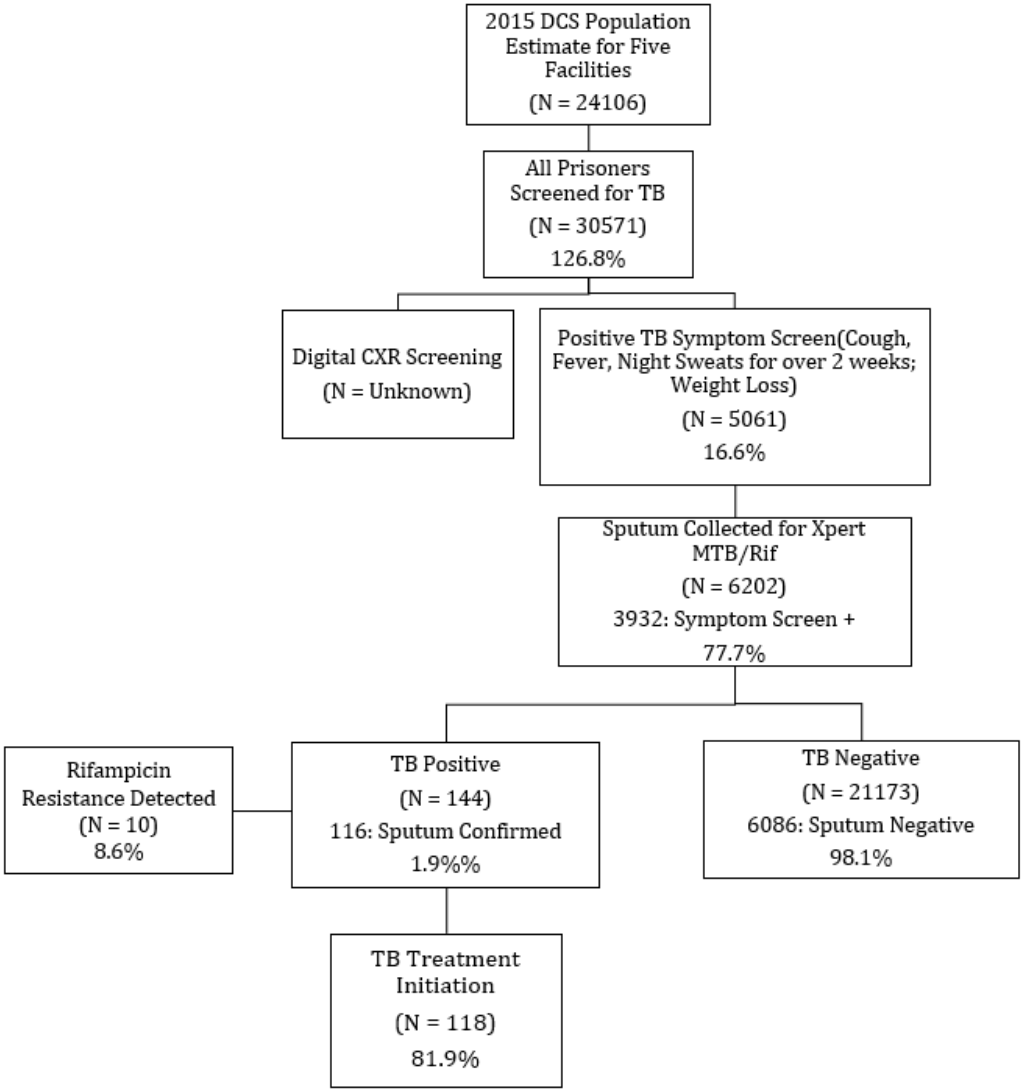
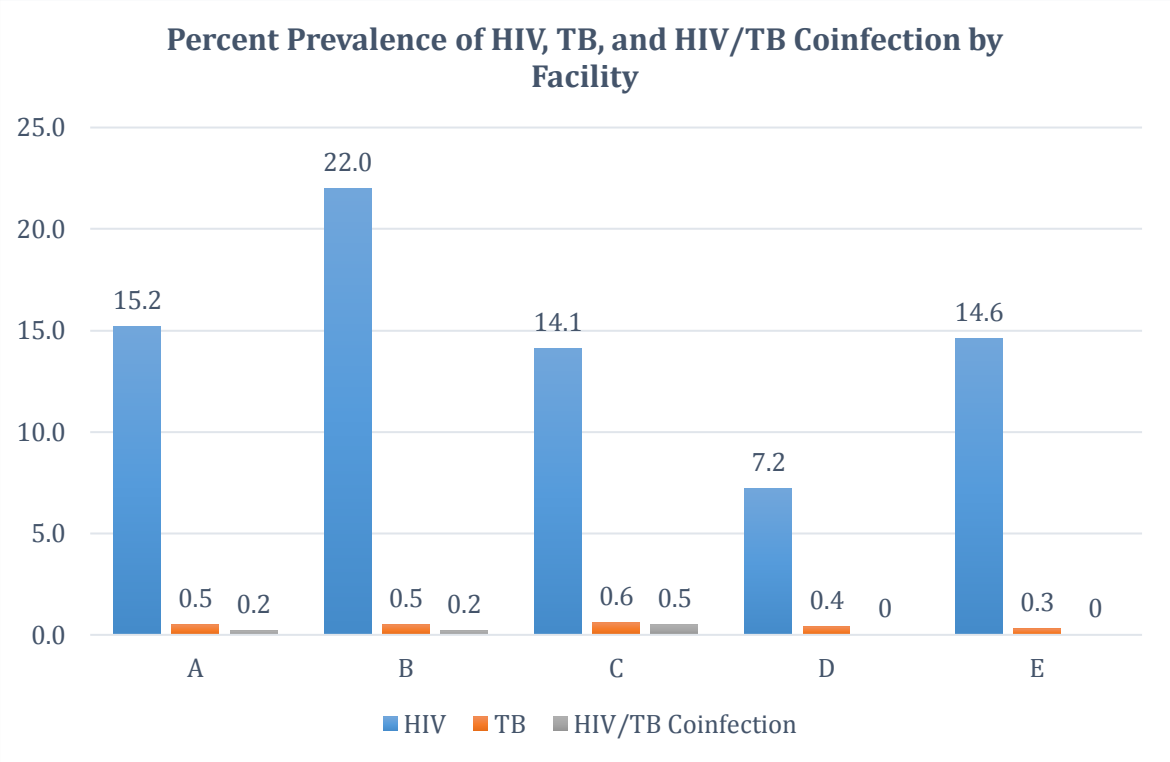


Figure 8. Percent Prevalence of HIV, TB, and HIV/TB Coinfection by Facility



TABLES

Table 1. Facility population estimates and population screened for HIV and TB in five South African correctional facilities (N=30571)

Site	2015 DCS Population Estimate	Screened via HCT N (%)	Known HIV-positive upon entry N (%)	Screened for TB N (%)	Screened for HIV and TB N (%)
A	7673	5405 (70.4)	286 (3.7)	9799 (127.71)	5405 (70.4)
B	8247	6903 (83.7)	27 (0.3)	11613 (140.81)	6903 (83.7)
C	1796	1343 (74.8)	8 (0.4)	3074 (171.16)	1343 (74.8)
D	3863	1364 (35.3)	18 (0.5)	3100 (80.25)	1364 (35.3)
E	2527	2269 (89.8)	36 (1.4)	2985 (118.12)	2269 (89.8)
Total	24106	17284	375	30571	17284

Table 2. Prevalence rate and percent prevalence of HIV, TB, and HIV/TB coinfection in five South African correctional facilities (N=30571)

Site	HIV Prevalence N (%)	TB Prevalence N (%)	HIV/TB Coinfection Prevalence† N (%)
A	15199 (15.2)	490 (0.5)	175 (0.2)
B	22035 (22.0)	499 (0.5)	216 (0.2)
C	14064 (14.1)	553 (0.6)	518 (0.5)
D	7164 (7.2)	355 (0.4)	0
E	14577 (14.6)	335 (0.3)	0

*Per 100,000.

†Denominator data for coinfection is all those with known HIV-positive status.

Table 3. Characteristics of persons included in analysis of HIV and TB in five South African correctional facilities (N=30571)

	No reported HIV or TB N (%)	HIV Only N (%)	TB Only N (%)	HIV/TB Coinfection* N (%)	Total
Site					
A	8896 (32.4)	855 (28.6)	38 (33.9)	10 (31.25)	9799 (32.1)
B	10043 (36.6)	1512 (50.7)	43 (38.4)	15 (46.88)	11613 (38.0)
C	2874 (10.5)	183 (6.1)	10 (8.9)	7 (21.88)	3074 (10.1)
D	2990 (10.9)	99 (3.3)	11 (9.8)	0	3100 (10.1)
E	2639 (9.6)	336 (11.3)	10 (8.9)	0	2985 (9.8)
Gender					
Male	26065 (95.1)	2700 (90.5)	101 (90.2)	28 (87.5)	28894 (94.5)
Female	1335 (4.87)	282 (9.5)	11 (9.8)	4 (12.5)	1632 (5.3)
Missing	42	3	0	0	45 (0.1)
Age (years)					
18-24	5774 (21.1)	350 (11.8)	14 (12.7)	4 (12.5)	6142 (20.0)
25-34	12491 (45.7)	1466 (49.3)	47 (42.7)	12 (37.5)	14016 (45.8)
35-44	4507 (16.5)	697 (23.4)	27 (24.6)	12 (37.5)	5243 (17.2)
44-54	1357 (5.0)	165 (5.6)	7 (6.4)	0	1529 (5.0)
55+	3226 (11.8)	296 (10.0)	15 (13.6)	4 (12.5)	3541 (11.6)
Missing	87	11	2	0	100 (0.3)
Race/Ethnicity					
Black/African	25761 (94.0)	2917 (97.8)	108 (96.4)	32 (100.0)	28818 (94.3)
Mixed race	935 (3.4)	40 (1.3)	2 (1.8)	0	977 (3.2)
Indian/Asian	145 (0.5)	5 (0.2)	0	0	150 (0.5)
White/European	514 (1.9)	16 (0.5)	2 (1.8)	0	532 (1.7)
Other	45 (0.2)	4 (0.1)	0	0	49 (0.2)
Missing	42	3	0	0	45 (0.1)
Duration of Incarceration					
Less than 1 year	19007 (71.9)	2385 (82.8)	69 (68.3)	27 (84.4)	21488 (70.3)
1-2 years	3290 (12.5)	251 (8.7)	18 (17.8)	3 (9.4)	3562 (11.7)
3-4 years	1629 (6.2)	84 (2.9)	6 (5.9)	1 (3.1)	1720 (5.6)
5-9 years	1637 (6.2)	107 (3.7)	4 (4.0)	0 (0)	1748 (5.7)
10 years or more	869 (3.3)	52 (1.8)	4 (4.0)	1 (3.1)	926 (3.0)
Missing	1010	106	11	0	1127 (3.7)

*Denominator data does not consider only those consenting to HIV testing.

Table is continued on the following page.

Table 3. Characteristics of persons included in analysis of HIV and TB in five South African correctional facilities (N=30571)					
	No reported HIV or TB N (%)	**HIV Only N (%)**	**TB Only N (%)**	**HIV/TB Coinfection* N (%)**	**Total**
Cough					
No	22432 (81.8)	2393 (80.3)	26 (32.4)	9 (28.1)	24860 (81.3)
<1 week	1711 (6.3)	190 (6.4)	23 (18.7)	5 (15.6)	1929 (6.3)
1-2 weeks	1223 (4.5)	159 (5.3)	24 (19.5)	7 (21.9)	1413 (4.6)
2+ weeks	2005 (7.4)	240 (8.0)	36 (29.3)	11 (34.4)	2292 (7.5)
Missing	62	3	3	9	77 (0.3)
Fever					
No	24755 (90.3)	2631 (88.2)	56 (50.0)	13 (40.6)	27455 (89.8)
<1 week	1225 (4.5)	157 (5.3)	24 (21.4)	5 (15.6)	1411 (4.6)
≤2 weeks	599 (2.2)	72 (2.4)	16 (14.3)	4 (12.5)	691 (2.3)
2+ weeks	813 (3.0)	123 (4.1)	16 (14.3)	10 (31.2)	962 (3.1)
Missing	51	1	0	0	52 (0.2)
Night Sweats					
No	23659 (86.3)	2462 (82.5)	42 (37.5)	12 (37.5)	26175 (85.6)
<1 week	1351 (5.0)	159 (5.3)	22 (19.6)	6 (18.8)	1538 (5.0)
≤2 weeks	830 (3.0)	116 (3.9)	20 (17.9)	3 (9.4)	969 (3.2)
Yes	1552 (5.7)	248 (8.3)	28 (25.0)	11 (34.4)	1839 (6.0)
Missing	50	0	0	0	50 (0.2)
Weight Loss					
No	25045 (91.3)	2598 (87.0)	58 (51.8)	14 (43.8)	27715 (90.7)
Yes	2385 (8.7)	387 (13.0)	54 (48.2)	18 (56.3)	2844 (9.3)
Missing	12	0	0	0	12 (0.03)
Number of Symptoms Indicating Presumptive TB†					
0	23085 (84.1)	2379 (79.7)	38 (33.9)	8 (25.0)	25510 (83.4)
1	2868 (10.5)	372 (12.5)	42 (37.5)	12 (37.5)	3294 (10.8)
2	832 (3.0)	119 (4.0)	11 (9.8)	4 (12.5)	966 (3.2)
3	405 (1.5)	72 (2.4)	14 (12.5)	2 (6.3)	493 (1.6)
4	252 (0.9)	43 (1.4)	7 (6.3)	6 (18.8)	308 (1.0)

*Denominator data does not consider only those consenting to HIV testing.
†Includes the sum of cough, fever, or night sweats lasting >2 weeks or any reported weight loss.

Table 4. Bivariate associations between HIV and demographic and clinical variables in five South African correctional facilities (N=30571				
	HIV-negative or unknown status N (%)	**HIV-positive status N (%)**	**Crude Odds Ratio (95% CI)**	**Crude OR p-value**
Site				
A	8934 (32.4)	865 (28.67)	2.94 (2.37, 3.63)	<.0001
B	10086 (36.6)	1527 (50.61)	4.59 (3.73, 5.65)	<.0001
C	2884 (10.5)	190 (6.30)	2.00 (1.56, 2.56)	<.0001
D	3001 (10.9)	99 (3.28)	Reference	
E	2649 (9.6)	336 (11.14)	3.85 (3.05, 4.84)	<.0001
Gender				
Male	26166 (95.11)	2728 (90.51)	Reference	
Female	1346 (4.89)	286 (9.49)	2.04 (1.78, 2.33)	<.0001
Age (years)				
18-24	5788 (21.07)	354 (11.78)	0.66 (0.56, 0.78)	<.0001
25-34	12538 (45.65)	1478 (49.17)	1.27 (1.12, 1.45)	0.0003
35-44	4534 (16.51)	709 (23.59)	1.69 (1.47, 1.95)	<.0001
44-54	1364 (4.97)	165 (5.49)	1.31 (1.07, 1.60)	0.0088
55+	3241 (11.80)	300 (9.98)	Reference	
Race/Ethnicity				
Black/African	25869 (94.03)	2949 (97.84)	2.88 (2.24, 3.70)	<.0001
All other races/ethnicities	1643 (5.97)	65 (2.16)	Reference	
Duration of Incarceration				
Less than 1 year	19076 (71.90)	2412 (82.86)	2.14 (1.87, 2.45)	<.0001
1-2 years	3308 (12.47)	254 (8.73)	1.30 (1.09, 1.56)	0.0045
3+ years	4149 (15.64)	245 (8.42)	Reference	
Table continues on following page.				

Table 4. Bivariate associations between HIV and demographic and clinical variables in five South African correctional facilities (N=30571				
	HIV-negative or unknown status N (%)	**HIV-positive status N (%)**	**Crude Odds Ratio (95% CI)**	**Crude OR p-value**
Cough >2 weeks				
No	25513 (92.59)	2766 (91.68)	Reference	
Yes	2041 (7.41)	251 (8.32)	1.13 (0.99, 1.30)	0.71
Fever >2 weeks				
No	26725 (96.99)	2884 (95.59)	Reference	
Yes	829 (3.01)	133 (4.41)	1.49 (1.23, 1.79)	<.0001
Night Sweats >2 weeks				
No	25974 (94.27)	2758 (91.42)	Reference	
Yes	1580 (5.73)	259 (8.58)	1.54 (1.35, 1.77)	<.0001
Weight Loss				
No	25103 (91.14)	2612 (86.58)	Reference	
Yes	2439 (8.86)	405 (13.42)	1.60 (1.43, 1.79)	<.0001
TB Diagnosis				
No	27442 (99.59)	2985 (98.94)	Reference	
Yes	112 (0.41)	32 (1.06)	2.63 (1.77, 3.90)	<.0001
Number of Symptoms Indicating Presumptive TB*				
0	23123 (83.9)	2387 (79.1)	Reference	
1	2910 (10.6)	384 (12.7)	1.28 (1.14, 1.43)	<.0001
2+	1521 (5.5)	246 (8.2)	1.57 (1.36, 1.80)	<.0001
*Includes the sum of cough, fever, or night sweats lasting >2 weeks or any reported weight loss.				

Table 5. Bivariate associations between TB and demographic and clinical variables in five South African correctional facilities (N=30571)

	TB-negative or unknown status N (%)	Reported or newly diagnosed TB N (%)	Crude Odds Ratio (95% CI)	Crude OR p-value
Site				
A	9751 (32.05)	48 (33.33)	1.46 (0.74, 2.90)	0.27
B	11555 (37.98)	58 (40.28)	1.49 (0.76, 2.93)	0.24
C	3057 (10.05)	17 (11.81)	1.65 (0.76, 3.62)	0.21
D	3089 (10.15)	11 (7.64)	1.06 (0.45, 2.50)	0.9
E	2975 (9.78)	10 (6.94)	Reference	
Gender				
Male	28765 (94.68)	129 (89.58)	Reference	
Female	1617 (5.32)	15 (10.42)	2.07 (1.21, 3.54)	<.0001
Age (years)				
18-24	6124 (20.19)	18 (12.68)	Reference	
25-34	13957 (46.02)	59 (41.55)	1.44 (0.85, 2.44)	0.18
35-44	5204 (17.16)	39 (27.46)	2.55 (1.46, 4.46)	0.001
44-54	1522 (5.02)	7 (4.93)	1.57 (0.62, 3.75)	0.32
55+	3522 (11.61)	19 (13.38)	1.84 (0.96, 3.50)	0.07
Race/Ethnicity				
Black/African	28678 (94.39)	140 (97.22)	2.08 (0.77, 5.62)	0.15
All other races/ethnicities	1704 (5.61)	4 (2.78)	Reference	
Duration of Incarceration				
Less than 1 year	21392 (72.98)	96 (72.18)	1.23 (0.72, 2.09)	0.45
1-2 years	3541 (12.08)	21 (15.79)	1.62 (0.85, 3.11)	0.15
3+ years	4378 (14.94)	16 (12.03)	Reference	

Table continues on following page.

Table 5. Bivariate associations between TB and demographic and clinical variables in five South African correctional facilities (N=30571)				
	TB-negative or unknown status N (%)	**Reported or newly diagnosed TB N (%)**	**Crude Odds Ratio (95% CI)**	**Crude OR p-value**
Cough >2 weeks				
No	28182 (92.62)	97 (67.36)	Reference	
Yes	2245 (7.38)	47 (32.64)	6.8 (4.28, 8.64)	<.0001
Fever >2 weeks				
No	29491 (96.92)	118 (81.94)	Reference	
Yes	936 (3.08)	26 (18.06)	6.94 (4.52, 10.67)	<.0001
Night Sweats >2 weeks				
No	28627 (94.08)	105 (72.92)	Reference	
Yes	1800 (5.92)	39 (27.08)	5.91 (4.08, 8.56)	<.0001
Weight Loss				
No	27643 (90.89)	72 (50.00)	Reference	
Yes	2772 (9.11)	72 (50.00)	9.97 (7.18, 13.86)	<.0001
HIV Diagnosis				
No	27442 (90.19)	112 (77.78)	Reference	
Yes	2985 (9.81)	32 (22.22)	2.63 (1.77, 3.90)	<.0001
Number of Symptoms Indicating Presumptive TB*				
0	25464 (83.7)	46 (31.9)	Reference	
1	3240 (10.7)	54 (37.5)	9.23 (6.22, 13.69)	<.0001
2+	1723 (5.7)	44 (30.6)	14.14 (9.32, 21.43)	<.0001
*Includes the sum of cough, fever, or night sweats lasting >2 weeks or any reported weight loss.				

Table 6. Bivariate associations between HIV and demographic and clinical variables in five South African correctional facilities for those with known TB (N=144)

	HIV-negative or unknown status N (%)	HIV-positive status N (%)	Crude Odds Ratio (95% CI)	Crude OR p-value
Site				
A	38 (33.9)	10 (31.3)	>999.99 (<0.001, >999.99)	0.95
B	43 (38.4)	15 (46.9)	>999.99 (<0.001, >999.99)	0.95
C	10 (8.9)	7 (21.9)	>999.99 (<0.001, >999.99)	0.95
D	11 (9.8)	0	Reference	
E	10 (8.9)	0	1.00 (<0.001, >999.99)	1.00
Gender				
Male	101 (90.2)	28 (87.5)	Reference	
Female	11 (9.8)	4 (12.5)	1.31 (0.39, 4.44)	0.66
Age (years)				
18-24	14 (12.7)	4 (12.5)	1.07 (0.22, 5.13)	0.93
25-34	47 (42.47)	12 (37.5)	0.96 (0.27, 3.42)	0.95
35-44	27 (24.6)	12 (37.5)	1.67 (0.46, 6.09)	0.44
44-54	7 (6.4)	0	<0.001 (<0.001, >999.99)	0.97
55+	15 (13.6)	4 (12.5)	Reference	
Race/Ethnicity				
Black/African	108 (96.4)	32 (100.00)	>999.99 (<0.001, >999.99)	0.98
All other races/ethnicities	4 (3.6)	0	Reference	

Table continues on following page.

Table 6. Bivariate associations between HIV and demographic and clinical variables in five South African correctional facilities for those with known TB (N=144)

	HIV-negative or unknown status N (%)	HIV-positive status N (%)	Crude Odds Ratio (95% CI)	Crude OR p-value
Duration of Incarceration				
Less than 1 year	69 (68.3)	27 (84.4)	2.74 (0.58, 12.87)	0.20
1-2 years	18 (17.8)	3 (3.4)	1.17 (0.17, 7.96)	0.88
3+ years	14 (13.9)	2 (6.3)	Reference	
Cough >2 weeks				
No	76 (67.9)	21 (65.6)	Reference	
Yes	36 (32.1)	11 (34.4)	1.11 (0.48, 2.54)	0.81
Fever >2 weeks				
No	96 (85.7)	22 (68.8)	Reference	
Yes	16 (14.3)	10 (31.3)	2.73 (1.09, 6.82)	0.03
Night Sweats >2 weeks				
No	84 (75.0)	21 (65.6)	Reference	
Yes	28 (25.0)	11 (34.4)	1.57 (0.68, 3.66)	0.29
Weight Loss				
No	58 (51.8)	14 (43.8)	Reference	
Yes	54 (48.2)	18 (56.3)	1.38 (0.63, 3.04)	0.42
Number of Symptoms Indicating Presumptive TB*				
0	38 (33.9)	8 (25)	Reference	
1	42 (37.5)	12 (37.5)	1.36 (0.50, 3.68)	0.55
2+	32 (28.6)	12 (37.5)	1.78 (0.65, 4.89)	0.26

*Includes the sum of cough, fever, or night sweats lasting >2 weeks or any reported weight loss

Table 7. Results of a multivariable logistic regression model for factors associated with HIV among individuals with TB in five South African correctional facilities (N=144)		
	Age-Adjusted Odds Ratio (95% CI)	**Age-Adjusted OR p-value**
Age (years)	1.00 (0.96, 1.04)	0.92
Fever >2 weeks		
No	Reference	
Yes	2.66 (1.06, 6.67)	0.03

Table 8. Bivariate associations between HIV and demographic and clinical variables in five South African correctional facilities for those without TB (N=30427)

	HIV-negative or unknown status N (%)	HIV-positive status N (%)	Crude Odds Ratio (95% CI)	Crude OR p-value
Site				
A	8896 (32.4)	855 (28.6)	2.90 (2.35, 3.59)	<.0001
B	10043 (36.6)	1512 (50.7)	4.55 (3.70, 5.60)	<.0001
C	2874 (10.5)	183 (6.1)	1.92 (1.50, 2.47)	<.0001
D	2990 (10.9)	99 (3.3)	Reference	
E	2639 (9.6)	336 (11.3)	3.85 (3.06, 4.84)	<.0001
Gender				
Male	26065 (95.1)	2700 (90.5)	Reference	
Female	1335 (4.9)	282 (9.46)	2.04 (1.78, 2.33)	<.0001
Age (years)				
18-24	5774 (21.1)	350 (11.8)	0.66 (0.56, 0.78)	<.0001
25-34	12491 (45.7)	1466 (49.3)	1.28 (1.12, 1.46)	0.0002
35-44	4507 (16.5)	697 (23.4)	1.69 (1.46, 1.95)	<.0001
44-54	1357 (5.0)	165 (5.6)	1.33 (1.08, 1.62)	0.006
55+	3226 (11.8)	296 (10.0)	Reference	
Race/Ethnicity				
Black/African	25761 (94.0)	2917 (97.8)	2.85 (2.22, 3.67)	<.0001
All other races/ethnicities	1639 (6.0)	65 (2.2)	Reference	

Table continues on following page.

Table 8. Bivariate associations between HIV and demographic and clinical variables in five South African correctional facilities for those without TB (N=30427)

	HIV-negative or unknown status N (%)	HIV-positive status N (%)	Crude Odds Ratio (95% CI)	Crude OR p-value
Duration of Incarceration				
Less than 1 year	19007 (71.9)	2385 (82.8)	2.14 (1.86, 2.45)	<.0001
1-2 years	3290 (12.5)	251 (8.7)	1.30 (1.08, 1.56)	0.005
3+ years	4135 (15.6)	243 (8.4)	Reference	
Cough >2 weeks				
No	25437 (92.7)	2745 (92.0)	Reference	
Yes	2005 (7.3)	240 (8.0)	1.11 (0.97, 1.28)	0.15
Fever >2 weeks				
No	26629 (97.0)	2862 (95.9)	Reference	
Yes	813 (3.0)	123 (4.1)	1.41 (1.16, 1.71)	0.0005
Night Sweats >2 weeks				
No	25890(94.3)	2737 (91.7)	Reference	
Yes	1552 (5.7)	248 (8.3)	1.51 (1.31, 1.74)	<.0001
Weight Loss				
No	25045 (91.3)	2598 (87.0)	Reference	
Yes	2385 (8.7)	387 (13.0)	1.56 (1.40, 1.75)	<.0001
Number of Symptoms Indicating Presumptive TB*				
0	23085 (84.1)	2379 (79.7)	Reference	
1	2868 (10.5)	372 (12.5)	1.26 (1.12, 1.41)	0.0001
2+	1489 (5.4)	234 (7.8)	1.53 (1.32, 1.76)	<.0001

*Includes the sum of cough, fever, or night sweats lasting >2 weeks or any reported weight loss

Table 9. Results of a multivariable logistic regression model for factors associated with HIV among individuals without TB in five South African correctional facilities (N=30427)		
	Adjusted Odds Ratio (95% CI)	**Adjusted OR p-value**
Site		
A	2.31 (1.81, 2.96)	<.0001
B	4.17 (3.27, 5.32)	<.0001
C	1.58 (1.19, 2.09)	0.002
D	Reference	
E	3.88 (2.97, 5.06)	<.0001
Gender		
Male	Reference	
Female	1.70 (1.48, 1.97)	<.0001
Age (years)	1.03 (1.03, 1.03)	<.0001
Race/Ethnicity		
Black/African	4.15 (3.22, 5.36)	<.0001
All other races/ethnicities	Reference	
Duration of Incarceration		
Less than 1 year	2.72 (2.34, 3.15)	<.0001
1-2 years	1.66 (1.38, 2.00)	<.0001
3+ years	Reference	
Number of Symptoms Indicating Presumptive TB*		
0	Reference	
1	1.53 (1.36, 1.73)	<.0001
2 +	1.95 (1.67, 2.27)	<.0001
*Includes the sum of cough, fever, or night sweats lasting >2 weeks or any reported weight loss		

Table 10. Bivariate associations between TB and demographic and clinical variables in five South African correctional facilities for those with known HIV (N=3017)

	TB-negative or unknown status N (%)	Reported or newly diagnosed TB N (%)	Crude Odds Ratio (95% CI)	Crude OR p-value
Site				
A	855 (28.6)	10 (31.3)	>999.99 (<0.001, >999.99)	0.93
B	1512 (50.7)	15 (46.9)	>999.99 (<0.001, >999.99)	0.95
C	183 (6.1)	7 (21.9)	>999.99 (<0.001, >999.99)	0.94
D	99 (3.3)	0	Reference	
E	336 (11.3)	0	0.46 (<0.001, >999.99)	1.00
Gender				
Male	2700 (90.5)	28 (87.5)	Reference	
Female	282 (9.5)	4 (12.5)	1.37 (0.48, 3.93)	0.56
Age (years)				
18-24	350 (11.8)	4 (12.5)	0.84 (0.21, 3.41)	0.81
25-34	1466 (49.3)	12 (37.5)	0.61 (0.19, 1.89)	0.39
35-44	697 (23.4)	12 (37.5)	1.27 (0.41, 3.98)	0.68
44-54	165 (5.6)	0	<.001 (<0.001, >999.99)	0.98
55+	296 (10.0)	4 (12.5)	Reference	
Race/Ethnicity				
Black/African	2917 (97.8)	32 (100.0)	>999.99 (<0.001, >999.99)	0.98
All other races/ethnicities	65 (2.2)	0	Reference	

Table continues on following page.

Table 10. Bivariate associations between TB and demographic and clinical variables in five South African correctional facilities for those with known HIV (N=3017)

	TB-negative or unknown status N (%)	Reported or newly diagnosed TB N (%)	Crude Odds Ratio (95% CI)	Crude OR p-value
Duration of Incarceration				
Less than 1 year	2385 (82.8)	27 (84.4)	1.37 (0.33, 5.81)	0.67
1-2 years	251 (8.7)	3 (9.4)	1.45 (0.24, 8.76)	0.68
3+ years	243 (8.4)	2 (6.3)	Reference	
Cough >2 weeks				
No	2745 (92.0)	21 (65.6)	Reference	
Yes	240 (8.0)	11 (34.4)	5.99 (2.86, 12.58)	<.0001
Fever >2 weeks				
No	2862 (95.9)	22 (68.8)	Reference	
Yes	123 (4.1)	10 (31.3)	10.58 (4.90, 22.82)	<.0001
Night Sweats >2 weeks				
No	2737 (91.7)	21 (65.6)	Reference	
Yes	248 (8.3)	11 (34.4)	5.78 (2.76, 12.13)	<.0001
Weight Loss				
No	2598 (87.0)	14 (43.8)	Reference	
Yes	387 (13.0)	18 (56.3)	8.63 (4.26, 17.50)	<.0001
Number of Symptoms Indicating Presumptive TB*				
0	2379 (79.7)	8 (25.0)	Reference	
1	372 (12.5)	12 (37.5)	9.59 (3.90, 23.62)	<.0001
2+	234 (7.8)	12 (37.5)	15.25 (6.17, 37.68)	<.0001

*Includes the sum of cough, fever, or night sweats lasting >2 weeks or any reported weight loss

Table 11. Results of a multivariable logistic regression model for factors associated with TB among individuals with HIV in five South African correctional facilities (N=3017)		
	Age-Adjusted Odds Ratio (95% CI)	**Age-Adjusted OR p-value**
Age (years)	1.02 (0.97, 1.06)	0.46
Number of Symptoms Indicating Presumptive TB*		
0	Reference	
1	9.50 (3.86, 23.41)	<.0001
2+	15.06 (6.09, 37.22)	<.0001
*Includes the sum of cough, fever, or night sweats lasting >2 weeks or any reported weight loss		

Table 12. Bivariate associations between TB and demographic and clinical variables in five South African correctional facilities for those with negative or unknown HIV status
(N=27554)

	TB-negative or unknown status N (%)	Reported or newly diagnosed TB N (%)	Crude Odds Ratio (95% CI)	Crude OR p-value
Site				
A	8896 (32.4)	38 (33.9)	1.16 (0.59, 2.27)	0.66
B	10043 (36.6)	43 (38.4)	1.16 (0.60, 2.26)	0.65
C	2874 (10.5)	10 (8.9)	0.95 (0.40, 2.23)	0.90
D	2990 (10.9)	11 (9.8)	Reference	
E	2639 (9.6)	10 (8.9)	1.03 (0.44, 2.43)	0.95
Gender				
Male	26065 (95.1)	101 (90.2)	Reference	
Female	1335 (4.9)	11 (9.8)	2.13 (1.14, 3.37)	0.02
Age (years)				
18-24	5774 (21.1)	14 (12.7)	0.52 (0.25, 1.08)	0.08
25-34	12491 (45.7)	47 (42.7)	0.81 (0.45, 1.45)	0.48
35-44	4507 (16.5)	27 (24.6)	1.28 (0.68, 2.43)	0.43
44-54	1357 (5.0)	7 (6.4)	1.11 (0.45, 2.72)	0.82
55+	3226 (11.8)	15 (13.7)	Reference	
Race/Ethnicity				
Black/African	25761 (94.0)	108 (96.4)	1.72 (0.63, 4.67)	0.29
All other races/ethnicities	1639 (6.0)	4 (3.6)	Reference	

Table continues on following page.

Table 12. Bivariate associations between TB and demographic and clinical variables in five South African correctional facilities for those with negative or unknown HIV status
(N=27554)

	TB-negative or unknown status N (%)	Reported or newly diagnosed TB N (%)	Crude Odds Ratio (95% CI)	Crude OR p-value
Duration of Incarceration				
Less than 1 year	19007 (71.9)	69 (68.3)	1.07 (0.60, 1.91)	0.81
1-2 years	3290 (12.5)	18 (17.8)	1.62 (0.80, 3.25)	0.18
3+ years	4135 (15.6)	14 (13.9)	Reference	
Cough >2 weeks				
No	25437 (92.7)	76 (67.9)	Reference	
Yes	2005 (7.3)	36 (32.1)	6.01 (4.03, 8.96)	<.0001
Fever >2 weeks				
No	26629 (97.0)	96 (85.7)	Reference	
Yes	813 (3.0)	16 (14.3)	5.46 (3.20, 9.31)	<.0001
Night Sweats >2 weeks				
No	25890 (94.3)	84 (75.0)	Reference	
Yes	1552 (5.7)	28 (25.0)	5.56 (3.61, 8.55)	<.0001
Weight Loss				
No	25045 (91.3)	58 (51.8)	Reference	
Yes	2385 (8.7)	54 (48.2)	9.78 (6.73, 14.20)	<.0001
Number of Symptoms Indicating Presumptive TB*				
0	23085 (84.1)	38 (33.9)	Reference	
1	2868 (10.5)	42 (37.5)	8.90 (5.73, 13.82)	<.0001
2+	1489 (5.4)	32 (28.6)	13.06 (8.13, 20.96)	<.0001

*Includes the sum of cough, fever, or night sweats lasting >2 weeks or any reported weight loss

Table 13. Results of a multivariable logistic regression model for factors associated with TB among individuals with negative or unknown HIV status in five South African correctional facilities (N=27554)

	Age-Adjusted Odds Ratio (95% CI)	**Age-Adjusted OR p-value**
Gender		
Male	Reference	
Female	2.85 (1.50, 5.42)	0.001
Age (years)	1.03 (1.01, 1.05)	0.0007
Number of Symptoms Indicating Presumptive TB*		
0	Reference	
1	9.94 (6.26, 15.78)	<.0001
2+	12.83 (7.67, 21.48)	<.0001

*Includes the sum of cough, fever, or night sweats lasting >2 weeks or any reported weight loss

Table 14. Bivariate associations between HIV/TB coinfection and demographic and clinical variables in five South African correctional facilities (N=30459)

				HIV Only vs Neither HIV nor TB		Coinfection v. Neither HIV nor TB	
	Neither HIV nor TB* N (%)	**HIV Only N (%)**	**Coinfection N (%)**	**Crude Odds Ratio† (95% CI)**	**Crude OR p-value**	**Crude Odds Ratio (95% CI)**	**Crude OR p-value**
Site							
A	8883 (32.42)	855 (28.67)	10 (31.25)	2.90 (2.35, 3.58)	<.0001	>999.99 (<0.001, >999.99)	0.96
B	10026 (36.59)	1509 (50.60)	15 (46.88)	4.53 (3.68, 5.58)	<.0001	>999.99 (<0.001, >999.99)	0.96
C	2870 (10.47)	183 (6.14)	7 (21.88)	1.92 (1.49, 2.46)	<.0001	>999.99 (<0.001, >999.99)	0.95
D	2985 (10.89)	99 (3.32)	0	Reference		Reference	
E	2636 (9.62)	336 (11.27)	0	3.84 (3.05, 4.83)	<.0001	>999.99 (<0.001, >999.99)	0.00
Gender							
Male	26025 (95.12)	2697 (90.53)	28 (87.50)	Reference		Reference	
Female	1334 (4.88)	282 (9.47)	4 (12.50)	2.04 (1.78, 2.33)	<.0001	2.54 (0.89, 7.25)	0.08
Age (years)							
18-24	5767 (21.11)	350 (11.78)	4 (12.50)	0.66 (0.57, 0.78)	<.0001	0.58 (0.14, 2.30)	0.43
25-34	12470 (45.65)	1466 (49.34)	12 (37.50)	1.28 (1.13, 1.46)	<.0001	0.76 (0.24, 2.35)	0.63
35-44	4501 (16.48)	695 (23.39)	12 (37.50)	1.68 (1.46, 1.94)	0.0002	2.03 (0.65, 6.30)	0.22
44-54	1355 (4.96)	165 (5.55)	0	1.33 (1.09, 1.63)	0.005	<.001 (<0.001, >999.99)	0.98
55+	3221 (11.79)	295 (9.93)	4 (12.50)	Reference		Reference	
Race/Ethnicity							
Black/African	25761 (94.02)	2917 (97.82)	32 (100.00)	2.85 (2.22, 3.66)	<.0001	>999.99 (<0.001, >999.99)	0.98
All other races/ethnicities	1639 (5.98)	65 (2.18)	0	Reference		Reference	
Duration of Incarceration							
Less than 1 year	18981 (71.91)	2382 (82.82)	27 (84.38)	2.13 (1.86, 2.44)	<.0001	2.76 (0.66, 11.61)	0.17
1-2 years	3284 (12.44)	251 (8.73)	3 (9.38)	1.30 (1.08, 1.56)	0.005	1.86 (0.31, 11.10)	0.50
3+ years	4131 (15.65)	243 (8.45)	2 (6.25)	Reference		Reference	

*Persons reporting only TB were excluded from this analysis (N = 112), and "Neither HIV nor TB" status indicates HIV status is either negative or unknown.
†Odds ratios are in comparison to the reference group, defined as those with neither known HIV nor known TB.
Table continues on the following page.

Table 14. Bivariate associations between HIV/TB coinfection and demographic and clinical variables in five South African correctional facilities (N=30459)

				HIV Only vs Neither HIV nor TB		Coinfection v. Neither HIV nor TB	
	Neither HIV nor TB* N (%)	**HIV Only N (%)**	**Coinfection N (%)**	**Crude Odds Ratio† (95% CI)**	**Crude OR p-value**	**Crude Odds Ratio (95% CI)**	**Crude OR p-value**
Cough >2 weeks							
No	25400 (92.70)	2742 (91.95)	21 (65.63)	Reference		Reference	
Yes	2000 (7.30)	240 (8.05)	11 (34.38)	1.11 (0.96, 1.27)	0.16	6.58 (3.17, 13.67)	<.0001
Fever >2 weeks							
No	26590 (97.04)	2859 (95.88)	22 (68.75)	Reference		Reference	
Yes	810 (2.96)	123 (4.12)	10 (31.25)	1.40 (1.15, 1.70)	0.0007	14.35 (6.78, 30.38)	<.0001
Night Sweats >2 weeks							
No	25851 (94.35)	2734 (91.68)	21 (65.63)	Reference		Reference	
Yes	1549 (5.65)	248 (8.32)	11 (34.38)	1.50 (1.31, 1.73)	<.0001	8.33 (4.01, 17.31)	<.0001
Weight Loss							
No	25008 (91.31)	2595 (87.02)	14 (43.75)	Reference		Reference	
Yes	2380 (8.69)	387 (12.98)	18 (56.25)	1.56 (1.39, 1.75)	<.0001	12.83 (6.37, 25.81)	<.0001
Number of Symptoms Indicating Presumptive TB‡							
0	23052 (84.1)	2376 (79.7)	8 (25.0)	Reference		Reference	
1	2862 (10.5)	372 (12.5)	12 (37.5)	1.26 (1.12, 1.41)	0.0001	11.80 (4.81, 28.88)	<.0001
2	831 (3.0)	119 (4.0)	4 (12.5)	1.38 (1.14, 1.68)	0.001	13.39 (4.02, 44.53)	<.0001
3	405 (1.5)	72 (2.4)	2 (6.3)	1.72 (1.33, 2.21)	<.0001	13.33 (2.82, 62.93)	0.001
4	250 (0.9)	43 (1.4)	32 (0.1)	1.63 (1.17, 2.26)	0.003	65.09 (22.44, 188.76)	<.0001

‡Includes the sum of cough, fever, or night sweats lasting >2 weeks or any reported weight loss

Table 15. Results of a multivariable logistic regression model for HIV/TB coinfection-associated covariates among individuals in five South African correctional facilities (N=30459)

	HIV Only vs Neither HIV nor TB		Coinfection v. Neither HIV nor TB	
	Adjusted Odds Ratio* (95% CI)	**Adjusted OR p-value**	**Adjusted Odds Ratio (95% CI)**	**Adjusted OR p-value**
Gender				
Male	Reference		Reference	
Female	2.12 (1.85, 2.43)	<.0001	3.53 (1.22, 10.21)	0.02
Duration of Incarceration				
Less than 1 year	2.19 (1.91, 2.51)	<.0001	3.69 (0.86, 15.59)	0.08
1-2 years	1.28 (1.07, 1.54)	0.008	1.84 (0.31, 11.04)	0.51
3+ years	Reference		Reference	
Number of Symptoms Indicating Presumptive TB†				
0	Reference		Reference	
1	1.36 (1.21, 1.53)	<.0001	13.12 (5.34, 32.20)	<.0001
2+	1.70 (1.46, 1.97)	<.0001	26.68 (10.79, 65.98)	<.0001

*Odds ratios are in comparison to the reference group, defined as those with neither known HIV nor known TB.

†Includes the sum of cough, fever, or night sweats lasting >2 weeks or any reported weight loss

Study ID Number/Participant Sputum Number: AUR6-10-117- -
Protocol Number - Site code - Participant Number

Date of Screening/Enrolment: / /
dd/MMM/yyyy

EL001: DCS TB Study Eligibility and Enrolment

Instructions: Complete this CRF for everyone, regardless of whether or not they provide a sputum specimen.

1. Prisoner number: .....
2. Unit/cell block: .....
3. Gender: ..... *1= Male, 2 =Female*
4. Age: ..... *in years*
5. Duration of incarceration to date: ..... *in years*
6. Ethnic group: .....
   1 = Black/African; 2 = Coloured; 3 = Indian/Asian; 4 = White/European; 9 = Other
7. Basis for screening? .....
   1 = New admission; 2 = Currently incarcerated; 3 = Referred from ART/TB clinic; 4 = Referred by inmate; 9 = Other
8. Is this inmate currently on, or have they been on TB treatment in the last 3 months? ..... *1=Yes, 0=No*
9. Does this person have cough? ..... *1=Yes, 0=No*

   9a. Cough duration: ..... *1=Less than 1 week, 2=1-2 Weeks, 3=More than 2 weeks*
10. Does this person have fever? ..... *1=Yes, 0=No*

    10a. Fever duration: ..... *1=Less than 1 week, 2=1-2 Weeks, 3=More than 2 weeks*
11. Does this person have night sweats? ..... *1=Yes, 0=No*

    11a. Night sweats duration: ..... *1=Less than 1 week, 2=1-2 Weeks, 3=More than 2 weeks*
12. Does this person have weight loss? ..... *1=Yes, 0=No*

    12a. Weight loss duration: ..... *1=Less than 1 week, 2=1-2 Weeks, 3=More than 2 weeks*

If answered No to ALL of questions 8-12 sputum not needed form is complete.
If answered YES to ANY of questions 8-12 sputum specimen is needed.

13 Did this person provide a sputum specimen? ..... *1=Yes, 0=No*

Completed By: Entered By: Date Entered: / /

Study ID Number/Participant Sputum Number: AUR6-10-117-☐☐☐-☐☐☐☐☐
Protocol Number - Site code - Participant Number

Date of Screening/Enrolment: ☐☐/☐☐☐/☐☐☐☐
dd/MMM/yyyy

THE AURUM INSTITUTE

EL002: DCS HIV Counseling and Testing

Instructions: Complete this CRF for all people who screen for the study, regardless of whether or not they provide a sputum specimen.

1. Prisoner number: ☐☐☐☐☐☐☐☐☐
2. Unit/cell block: ☐☐☐☐☐☐☐
3. Gender: *1= Male, 2 =Female* ☐
4. Age: *in years* ☐☐
5. Duration of incarceration to date: *in years* ☐☐
6. Ethnic group: ☐
   1 = Black/African
   2 = Coloured
   3 = Indian/Asian
   4 = White/European
   9 = Other, Specify: _____
7. Does this person consent to a blood test for HIV? *1=Yes, 0=No* ☐
8. First HIV screening results: ☐
   1 = Positive
   2 = Negative
   3 = Inconclusive
   4 = Refused

If Negative or Refused, go to question 9.

   8a. HIV Second screening results: ☐
   1 = Positive
   2 = Negative
   3 = Inconclusive
   4 = Refused

   8a. Was specimen taken for HIV ELISA? *1=Yes, 0=No* ☐

9. What was final result given to person? ☐
   1 = Positive
   2 = Negative
   3 = Inconclusive
   4 = Refused
10. Was this person referred? *1=Yes, 0=No* ☐

Completed By: ☐☐ Entered By: ☐☐ Date Entered: ☐☐/☐☐☐/☐☐☐☐