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Prevalence of Tuberculosis and Human Immunodeficiency Virus in Zambian correctional facilities

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1 Prevalence of Tuberculosis and Human Immunodeficiency 2 Virus in Zambian correctional facilities

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4 Mary Kagujje ([0000-0003-4818-6548](tel:0000-0003-4818-6548))¹, Sisa Hatwiinda¹, Paul Somwe², Joel Bwalya², Tamala
5 Zgambo³, Moomba Thornicroft¹, Fiammetta Bozzani⁴, Clement Nchimunya Moonga¹, Monde
6 Muyoyeta¹

7 Author affiliations

- 8 1. Tuberculosis department, Centre for Infectious Disease Research in Zambia, P.O. Box 34681
9 Lusaka, Zambia 10101
- 10 2. Strategic Information department, Centre for Infectious Disease Research in Zambia, P.O. Box
11 34681 Lusaka, Zambia 10101
- 12 3. Zambia Correctional Service, P.O. Box 80926 Kabwe, Zambia 10101
- 13 4. London School of Hygiene and Tropical Medicine, Keppel Street London WC1E 7HT, United
14 Kingdom

15
16 Correspondence to Mary Kagujje; mkagujje@gmail.com

17
18 **Key words:** Correctional facilities, Tuberculosis, HIV, Zambia

21 ABSTRACT

22 **Objective:** To determine the prevalence of Tuberculosis (TB) and Human Immunodeficiency
23 virus (HIV) in Zambian correctional facilities.

24 **Methods:** Cross sectional study

25 **Setting:** 13 correctional facilities in 7 of the 10 provinces in Zambia.

26 **Participants:** All incarcerated individuals were eligible for TB and HIV screening and testing.
27 Of the total population of 9,699 individuals, 8,271 and 8,164 were screened for TB and HIV
28 respectively.

29 **Interventions:** Mass and entry screening in correctional facilities was done between July 2018
30 and February 2019.

31 **Primary outcome measures:** All forms of TB, bacteriologically confirmed TB, drug resistant
32 TB, HIV

33 **Results:** Prevalence of all forms of TB and bacteriologically confirmed TB was 1598 per
34 100,000 population and 1056 per 100,000 population, respectively. Among those with
35 bacteriologically confirmed TB, 4.6% had drug resistant TB. The prevalence of HIV was 14.3%.

36 **Conclusion:** Prevalence of all forms of TB and HIV in correctional facilities has reduced by
37 about 75% and 8.6% respectively. However, the prevalence of all forms of TB and HIV was 3.5
38 and 1.3 times higher than in the general population, respectively. TB/HIV programs in
39 correctional facilities need further strengthening.

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5 40 **ARTICLE SUMMARY**
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9 41 **Strengths and limitations of this study**
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- 11 42 • Results are generalisable as a large sample was screened.
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13 43 • Variations in TB screening algorithms could have underestimated TB prevalence.
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16 44 • Asymptomatic TB was not consistently screened for.
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46 INTRODUCTION

47 Globally, correctional facilities are disproportionately affected by tuberculosis (TB) and the
48 Human Immunodeficiency Virus (HIV). (1-3) In some correctional facilities: the prevalence of
49 TB has been reported to be up to 100 times higher than the prevalence in the general
50 population (1) while the prevalence of HIV has been reported to be up to 23 times higher
51 than the prevalence in the general population(3). Much as the living conditions in correctional
52 facilities perpetuate TB and HIV (4, 5), incarcerated people also often come from socio-
53 economically disadvantaged backgrounds where the burden of TB and HIV is already high. (1,
54 3)

56 The prevalence of all forms of TB in Zambian correctional facilities was 6,428 per 100,000
57 population, in 2011, which was 18 times higher than the national estimates. (6) In the same
58 study, 0.6% of those with bacteriologically confirmed TB had rifampicin-resistant TB and the
59 overall prevalence of HIV was 22.9%, which was 1.5 times the national prevalence.

61 Since the last documented prevalence survey, several interventions including test and treat
62 for HIV, health systems strengthening, nutritional support, entry TB and HIV screening, among
63 others, have been put in place to control the burden of TB and its associated risk factors in
64 Zambia correctional facilities. (7-10)

66 This study aimed to determine current prevalence of all forms of TB, bacteriologically
67 confirmed TB, and drug resistant (DR) TB and the prevalence of HIV in Zambian correctional
68 facilities.

69 **METHODS**

70 **Study design**

71 We present an analysis of cross-sectional programmatic data collected by the Elton John
72 Juvenile Offenders health (EJJOH) project during entry and mass screening of incarcerated
73 people. The EJJOH project was a health system strengthening project aimed at supporting
74 provision of holistic and integrated health services to juvenile offenders. While the project
75 primarily targeted juveniles, it extended support to incarcerated adults in relation to
76 infectious disease control. The project conducted a mass screening of inmates as part of its
77 baseline assessment and strengthened entry screening, a routine practice in correctional
78 facilities.

79 **Study setting and population**

80 Zambia has 87 correctional facilities with a total population of 21,000 incarcerated people.
81 (11) The data was collected between July 2018 and February 2019 in 13 correctional facilities
82 with a combined population of 9,699, representing 46.2% of the total correctional facility
83 population in Zambia. The 13 facilities include Lusaka Central, Kamwala Remand, Livingstone
84 Central, Katombora Reformatory School, Nakambala Approved school, Mukobeko Medium,
85 Ndola remand, Kamfinsa State, Chingola, Insakwe Approved School, Chipata Central, Mongu
86 Central and Kasama Central (locations shown in Supplementary Figure 1). The Reformatory
87 and approved schools hold juveniles (persons less than 19 years old)(12); the other facilities
88 are intended only for adults and circumstantial children(13) but also hold juveniles who are
89 still undergoing trial.

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6 91 Routinely, incarcerated people undergo TB screening and HIV testing at entry or within 7 days
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8 92 of admission into correctional facilities. Depending on availability of logistics, periodic TB and
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10 93 HIV mass screening are carried out, with freedom to opt out of HIV testing but not TB
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12
13 94 screening and testing.
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19 96 **Study Procedures**

23 97 A project specific register was used; it was a modification of the National Presumptive TB
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25 98 register with additional data elements on entry point, category of individual and previous
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28 99 history of TB. All inmates were screened for TB; those who did not opt out were tested for
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30 100 HIV. The screening entry point was documented under one of the following: mass screening,
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32 101 entry screening from the community or entry screening transfer from other correctional
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34
35 102 facility. The categories of individuals included adults, juveniles and circumstantial children.
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37 103 Those already on anti-TB treatment at the time of screening were documented as TB cases
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39 104 and those on anti-retroviral therapy (ART) were recorded as HIV positive; they were not
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42 105 retested. Those with cough, fever, weight loss, night sweats, chest pain and shortness of
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45 106 breath, irrespective of duration, were considered presumptive TB patients and submitted
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47 107 sputum for testing using GeneXpert (Xpert MTB/Rif Assay. Cepheid, Sunnyvale, California,
48
49 108 USA). Symptomatic individuals with a negative GeneXpert were referred for Chest x-ray (CXR)
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51
52 109 depending on the clinician's discretion. There were 3 variations to this algorithm: 1) In Lusaka
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55 110 central, a random proportion of the incarcerated population received CXR in addition to
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57 111 symptoms screening and those with either abnormal CXR or symptoms submitted sputum for
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59 112 GeneXpert; 2) at Ndola remand, all except those already on TB treatment submitted sputum
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3 113 irrespective of symptoms; and 3) in Kabwe medium, Fluorescent Microscopy (FM) was used
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6 114 for sputum examination instead of GeneXpert.
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10 116 Alere Determine™ HIV-1/2 test (AlereHIV-1/2; Abbott, Chicago, IL, USA) was used for HIV
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13 117 screening and SD-Bioline HIV-1/2 (SD-Bioline HIV-1/2; Abbott, Chicago, IL, USA) for
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15 118 confirmation of positive screening test, following the standard Zambian HIV testing algorithm.

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18 119 All individuals received pre- and post-test HIV counselling. HIV positive inmates were
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20 120 commenced on ART within 1-2 days.
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23 24 121 **Data analysis**

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28 122 STATA Statistical Software (Stata Corporation Version 14. College Station, Texas 77845, USA)
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30 123 was used for data analysis. A descriptive analysis was done to determine the characteristics
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32 124 of the population screened and the prevalence of TB and HIV; overall prevalence and
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35 125 prevalence among subgroups was determined. The prevalence of all forms of TB included
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37 126 bacteriologically confirmed TB and clinically diagnosed TB. Bacteriologically confirmed TB
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39 127 prevalence included those who had a positive GeneXpert or FM result, while patients already
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42 128 on TB treatment at time of screening were excluded from this analysis since data on the type
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45 129 of TB had not been collected. DR-TB prevalence included incarcerated people with rifampicin
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47 130 resistance on GeneXpert. Missing data was excluded from the analysis.
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51 131 Additionally, a chi-square test was done to determine if there was a statistically significant
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53 132 difference in prevalence of TB and HIV between residents and new entrants into correctional
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55 133 facilities. New entrants were defined as incarcerated people whose entry point was entry
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3 134 screening from community while residents were defined as those whose entry point was
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6 135 either mass screening or entry screening transfer from other correctional facility.
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9 **136 Ethical issues**
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13 137 Approval to use the programmatic data was obtained from the University of Zambia
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15 138 Biomedical Research Ethics Committee No: 018-11-18 and the London School of Hygiene and
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18 139 Tropical Medicine Ethics Committee No: 21332. The EJJOH project had obtained permission
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20 140 from the Zambia Correctional service and the Ministry of Community Development and Social
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23 141 services to conduct the screening activities. When migrating data from the paper-based
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25 142 registers to the electronic database, participant identifying information was excluded.
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29 **143 Patient and Public involvement**
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33 144 The development of the research questions was intended to inform priority setting by the
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35 145 EJJOH project based on the disease burden in correctional facilities. The incarcerated
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38 146 population were not involved in the design of the project. The correctional health committee
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40 147 constituting of the incarcerated persons, correctional officers and health care workers were
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43 148 involved in the data collection. A representative of the correctional health committee at each
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45 149 correctional facility participated in the dissemination meeting on project findings.
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53 **152 RESULTS**
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58 **153 Flow diagram and participant characteristics**
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3 154 Of the total population of 9,699 in the 13 correctional facilities, 8164 (84.2%) were screened
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6 155 for HIV and 8,271(85.3%) individuals were screened for TB (Figure 1). Of those screened for
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8 156 HIV, 1170(14.3%) were HIV positive while 6994 were HIV negative. Of those screened for TB,
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10 157 3,085 (37.3%) individuals had symptoms of TB, 5,173 (62.5%) were asymptomatic while 13
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13 158 (0.2%) had missing data. Of the 4,278, who submitted sputum, 3,085 (72.1%) were
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15 159 symptomatic and 1,193 (27.9%) were asymptomatic for TB. Of the asymptomatic who
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17 160 submitted sputum 25(2.1%) were bacteriologically confirmed while of the symptomatic,
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19 161 62(2.0%) submitted sputum. A total of 132 TB cases were identified including 87 (65.9%)
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21 162 bacteriologically confirmed TB cases, 28 (21.2%) clinically diagnosed TB cases and 17 (12.9%)
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23 163 that were already on TB treatment at the time of screening.
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28 164 Figure 1: Flow diagram of TB screening and diagnosis
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33 166 Of those screened, 7,805 (94.37%) were adults, 462 (5.59%) were juveniles while 4 (0.05%)
34
35 167 were circumstantial children (Table 1). The overall median age (interquartile range (IQR)) of
36
37 168 the participants was 32 years (IQR 10-93); 8,181 (98.75%) of the participants were male and
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39 169 467 (5.65%) of the participants had a history of previous TB. Among those screened, 8099
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41 170 (97.92%) were resident inmates while 169 (2.04%) were new entrants.
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45 171 Table 1: Characteristics of population screened
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Variable	Participants (n= 8271)
Category of individual, n (%)	
Adults	7,805 (94.37%)
Juveniles	462 (5.59%)
Circumstantial children	4 (0.05%)
Median Age (interquartile range)	
Overall	32(10-93)

Adults	33 (19-93)
Juveniles	17 (10-18)
Circumstantial children ¹	
Sex, n (%)	
Male	8,168 (98.75%)
Female	92 (1.11%)
Missing	11 (0.13%)
History of previous TB, n (%)	
Yes	467 (5.65%)
No	7,790 (94.18%)
Missing	14 (0.17%)
Type of screening visit, n (%)	
Mass screening	7,602 (91.92%)
Entry screening other correctional facility	497 (6.01%)
Entry screening community	169 (2.04%)
Missing	3 (0.03%)

¹ Ages of circumstantial children were missing.

Prevalence of all forms of TB and bacteriologically confirmed TB

The overall prevalence of all forms of TB was 1,598 (1339-1892) per 100,000 population while the overall prevalence of bacteriologically confirmed TB was 1,056 (844-1301) per 100,000 population (Table 2). There was no statistically significant difference in the prevalence of both all forms of TB and bacteriologically confirmed TB between males and females ($p=0.51$) and ($p=1.00$) respectively. It was the same for adults and juveniles ($p= 0.82$) and ($p= 0.23$) for the respective types of TB. There were no prevalent TB cases among circumstantial children.

Table 2: Prevalence of all forms of TB and bacteriologically confirmed TB

	Cases/ Participants (n/N)	Prevalence of all forms of TB per 100,000 (CI)	p- value	Cases/ Participants (n/N)	Prevalence of Bacteriologically confirmed TB per 100,000 (CI)	p- value
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Overall	132/8,258 ²	1598 (1339-1892)		87/8,241 ^{2,3}	1056 (844-1301)	
Sex						
Male	129/8,155	1582 (1322-1877)	0.51	84/8,138	1032 (824-1276)	1.00
Female	1/92	1087 (27- 5908)		1/92	1087 (27- 5908)	
Missing gender	2/11			2/11		
Category of individual						
Adult inmate	124/7,792	1591 (1325- 1894)	0.82	79/7,775	1016 (805-1265)	0.23
Juvenile inmate	8/462	1732 (750-3383)		8/462	1732 (750-3383)	
Circumstantial children	0/4	0 (0-60236) *		0/4	0 (0-60236) *	

² Thirteen (13) participants had missing values on TB.

³ Seventeen participants were already on TB treatment, bacteriological status unknown

(*) one-sided, 97.5% confidence interval

The differences in prevalence of all forms TB and bacteriologically confirmed TB between residents and new entrants in correctional facilities were not statistically significant ($p=0.25$) and ($p=0.21$) respectively (Supplemental Table 1).

Prevalence of DR TB

Among the bacteriologically confirmed TB cases, the overall prevalence of DR-TB was 4.6% (1.3%-11.4%) (Table 3). There was no statistically significant difference in prevalence of DR-TB between males and females ($p=0.95$), between adults and juveniles ($p=0.68$) and between those with and those without previous history of TB ($p=0.72$).

Table 3: Prevalence of drug resistant TB

	Cases/ Participants (n/N)	Prevalence of DR TB % (CI)	p-value
Overall	4/87	4.6 (1.3-11.4)	
Sex			
Male	4/84	4.8 (1.3-11.7)	0.95
Female	0/1	0 (0- 97.5) *	
Missing	0/2		
Category of individual			
Adult incarcerated people	4/79	5.1 (1.4- 12.5)	0.68
Juveniles	0/8	0 (0-3.7) *	
Circumstantial children	0/0	0	
Previous History of TB			
No	3/64	4.7 (1.0-13.1)	0.72
Yes	1/23	4.3 (0.1- 21.9)	

* one-sided, 97.5% confidence interval

There was no statistically significant difference in prevalence of DR TB between resident incarcerated people and new entrants into correctional facilities (p= 0.26).

Prevalence of HIV

The overall HIV prevalence was 14.3% (13.6%-15.1%) (Table 4). The prevalence of HIV among males was 14.1% (13.4%-14.9%) and among females 25.0% (16.6%-35.1%) (p=0.01). The prevalence of HIV among adults and juveniles was 15.0% (14.1%-15.7%) and 3.9% (2.3%-6.2%) (p<0.01). There were no prevalent HIV cases among circumstantial children.

Table 4: Prevalence of HIV

	Cases/ (n/N)	Participants	Prevalence of HIV % (CI)	p-value
Overall	1,170/8,164 ^d		14.3 (13.6-15.1)	
Sex				

Male	1,139/8,062	14.1 (13.4-14.9)	0.01
Female	23/92	25.0 (16.6-35.1)	
Missing sex	8/10		
Category of individual			
Adults	1,153/7,727	15.0 (14.1-15.7)	0.00
Juveniles	17/433	3.9 (2.3- 6.2)	
Circumstantial children	0/4	0 (0-60.2) *	

⁴ One hundred and seven (107) participants either opted out of HIV testing or had missing data (*) one-sided, 97.5% confidence interval.

** not determined.

The differences in prevalence of HIV between residents and new entrants into correctional facilities were not statistically significant ($p=0.05$) (Supplemental Table 1).

DISCUSSION

This study found that in Zambian correctional facilities, the prevalence of all forms of TB, bacteriologically confirmed TB and DR-TB were 3.5 times higher, 1.7 times higher and almost twice as high as in the general population, respectively. (14, 15) Additionally, the prevalence of HIV was 1.3 times higher than the prevalence in the general population (16). 25.8% of the bacteriologically confirmed TB cases were asymptomatic.

In comparison to the 2010-2011 study, the prevalence of all forms of TB had reduced by about 75%, the prevalence of bacteriologically confirmed TB has reduced by 50% but the prevalence of DR-TB has increased by 4%. (6) The prevalence of DR-TB among people with no history of TB is similar to the prevalence among people with previous history of TB, suggesting

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3 226 significant transmission of DR-TB either in correctional facilities or in the communities where
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6 227 the incarcerated people come from, or both. Strengthening TB infection control can reduce
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8 228 transmission of DR-TB. (17) There has been an 8.6% reduction in prevalence of HIV since the
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10 229 study in 2010-2011. (6) Similar to the national picture, the prevalence of HIV was higher
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13 230 among adults than juvenile incarcerated people and was higher among females than males.
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15 231 (16) However, the prevalence of HIV in women relative to the prevalence of HIV in men is
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17 232 much higher in the incarcerated population than the general population because women with
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19 233 HIV risk factors like sex worker status, intimate partner violence, drug and substance abuse
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21 234 are overrepresented in this population. (18)
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27 236 The difference in prevalence of TB and HIV between residents and new entrants into
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29 237 correctional facilities was not statistically significant. This is possibly due to the following
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31 238 reasons: a) individuals entering correctional facilities come from socio-economically
32
33 239 disadvantaged backgrounds where prevalence of TB and HIV are already high (1); b) there are
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35 240 high rates of recidivism (19); and c) detainees spend long periods in police cells, which have
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37 241 similar conditions to the correctional facilities (20, 21).
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44 243 The results of our study are generalizable to all correctional facilities in Zambia, as a large
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46 244 sample of the inmate population, representing 36.3% of the total correctional facility
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48 245 population, was screened.(11) However, there were variations in the strength of screening
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50 246 algorithms for TB, hence the prevalence of TB could have been underestimated in some
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52 247 correctional facilities. Additionally, asymptomatic TB was not consistently screened for.
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248 CONCLUSION

249 Despite significant progress over the last decade in controlling TB and HIV in Zambian
 250 correctional facilities, these continue to be disproportionately affected by both diseases.
 251 TB/HIV programs in correctional facilities need further strengthening including aspects of
 252 gender responsive HIV programming. Additional studies that screen for asymptomatic TB are
 253 required.

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313 showing study sites.
314

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318 AUTHOR CONTRIBUTIONS

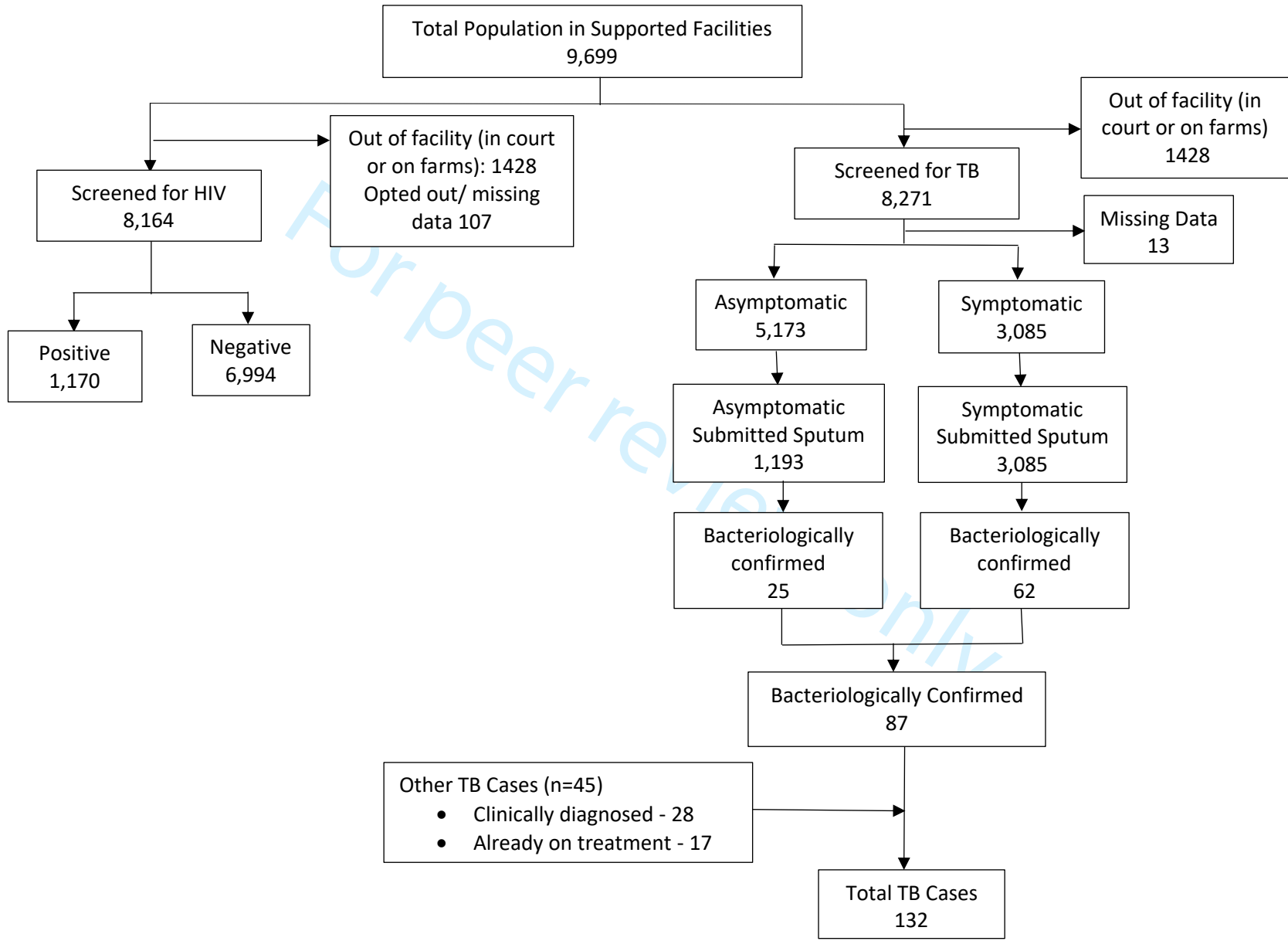
319 Conceived and designed the study: MK, SH, CNM, MM. Database design and data curation:
320 PS, JB. Implemented the study: MK, SH, MT, TZ, CNM, MM. Data analysis: PS, MK, FB. Wrote
321 the original draft: MK. Reviewed the manuscript: SH, MT, JB, PS, TZ, FB, CNM, MM. Approved
322 the final version to be published: MK, SH, PS, MT, JB, TZ, FB, CNM, MM.
323 The corresponding author attests that all listed authors meet authorship criteria and that no
324 others meeting the criteria have been omitted.

326 CONFLICT OF INTEREST

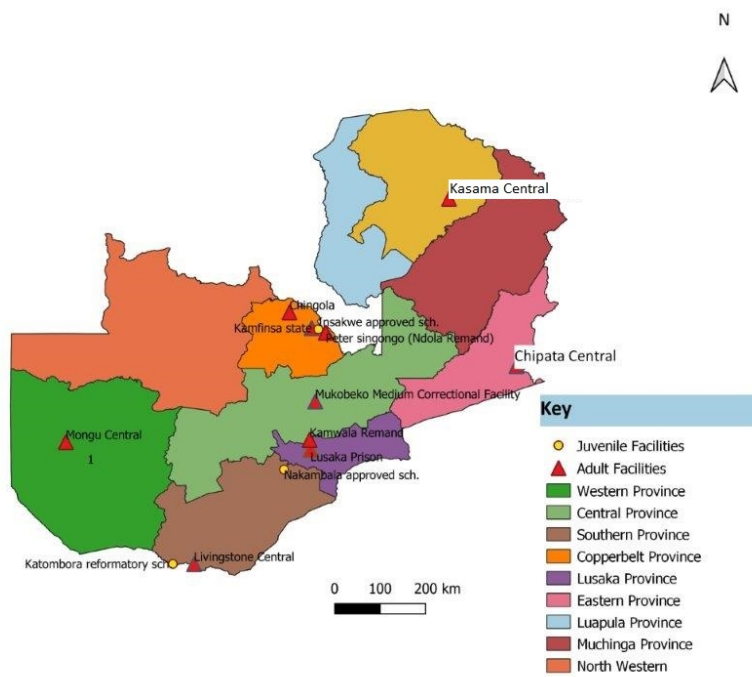
327 The authors declare no conflict of interest.

329 DATA SHARING STATEMENT

330 Additional data is available upon request by emailing Monde.Muyoyeta@cidrz.org



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Supplementary Table 1: Difference in prevalence of TB and HIV between resident incarcerated people and new entrants

Type of TB	Cases/ Participants (n/N)	Residents	Cases/ Participants (n/N)	New Entrants	P- value
All forms TB prevalence per 100,000 per 100,000 population (CI)	121/7,780	1555 (1280-1830)	11/496	2218 (917-3518)	0.25
Bacteriologically confirmed TB prevalence per 100,000 population (CI)	79/7,763	1018 (794- 1241)	8/496	1613 (500-2725)	0.21
DR TB prevalence	3/76	3.9 (0.8-10.7)	1/8	12.5 (0.4-52.7)	0.26
HIV prevalence % (CI)	1,119/7,722	14.5 (13.7-15.3)	52/462	11.3 (8.4-14.1)	0.05

STROBE Statement—Checklist of items that should be included in reports of *cross-sectional studies*

	Item No	Recommendation	Page No
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	2
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	3
Objectives	3	State specific objectives, including any prespecified hypotheses	3
Methods			
Study design	4	Present key elements of study design early in the paper	4
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	4,5
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants	5,6
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	5,6
Bias	9	Describe any efforts to address potential sources of bias	5
Study size	10	Explain how the study size was arrived at	5
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	6
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	6
		(b) Describe any methods used to examine subgroups and interactions	6
		(c) Explain how missing data were addressed	6
		(d) If applicable, describe analytical methods taking account of sampling strategy	
		(e) Describe any sensitivity analyses	
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	8
		(b) Give reasons for non-participation at each stage	8
		(c) Consider use of a flow diagram	8
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	8,9
		(b) Indicate number of participants with missing data for each variable of interest	9-12
Outcome data	15*	Report numbers of outcome events or summary measures	9-12
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	

		(b) Report category boundaries when continuous variables were categorized	9-12
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	9-12
Discussion			
Key results	18	Summarise key results with reference to study objectives	12
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	13
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	12-13
Generalisability	21	Discuss the generalisability (external validity) of the study results	13
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	15

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at www.strobe-statement.org.

BMJ Open

A cross sectional assessment of Tuberculosis and Human Immunodeficiency Virus prevalence in 13 correctional facilities in Zambia

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4 1 **A cross sectional assessment of Tuberculosis and Human**
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8 3 **facilities in Zambia**
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12 5 Mary Kagujje ([0000-0003-4818-6548](tel:0000-0003-4818-6548))¹, Paul Somwe², Sisa Hatwiinda¹, Joel Bwalya², Tamala
13
14 6 Zgambo³, Moomba Thornicroft¹, Fiammetta Bozzani⁴, Clement Nchimunya Moonga¹, Monde
15
16 7 Muyoyeta¹
17
18
19

20 8 **Author affiliations**

- 21
22 9 1. Tuberculosis department, Centre for Infectious Disease Research in Zambia, P.O. Box 34681
23
24 10 Lusaka, Zambia 10101
25
26 11 2. Strategic Information department, Centre for Infectious Disease Research in Zambia, P.O. Box
27
28 12 34681 Lusaka, Zambia 10101
29
30 13 3. Zambia Correctional Service, P.O. Box 80926 Kabwe, Zambia 10101
31
32 14 4. London School of Hygiene and Tropical Medicine, Keppel Street London WC1E 7HT, United
33
34 15 Kingdom
35
36
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41 17 Correspondence to Mary Kagujje; mkagujje@gmail.com
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46 19 **Key words:** Correctional facilities, Tuberculosis, HIV, Zambia
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22 ABSTRACT

23 **Objective:** To determine the prevalence of Tuberculosis (TB) and Human Immunodeficiency
24 virus (HIV) in 13 Zambian correctional facilities.

25 **Methods:** Cross sectional study

26 **Setting:** 13 correctional facilities in 7 of the 10 provinces in Zambia.

27 **Participants:** All incarcerated individuals were eligible for TB and HIV screening and testing.

28 Of the total study population of 9,695 individuals, which represent 46.2% of total correctional
29 population at the beginning of the study, 8,267 and 8,160 were screened for TB and HIV
30 respectively.

31 **Interventions:** TB and HIV screening and testing was done between July 2018 and February
32 2019.

33 **Primary outcome measures:** All forms of TB, bacteriologically confirmed TB, drug resistant
34 TB, HIV

35 **Results:** Prevalence of all forms of TB and bacteriologically confirmed TB was 1598 per
36 100,000 population and 1056 per 100,000 population, respectively. Among those with
37 bacteriologically confirmed TB, 4.6% had drug resistant TB. The prevalence of HIV was 14.3%.

38 **Conclusion:** Compared to the study in 2011 which screened inmates representing 30% of the
39 country's inmate population then, the prevalence of all forms of TB and HIV in correctional
40 facilities has reduced by about 75% and 8.6% respectively. However, compared to the general
41 population, the prevalence of all forms of TB and HIV was 3.5 and 1.3 times higher,
42 respectively. TB/HIV programs in correctional facilities need further strengthening.

ARTICLE SUMMARY

Strengths and limitations of this study

- This is the only study on prevalence of TB and HIV in Zambian correctional facilities in the past 8 years.
- Results are generalisable to the 13 correctional facilities as a large sample was screened for TB and HIV.
- Data disaggregates can inform targeted interventions to reduce the burden of both diseases.
- Variations in TB screening algorithms could have underestimated TB prevalence.
- Asymptomatic TB was not consistently screened for.

54 INTRODUCTION

55 Globally, correctional facilities are disproportionately affected by tuberculosis (TB) and the
56 Human Immunodeficiency Virus (HIV). (1-3) In some correctional facilities: the prevalence of
57 TB has been reported to be up to 100 times higher than the prevalence in the general
58 population (1) while the prevalence of HIV has been reported to be up to 23 times higher
59 than the prevalence in the general population(3). The poor living conditions in correctional
60 facilities perpetuate TB and HIV. While overcrowding, poor ventilation, HIV, poor nutrition
61 and late case detection perpetuate TB; sexual violence, sharing of sharp objects and lack of
62 access to condoms perpetuate HIV. (4, 5) Additionally, incarcerated people often come from
63 socio-economically disadvantaged backgrounds where the burden of TB and HIV is already
64 high. (1, 3)

65
66 In 2011, the prevalence of all forms of TB in 6 Zambian correctional facilities representing 30%
67 of the total incarcerated population was 6,428 per 100,000 population, which was 18 times
68 higher than the national estimates. (6) In the same study, 0.6% of those with bacteriologically
69 confirmed TB had rifampicin-resistant TB and the overall prevalence of HIV was 22.9%, which
70 was 1.5 times the national prevalence.

71
72 Since the last documented prevalence survey, several interventions including test and treat
73 for HIV, health systems strengthening, nutritional support, TB and HIV entry screening, among
74 others, have been put in place to control the burden of TB and its associated risk factors in
75 Zambia correctional facilities. (7-10)

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3 77 This study aimed to determine current prevalence of all forms of TB, bacteriologically
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5 78 confirmed TB, and drug resistant (DR) TB and the prevalence of HIV in 13 Zambian correctional
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8 79 facilities.
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10 11 12 80 **METHODS** 13 14 15

16 17 81 **Study design** 18 19

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21 82 We present an analysis of cross-sectional data collected under programmatic conditions by
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23 83 the Elton John Juvenile Offenders' health (EJJOH) project. The EJJOH project was a health
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25 84 system strengthening project aimed at supporting provision of holistic and integrated health
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27 85 services to juvenile offenders. While the project primarily targeted juveniles, where these
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29 86 were held in adults' facilities, support was extended to incarcerated adults in relation to
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31 87 infectious disease control. The project screened as part of its baseline assessment.
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36 37 88 **Study setting and population** 38 39

40
41 89 Zambia has 87 correctional facilities with a total capacity of 9,150 incarcerated individuals.
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43 90 (11) However, the total incarcerated population in Zambia was slightly over 21,000 in 2018
44
45 91 and 22,823 in 2019. In 2019, almost one in five individuals detained was in pre-trial detention.
46
47 92 (11) The data was collected between July 2018 and February 2019 in 13 correctional facilities
48
49 93 with a combined population of 9,695, representing 46.2% of the total correctional facility
50
51 94 population in Zambia in 2018. The 13 correctional facilities had been purposefully selected by
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53 95 the EJJOH project because they held a significant number of juveniles. The facilities include;
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55 96 Lusaka Central, Kamwala Remand, Livingstone Central, Katombora Reformatory School,
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3 97 Nakambala Approved school, Mukobeko Medium, Ndola remand, Kamfinsa State, Chingola,
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5 98 Insakwe Approved School, Chipata Central, Mongu Central and Kasama Central (locations
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8 99 shown in Supplementary Figure 1). The Reformatory and approved schools hold ordered
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10 100 (convicted) juveniles (persons less than 19 years old)(12); the other facilities are intended only
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13 101 for adults and circumstantial children(13) but also hold juveniles who are still undergoing
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15 102 trial.

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20 104 Across Zambia, routinely, incarcerated people should undergo universal TB screening and HIV
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22 105 testing at entry or within 7 days of admission into correctional facilities. However, in some
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24 106 facilities entry screening is not done due to various constraints. Depending on availability of
25
26 107 logistics, periodic TB and HIV mass screening are carried out, with freedom to opt out of HIV
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28 108 testing but not TB screening and testing. TB screening is mandatory to increase early TB
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30 109 detection and treatment so as to protect other inmates from TB.

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36 37 38 111 **Study Procedures**

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42 112 A project specific register was used; it was a modification of the National Presumptive TB
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44 113 register with additional data elements on entry point, category of individual and previous
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46 114 history of TB. All inmates were screened for TB; those who did not opt out were tested for
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48 115 HIV. The screening point was documented under one of the following categories: mass
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50 116 screening, entry screening from the community or entry screening transfer from other
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52 117 correctional facility. The categories of individuals included adults and juveniles. Those already
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54 118 on anti-TB treatment at the time of screening were documented as TB cases and those on
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56 119 anti-retroviral therapy (ART) were recorded as HIV positive and were not retested. Those with

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3 120 cough, fever, weight loss, night sweats, chest pain and shortness of breath, irrespective of
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6 121 duration, were considered presumptive TB patients and submitted sputum for testing using
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8 122 GeneXpert (Xpert MTB/Rif Assay. Cepheid, Sunnyvale, California, USA). Symptomatic
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10 123 individuals with a negative GeneXpert were referred for Chest x-ray (CXR) depending on the
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13 124 clinician's discretion. There were 3 variations to this algorithm: 1) In Lusaka central, a random
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15 125 proportion of the incarcerated population received CXR in addition to symptoms screening
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17 126 and those with either abnormal CXR or symptoms submitted sputum for GeneXpert; 2) at
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20 127 Ndola remand, all except those already on TB treatment submitted sputum irrespective of
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23 128 symptoms; and 3) in Kabwe medium, Fluorescent Microscopy (FM) was used for sputum
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25 129 examination instead of GeneXpert.

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30 131 Alere Determine™ HIV-1/2 test (AlereHIV-1/2; Abbott, Chicago, IL, USA) was used for HIV
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32 132 screening and SD-Bioline HIV-1/2 (SD-Bioline HIV-1/2; Abbott, Chicago, IL, USA) for
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34 133 confirmation of positive screening test, following the standard Zambian HIV testing algorithm.
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37 134 All individuals received pre- and post-test HIV counselling. HIV positive inmates were
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40 135 commenced on ART within 1-2 days.

41 42 43 136 **Data analysis**

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47 137 STATA Statistical Software (Stata Corporation Version 14. College Station, Texas 77845, USA)
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49 138 was used for data analysis. A descriptive analysis was done to determine the characteristics
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51 139 of the population screened and the prevalence of TB and HIV; overall prevalence and
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53 140 prevalence among subgroups was determined. The prevalence of all forms of TB included
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55 141 bacteriologically confirmed TB and clinically diagnosed TB. Bacteriologically confirmed TB
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58 142 prevalence included those who had a positive GeneXpert or FM result, while patients already
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3 143 on TB treatment at time of screening were excluded from this analysis since data on the type
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5 144 of TB had not been collected. DR TB prevalence included incarcerated people with rifampicin
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8 145 resistance on GeneXpert. Missing data was excluded from the analysis.
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11 146 Additionally, a chi-square test was done to determine if there was a statistically significant
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13 147 difference in prevalence of TB and HIV between residents and new entrants into correctional
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15 148 facilities. New entrants were defined as incarcerated people whose entry point was entry
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17 149 screening from community while residents were defined as those whose entry point was
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19 150 either mass screening or entry screening transfer from other correctional facility.
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24 25 151 **Patient and Public involvement**

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28 152 The development of the research questions was intended to inform priority setting by the
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30 153 EJJOH project based on the disease burden in correctional facilities. The incarcerated
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32 154 population were not involved in the design of the project. The correctional health committee
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34 155 constituting of the incarcerated persons, correctional officers and health care workers were
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36 156 involved in the data collection. A representative of the correctional health committee at each
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38 157 correctional facility participated in the dissemination meeting on project findings.
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46 47 159 **RESULTS**

48 49 160 **Flow diagram and participant characteristics**

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53 161 Of the total adult and juvenile population of 9,695 in the 13 correctional facilities, 8160
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55 162 (84.2%) were screened for HIV and 8,267(85.3%) were screened for TB (Figure 1). Individuals
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3 163 not screened were 1,428 (14.7%) and they constituted those either in court or the farms. Of
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6 164 those screened for HIV, 1170(14.3%) were HIV positive, of which 816 were known positive
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8 165 and 354 were new positives, while 6,990 (85.7%) were HIV negative. Of those screened for
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10 166 TB, 17(0.2%) were already on treatment, 3,076 (37.3%) individuals had symptoms of TB, 5,161
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12 167 (62.5%) were asymptomatic while 13 (0.2%) had missing data. A total of 4,269 individuals had
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14 168 documented sputum results. Eighty seven (87) bacteriologically confirmed TB cases were
15
16 169 reported including 25(28.7%) asymptomatic individuals 62(71.3%) symptomatic individuals. A
17
18 170 total of 132 TB cases were identified including 87 (65.9%) bacteriologically confirmed TB
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20 171 cases, 28 (21.2%) clinically diagnosed TB cases and the 17 (12.9%) that were already on TB
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22 172 treatment at the time of screening.

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27 173 Figure 1: Flow diagram of TB screening and diagnosis

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33 175 Of those screened, 7,805 (94.41%) were adults and 462 (5.58%) were juveniles (Table 1). The
34
35 176 overall median age (interquartile range (IQR)) of the participants was 32 years (IQR 10-93);
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37 177 the median ages for the adults and juveniles were 33(IQR 19-93) and 17(IQR 10-18)
38
39 178 respectively. The males were 8,167 (98.79%), participants with a history of previous TB were
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41 179 467 (5.65%), resident inmates were 7,767 (93.95%) while new entrants were 497 (6.01%).

42
43
44
45 180 Table 1: Characteristics of population screened

Variable	Participants (n= 8267)
Category of individual	n (%)
Adults	7,805 (94.41%)
Juveniles	462 (5.58%)
Median Age (IQR)	
Overall	32(10-93)
Adults (≥19 years)	33 (19-93)

Juveniles (<19 years)	17 (10-18)
Sex	n (%)
Male	8,167 (98.79%)
Female	89 (1.08%)
Missing	11 (0.13%)
History of previous TB	n (%)
Yes	467 (5.65%)
No	7,786 (94.18%)
Missing	14 (0.17%)
Type of screening visit	n (%)
Mass screening	7,602 (91.92%)
Entry screening other correctional facility	165 (2.00%)
Entry screening community	497 (6.01%)
Missing	3 (0.04%)

Abbreviations: IQR- Interquartile range, TB- Tuberculosis

Prevalence of all forms of TB and bacteriologically confirmed TB

The overall prevalence of all forms of TB was 1,598 (1339-1892) per 100,000 population while the overall prevalence of bacteriologically confirmed TB was 1,056 (844-1301) per 100,000 population (Table 2). There was no statistically significant difference in the prevalence of both all forms of TB and bacteriologically confirmed TB between males and females, ($p=0.51$) and ($p=1.00$) respectively. It was the same for adults and juveniles ($p= 0.82$) and ($p= 0.23$) respectively and the new entrants and residents ($p=0.25$) and ($p=0.21$) respectively.

Table 2: Prevalence of all forms of TB and bacteriologically confirmed TB

	Cases/ Participants (n/N)	Prevalence of all forms of TB per 100,000 (CI)	p- value	Cases/ Participants (n/N)	Prevalence of Bacteriologically confirmed TB per 100,000 (CI)	p- value
Overall	132/8,254 ¹	1599 (1340-1894)		87/8,237 ^{1,2}	1056 (847-1301)	

Sex						
Male	129/8,154	1582 (1322-1877)	0.60	84/8,137	1032 (824-1276)	0.79
Female	1/89	1124 (28- 6102)		1/89	1124 (28- 6102)	
Missing gender	2/11			2/11		
Category of individual						
Adult (≥19 years)	124/7,792	1591 (1325- 1894)	0.82	79/7,775	1016 (805-1265)	0.23
Juvenile (<19 years)	8/462	1732 (750-3383)		8/462	1732 (750-3383)	
Entry point ^{1,3}						
Residents	121/ 7757	1560 (1296- 1861)	0.25	79/7740	1020 (809-1270)	0.21
New entrants	11/494	2227 (1117-3949)		8/494	1619 (702-3166)	

Abbreviations: CI- Confidence interval, TB- Tuberculosis

Residents include those screened through mass screening and those under entry screening as a transfer from other correctional facility.

New entrants include those screened under entry screening from the community (police cells).

¹ Thirteen (13) participants had missing values on TB.

² Seventeen participants were already on TB treatment, bacteriological status unknown

³Three (3) participants had missing values on entry point

198 Prevalence of DR TB

199 Among the bacteriologically confirmed TB cases, the overall prevalence of DR TB was 4.6%
 200 (1.3%-11.4%) (Table 3). There was no statistically significant difference in prevalence of DR TB
 201 between males and females ($p=0.95$), between adults and juveniles ($p=0.68$), between those
 202 with and those without previous history of TB ($p=0.72$) and between the new entrants and
 203 residents($p=0.26$).

204 Table 3: Prevalence of drug resistant TB

	Cases/ Participants (n/N)	Prevalence of DR TB % (CI)	p-value
Overall	4/87	4.6 (1.3-11.4)	
Sex			
Male	4/84	4.8 (1.3-11.7)	0.95
Female	0/1	0 (0- 97.5) *	
Missing	0/2		
Category of individual			
Adults (≥19 years)	4/79	5.1 (1.4- 12.5)	0.68
Juveniles (<19 years)	0/8	0 (0-3.7) *	
Previous History of TB			
No	3/64	4.7 (1.0-13.1)	0.72
Yes	1/23	4.3 (0.1- 21.9)	
Entry point			
Residents	3/76	3.8 (0.8-10.7)	0.26
New entrants	1/8	12.5 (0.3-52.7)	

205 Abbreviations: DR TB- Drug Resistant Tuberculosis CI- Confidence interval
 206 Residents include those screened through mass screening and those under entry screening as a transfer from
 207 other correctional facility.
 208 New incarcerated individuals include those screened under entry screening from the community (police cells).
 209 * one-sided, 97.5% confidence interval
 210

211 Prevalence of HIV

212 The overall HIV prevalence was 14.3% (13.6%-15.1%) (Table 4). The prevalence of HIV among
 213 males was 14.1% (13.4%-14.9%) and among females 25.0% (16.6%-35.1%) ($p=0.01$). The
 214 prevalence of HIV among adults and juveniles was 15.0% (14.1%-15.7%) and 3.9% (2.3%-
 215 6.2%) ($p<0.01$) respectively. There was no statistically significant differences in prevalence of
 216 HIV between residents and new entrants ($p=0.05$).

217 Table 4: Prevalence of HIV

	Cases/ Participants (n/N)	Prevalence of HIV % (CI)	p-value
--	--------------------------------------	-------------------------------------	----------------

Overall	1,170/8,160 ^f	14.3 (13.6-15.1)	
Sex			
Male	1,139/8,061	14.1 (13.4-14.9)	0.00
Female	23/89	25.8 (17.4-36.2)	
Missing sex	8/10		
Category of individual			
Adults (≥19 years)	1,153/7,727	15.0 (14.1-15.7)	0.00
Juveniles (<19 years)	17/433	3.9 (2.3- 6.2)	
Entry point ^{1,2}			
Residents	1,118/7699	14.5(13.7-15.3)	0.06
New entrants	52/460	11.3 (8.6-14.6)	

218 Abbreviations: CI- Confidence interval, HIV- Human Immunodeficiency virus
 219 Residents include those screened through mass screening and those under entry screening as a transfer from
 220 other correctional facility. New incarcerated individuals include those screened under entry screening from the
 221 community (police cells).
 222 ¹One hundred and seven (107) participants either opted out of HIV testing or had missing data
 223 ²Three (3) participants had missing entry point, 2 of which also had missing HIV status
 224 (*) one-sided, 97.5% confidence interval.
 225 ** not determined.
 226

227 DISCUSSION

228 Statement of principal findings

229 This study found that in Zambian correctional facilities, the prevalence of all forms of TB,
 230 bacteriologically confirmed TB and DR TB were 3.5 times higher, 1.7 times higher and almost
 231 twice as high as in the general population, respectively. (14, 15) Additionally, the prevalence
 232 of HIV was 1.3 times higher than the prevalence in the general population (16). 28.7% of the
 233 bacteriologically confirmed TB cases were asymptomatic.

234 Study findings in relation to other studies

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2
3 235 It is noteworthy that there is no statistically significant difference in prevalence of all forms
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5
6 236 TB and bacteriologically confirmed TB between juveniles and adults and that in fact the point
7
8 237 estimates for TB in juveniles were higher; generally older adults have a higher TB burden than
9
10 238 adolescents and young adults. (17, 18) This suggests that the disproportionate access to TB
11
12
13 239 services and health services in general among juveniles in Zambian correctional facilities
14
15 240 reported between 2009-2010 have persisted. (19) Another significant contrast relative to the
16
17
18 241 general population is the absence of a statistically significant difference in prevalence of
19
20 242 bacteriologically confirmed TB between males and females. (15) This could be due to absence
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22
23 243 of gender related differences in exposure to risk factors for TB infection and disease but could
24
25 244 also be due to the small sample size and very wide confidence intervals among females.
26
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28 245
29
30 246 In comparison to the 2010-2011 study, the prevalence of all forms of TB has reduced by about
31
32 247 75% while the prevalence of bacteriologically confirmed TB has reduced by 50%. (6) The
33
34
35 248 reduction in prevalence of all forms of TB and bacteriologically confirmed TB could be a result
36
37 249 of the TB control interventions being implemented within the Zambian correctional facilities.
38
39
40 250 However, it could also be in part because the correctional facilities in the two studies are not
41
42 251 the same and the variations in the sensitivity of screening algorithms as a more sensitive
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44
45 252 algorithm involving x-ray and culture(20, 21) for all inmates was used in the previous study.
46
47 253 An observational and modelling study done in Brazil supports the hypothesis of effectiveness
48
49
50 254 of TB control interventions being implemented: entry screening, active screening for TB
51
52 255 among inmates, TB preventive therapy and annual mass screening independently reduce the
53
54 256 incidence of TB in correctional facilities by 10.3%, 35%, 23.5% and 47.5% respectively after a
55
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57 257 period of 10 years and a combination of these interventions reduces the TB incidence by
58
59 258 79.2% after a period of 10 years. (22). Other countries in sub-Saharan Africa with results
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3 259 involving multiple correctional facilities report TB prevalence ranging from 457 - 888 per
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6 260 100,000 population. (23-25) However, a direct comparison to the prevalence reported in the
7
8 261 other countries can't be done due to differences in definitions of TB used.
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13 263 The prevalence of DR TB among people with no history of TB is similar to the prevalence
14
15 264 among people with previous history of TB, suggesting significant transmission of DR TB either
16
17 265 in correctional facilities or in the communities where the incarcerated people come from, or
18
19
20 266 both. Strengthening TB infection control can reduce transmission of DR TB. (26) In comparison
21
22 267 to the 2010-2011 study, the prevalence of DR TB has increased by 4%. (6) The increasing trend
23
24
25 268 of DR TB in the Zambian correctional facility setting is also seen at the global and national
26
27
28 269 levels.(27) The prevalence of DR TB in this study can't be directly compared to other
29
30 270 correctional facility settings since the forms of drug resistance reported are different. (28-30)

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35 272 Similar to the national picture, the prevalence of HIV was higher among adults than juveniles
36
37 273 and was higher among females than males. (16) However, the prevalence of HIV in women
38
39
40 274 relative to the prevalence of HIV in men is much higher in the incarcerated population than
41
42 275 the general population because women with HIV risk factors like sex worker status, intimate
43
44 276 partner violence, drug and substance abuse are overrepresented in this population. (31)

45
46
47 277 Despite the very high rates of HIV in this group, relative to the study done by Simooya et al in
48
49 278 1999 which showed a prevalence of 33% in females, the prevalence of HIV has reduced.(32)

50
51
52 279 There has been an 8.6% reduction in overall prevalence of HIV since the study in 2010-2011.

53
54 280 (6) The reduction in prevalence of HIV in correctional facilities is attributable to the reduction
55
56
57 281 of HIV prevalence in the general population(16), the implementation of test and treat across
58
59 282 Zambia(33), entry HIV testing and treatment(6) and use of correctional health committees to

1
2
3 283 strengthen TB/HIV service delivery at facility level(9). Among African countries with studies
4
5 284 involving several correctional facilities, Zambia's prevalence is lower than South Africa's (25)
6
7
8 285 but higher than Burkina Faso and Uganda.
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10 286

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12
13 287 The difference in prevalence of TB and HIV between residents and new entrants into
14
15 288 correctional facilities was not statistically significant. This is possibly due to the following
16
17 289 reasons: a) individuals entering correctional facilities come from socio-economically
18
19
20 290 disadvantaged backgrounds where prevalence of TB and HIV are already high (1); b) there are
21
22 291 high rates of recidivism (34); and c) detainees spend long periods in police cells, which have
23
24
25 292 similar conditions to the correctional facilities (35, 36). However, the small sample size and
26
27 293 wide confidence intervals especially for the new entrants is a limiting factor for drawing any
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30 294 inferences from this comparison.
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33 295 **Strengths and limitations**

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36 296 This study provides the most recent evidence on prevalence of TB and HIV in Zambian
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38 297 correctional facilities. The results of this study are generalizable to the 13 correctional
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40 298 facilities, as a large sample representing 85% and 84% of the correctional facility population,
41
42
43 299 was screened for TB and HIV respectively. By virtue of the data being disaggregated, it
44
45
46 300 provides an opportunity for targeting of interventions that can reduce the burden of both
47
48 301 diseases. However, there were variations in the strength of screening algorithms for TB, hence
49
50 302 the prevalence of TB could have been underestimated in some correctional facilities. That
51
52
53 303 said, among all forms TB cases, it is possible that some of the clinically diagnosed TB cases
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55 304 might not be true TB cases as there are other differential causes of chest x-ray abnormalities
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57
58 305 that mimic TB. Inmates in court or on the farms were not screened for TB which could have
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3 306 introduced bias during data collection. Additionally, asymptomatic TB was not consistently
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6 307 screened for.
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10 11 12 309 **CONCLUSION** 13 14 15

16 310 Despite significant progress over the last decade in controlling TB and HIV in Zambian
17
18 311 correctional facilities, these continue to be disproportionately affected by both diseases.
19
20 312 TB/HIV programs in correctional facilities need further strengthening including aspects of
21
22 313 juvenile specific TB programming and gender responsive HIV programming. Additionally,
23
24 314 there is need to consider use of more sensitive algorithms that include chest x-ray to minimize
25
26 315 the risk of missing asymptomatic TB cases. Additional studies are required to determine the
27
28 316 true prevalence of asymptomatic TB in correctional facilities, to better understand the reason
29
30 317 for high HIV burden among females in correctional facilities and to determine the prevalence
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32 318 of TB and HIV using a sample whose results can be generalized to all the correctional facilities
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34 319 in Zambia.
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42 320 **ETHICS STATEMENT** 43 44 45

46 321 Approval to use the programmatic data was obtained from the University of Zambia
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48 322 Biomedical Research Ethics Committee No: 018-11-18 and the London School of Hygiene and
49
50 323 Tropical Medicine Ethics Committee No: 21332. Since data was collected under programmatic
51
52 324 conditions, no consent was sought for TB screening and verbal consent and assent were
53
54 325 obtained for HIV testing. The EJJOH project had obtained permission from the Zambia
55
56 326 Correctional service and the Ministry of Community Development and Social services to
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3 327 conduct the screening activities including testing of juveniles. When migrating data from the
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6 328 paper-based registers to the electronic database, participant identifying information was
7
8 329 excluded.
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56 425 **ACKNOWLEDGEMENT**
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13
14
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16
17 429 showing study sites.
18

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2223
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29
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37 435 **AUTHOR CONTRIBUTIONS**
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42 436 Conceived and designed the study: MK, SH, CNM, MM. Database design and data curation:
43
44 437 PS, JB. Implemented the study: MK, SH, MT, TZ, CNM, MM. Data analysis: PS, MK, FB. Wrote
45
46 438 the original draft: MK. Reviewed the manuscript: SH, MT, JB, PS, TZ, FB, CNM, MM. Approved
47
48
49 439 the final version to be published: MK, SH, PS, MT, JB, TZ, FB, CNM, MM.

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52 440 The corresponding author attests that all listed authors meet authorship criteria and that no
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54 441 others meeting the criteria have been omitted.
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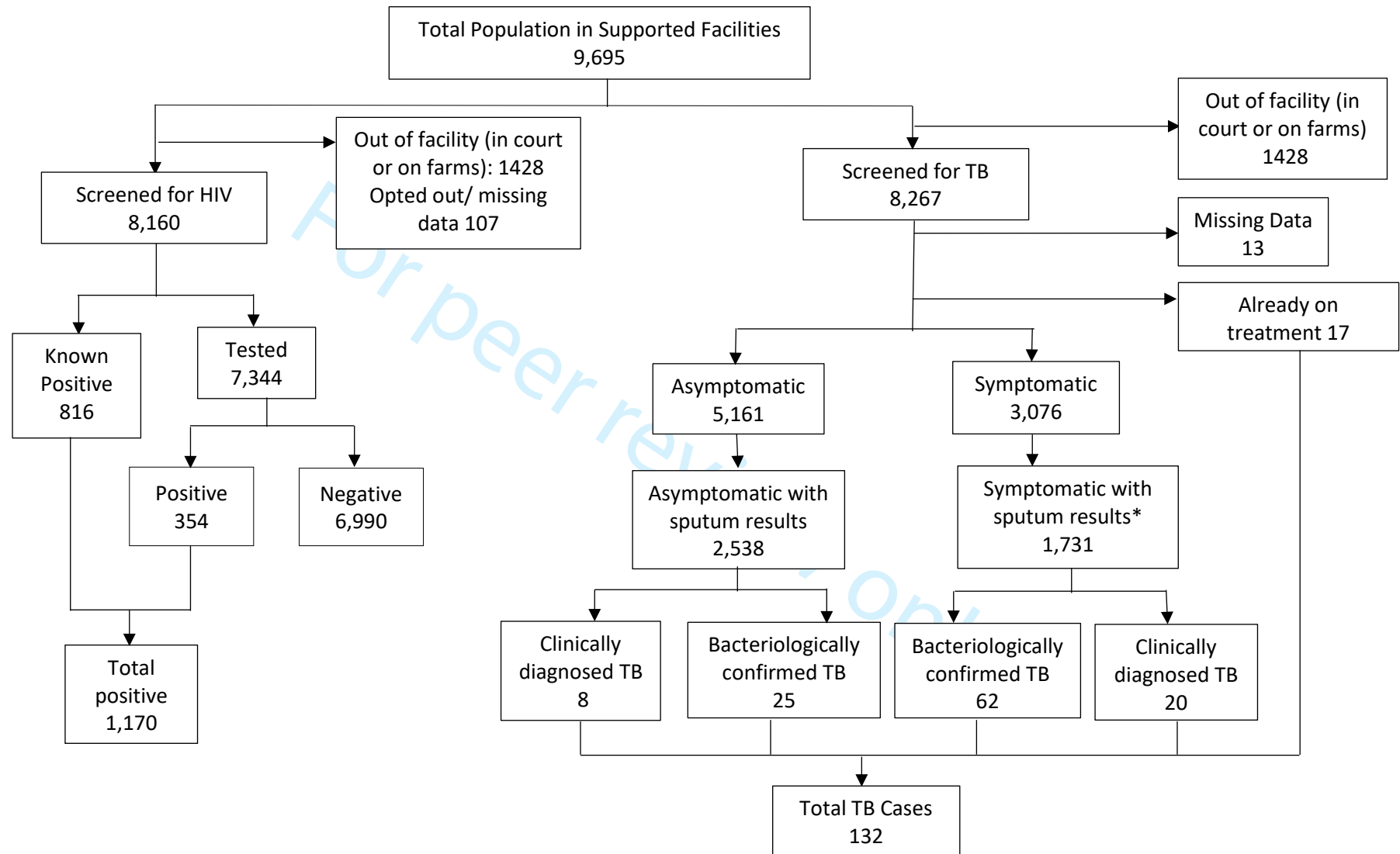
9 443 **CONFLICT OF INTEREST**

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13 444 The authors declare no conflict of interest.
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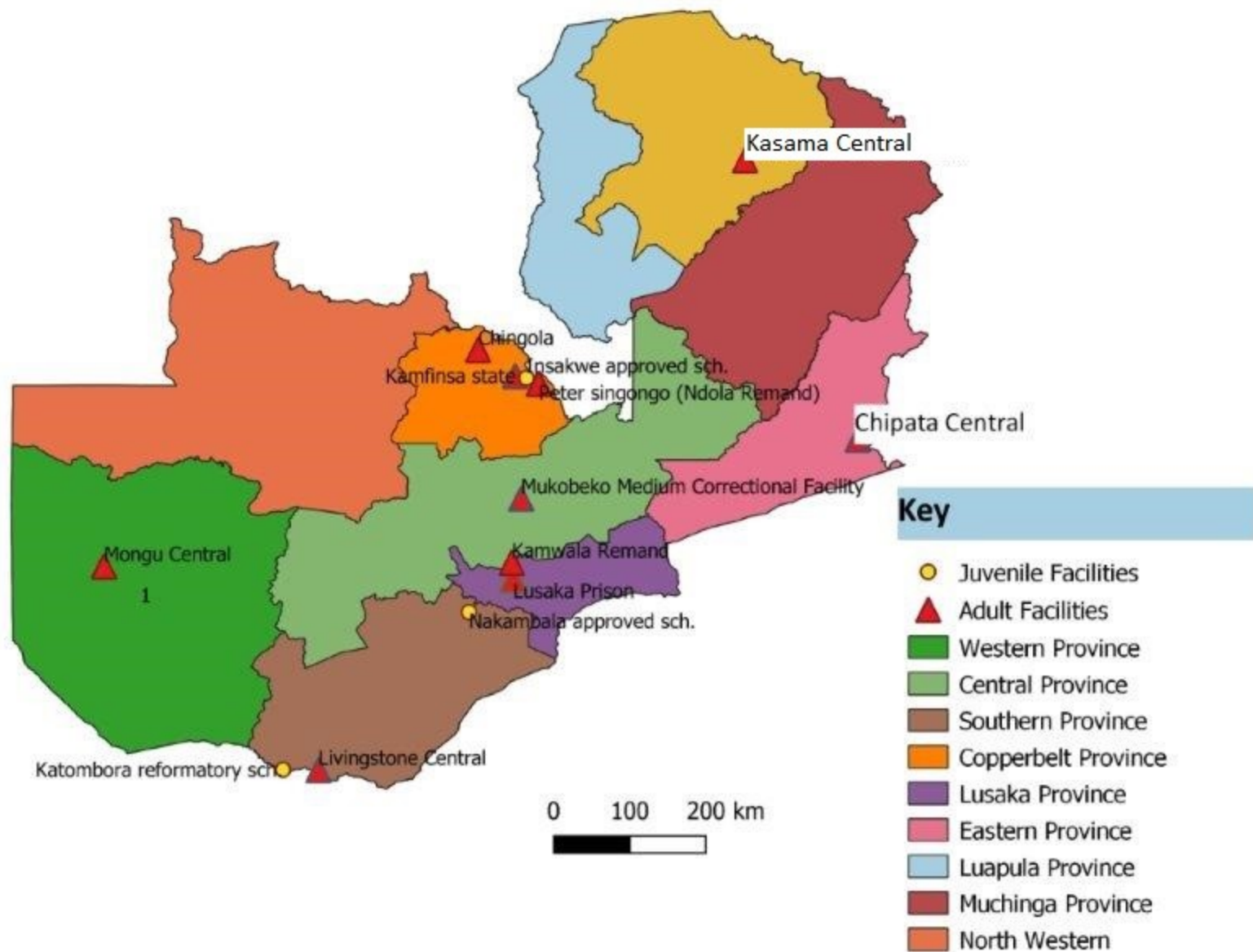
20 446 **DATA SHARING STATEMENT**

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24 447 Additional data is available upon request by emailing Monde.Muyoyeta@cidrz.org
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HIV- Human Immunodeficiency Virus, TB- Tuberculosis

*All symptomatic patients submitted sputum, however, some correctional facilities only documented results of patients with positive results.



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STROBE Statement—Checklist of items that should be included in reports of *cross-sectional studies*

	Item No	Recommendation	Page No
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	2
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	4
Methods			
Study design	4	Present key elements of study design early in the paper	5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5,6
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants	6,7
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	7,8
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	6,7
Bias	9	Describe any efforts to address potential sources of bias	6
Study size	10	Explain how the study size was arrived at	6
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	7,8
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	7,8
		(b) Describe any methods used to examine subgroups and interactions	7,8
	(c) Explain how missing data were addressed	8	
	(d) If applicable, describe analytical methods taking account of sampling strategy		
	(e) Describe any sensitivity analyses		
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	8, 9
		(b) Give reasons for non-participation at each stage	8,9
		(c) Consider use of a flow diagram	9
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	9,10
		(b) Indicate number of participants with missing data for each variable of interest	10-13
Outcome data	15*	Report numbers of outcome events or summary measures	10-13

1			
2	Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included
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6			(b) Report category boundaries when continuous variables were categorized
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8			(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period
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11	Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses
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14	Discussion		
15	Key results	18	Summarise key results with reference to study objectives
16	Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias
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20	Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence
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24	Generalisability	21	Discuss the generalisability (external validity) of the study results
25			
26	Other information		
27	Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based
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*Give information separately for exposed and unexposed groups.

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A cross sectional assessment of Tuberculosis and Human Immunodeficiency Virus prevalence in 13 correctional facilities in Zambia

Mary Kagujje ([0000-0003-4818-6548](tel:0000-0003-4818-6548))¹, Paul Somwe², Sisa Hatwiinda¹, Joel Bwalya², Tamala Zgambo³, Moomba Thornicroft¹, Fiammetta Bozzani⁴, Clement Nchimunya Moonga¹, Monde Muyoyeta¹

Author affiliations

1. Tuberculosis department, Centre for Infectious Disease Research in Zambia, P.O. Box 34681 Lusaka, Zambia 10101
2. Strategic Information department, Centre for Infectious Disease Research in Zambia, P.O. Box 34681 Lusaka, Zambia 10101
3. Zambia Correctional Service, P.O. Box 80926 Kabwe, Zambia 10101
4. London School of Hygiene and Tropical Medicine, Keppel Street London WC1E 7HT, United Kingdom

Correspondence to Mary Kagujje; mkagujje@gmail.com

Key words: Correctional facilities, Tuberculosis, HIV, incarcerated population, Zambia

22 ABSTRACT

23 **Objective:** To determine the prevalence of Tuberculosis (TB) and Human Immunodeficiency
24 virus (HIV) in 13 Zambian correctional facilities.

25 **Methods:** Cross sectional study

26 **Setting:** 13 correctional facilities in 7 of the 10 provinces in Zambia.

27 **Participants:** All incarcerated individuals were eligible for TB and HIV screening and testing.
28 Of the total study population of 9,695 individuals, which represent 46.2% of total correctional
29 population at the beginning of the study, 8,267 and 8,160 were screened for TB and HIV
30 respectively.

31 **Interventions:** TB and HIV screening and testing was done between July 2018 and February
32 2019.

33 **Primary outcome measures:** All forms of TB, bacteriologically confirmed TB, drug resistant
34 TB, HIV

35 **Results:** Prevalence of all forms of TB and bacteriologically confirmed TB was 1598(1340-
36 1894) per 100,000 population and 1056(847-1301) per 100,000 population, respectively.
37 Among those with bacteriologically confirmed TB, 4.6% (1.3%-11.4%) had drug resistant TB.
38 There was no statistically significant difference in the prevalence of different forms of TB
39 between adults and juveniles: (p= 0.82), (p= 0.23), (p=0.68). Of the bacteriologically
40 confirmed TB cases, 28.7% were asymptomatic. The prevalence of HIV was 14.3% (13.6%-
41 15.1%). The prevalence of HIV among females was 1.8 times the prevalence of HIV among
42 males (p=0.01).

43 **Conclusion:** Compared to the study in 2011 which screened inmates representing 30% of the
44 country's inmate population then, the prevalence of all forms of TB and HIV in correctional

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3 45 facilities has reduced by about 75% and 37.6% respectively. However, compared to the
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6 46 general population, the prevalence of all forms of TB and HIV was 3.5 and 1.3 times higher,
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8 47 respectively. TB/HIV programs in correctional facilities need further strengthening to include
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10 48 aspects of juvenile specific TB programming and gender responsive HIV programming.
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For peer review only

ARTICLE SUMMARY

Strengths and limitations of this study

- This is the only study on prevalence of TB and HIV in Zambian correctional facilities in the past 8 years.
- Results are generalisable to the 13 correctional facilities as a large sample was screened for TB and HIV.
- Data disaggregates can inform targeted interventions to reduce the burden of both diseases.
- Variations in TB screening algorithms could have underestimated TB prevalence.
- Asymptomatic TB was not consistently screened for.

60 INTRODUCTION

61 Globally, correctional facilities are disproportionately affected by tuberculosis (TB) and the
62 Human Immunodeficiency Virus (HIV). (1-3) In some correctional facilities: the prevalence of
63 TB has been reported to be up to 100 times higher than the prevalence in the general
64 population (1) while the prevalence of HIV has been reported to be up to 23 times higher
65 than the prevalence in the general population(3). The poor living conditions in correctional
66 facilities perpetuate TB and HIV. While overcrowding, poor ventilation, HIV, poor nutrition
67 and late case detection perpetuate TB; sexual violence, sharing of sharp objects and lack of
68 access to condoms perpetuate HIV. (4, 5) Additionally, incarcerated people often come from
69 socio-economically disadvantaged backgrounds where the burden of TB and HIV is already
70 high. (1, 3)

71
72 In 2011, the prevalence of all forms of TB in 6 Zambian correctional facilities representing 30%
73 of the total incarcerated population was 6,428 per 100,000 population, which was 18 times
74 higher than the national estimates. (6) In the same study, 0.6% of those with bacteriologically
75 confirmed TB had rifampicin-resistant TB and the overall prevalence of HIV was 22.9%, which
76 was 1.5 times the national prevalence.

77
78 Since the last documented prevalence survey, several interventions including test and treat
79 for HIV, health systems strengthening, nutritional support, TB and HIV entry screening, among
80 others, have been put in place to control the burden of TB and its associated risk factors in
81 Zambia correctional facilities. (7-10)

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3 83 This study aimed to determine current prevalence of all forms of TB, bacteriologically
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5 84 confirmed TB, and drug resistant (DR) TB and the prevalence of HIV in 13 Zambian correctional
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8 85 facilities.
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10 11 12 86 **METHODS** 13 14

15 16 17 87 **Study design** 18 19

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21 88 We present an analysis of cross-sectional data collected under programmatic conditions by
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23 89 the Elton John Juvenile Offenders' health (EJJOH) project. The EJJOH project was a health
24
25 90 system strengthening project aimed at supporting provision of holistic and integrated health
26
27 91 services to juvenile offenders. While the project primarily targeted juveniles, its support was
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29 92 extended to adults being held in the same facility with the juveniles so as to improve
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31 93 infectious disease control. The project screened the incarcerated population as part of its
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33 94 baseline assessment.
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39 95 **Study setting and population** 40 41

42
43 96 Zambia has 87 correctional facilities with a total capacity of 9,150 incarcerated individuals.
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45 97 (11) However, the total incarcerated population in Zambia was slightly over 21,000 in 2018
46
47 98 and 22,823 in 2019. In 2019, almost one in five individuals detained was in pre-trial detention.
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49 99 (11) The data was collected between July 2018 and February 2019 in 13 correctional facilities
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51 100 with a combined population of 9,695, representing 46.2% of the total correctional facility
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53 101 population in Zambia in 2018. The 13 correctional facilities had been purposefully selected by
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55 102 the EJJOH project because they held a significant number of juveniles. The facilities include
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3 103 Lusaka Central, Kamwala Remand, Livingstone Central, Katombora Reformatory School,
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6 104 Nakambala Approved school, Mukobeko Medium, Ndola remand, Kamfinsa State, Chingola,
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8 105 Insakwe Approved School, Chipata Central, Mongu Central and Kasama Central (locations
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10
11 106 shown in Supplementary Figure 1). The Reformatory and approved schools hold ordered
12
13 107 (convicted) juveniles (persons less than 19 years old)(12); the other facilities are intended only
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15 108 for adults and circumstantial children(13) but also hold juveniles who are still undergoing
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18 109 trial.

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23 111 Across Zambia, routinely, incarcerated people should undergo universal TB screening and HIV
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25 112 testing at entry or within 7 days of admission into correctional facilities. However, in some
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27 113 facilities entry screening is not done due to various constraints. Depending on availability of
28
29 114 logistics, periodic TB and HIV mass screening are carried out, with freedom to opt out of HIV
30
31 115 testing but not TB screening and testing. TB screening is mandatory to increase early TB
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33 116 detection and treatment so as to protect other inmates from TB.

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38 39 40 41 118 **Study Procedures**

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45 119 A project specific register was used; it was a modification of the National Presumptive TB
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47 120 register with additional data elements on entry point, category of individual and previous
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49 121 history of TB. All inmates were screened for TB; those who did not opt out were tested for
50
51 122 HIV. The screening point was documented under one of the following categories: mass
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53 123 screening, entry screening from the community or entry screening transfer from other
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55 124 correctional facility. The categories of individuals included adults and juveniles. Those already
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57 125 on anti-TB treatment at the time of screening were documented as TB cases and those on
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3 126 anti-retroviral therapy (ART) were recorded as HIV positive and were not retested. Those with
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6 127 cough, fever, weight loss, night sweats, chest pain and shortness of breath, irrespective of
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8 128 duration, were considered presumptive TB patients and submitted sputum for testing using
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10 129 GeneXpert (Xpert MTB/Rif Assay. Cepheid, Sunnyvale, California, USA). Symptomatic
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13 130 individuals with a negative GeneXpert were referred for Chest x-ray (CXR) depending on the
14
15 131 clinician's discretion. There were 3 variations to this algorithm: 1) In Lusaka central, a random
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17 132 proportion of the incarcerated population received CXR in addition to symptoms screening
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20 133 and those with either abnormal CXR or symptoms submitted sputum for GeneXpert; 2) at
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23 134 Ndola remand, all except those already on TB treatment submitted sputum irrespective of
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25 135 symptoms; and 3) in Kabwe medium, Fluorescent Microscopy (FM) was used for sputum
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27 136 examination instead of GeneXpert.
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32 138 Alere Determine™ HIV-1/2 test (AlereHIV-1/2; Abbott, Chicago, IL, USA) was used for HIV
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35 139 screening and SD-Bioline HIV-1/2 (SD-Bioline HIV-1/2; Abbott, Chicago, IL, USA) for
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37 140 confirmation of positive screening test, following the standard Zambian HIV testing algorithm.
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40 141 All individuals received pre- and post-test HIV counselling. HIV positive inmates were
41
42 142 commenced on ART within 1-2 days.
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143 **Data analysis**

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50 144 STATA Statistical Software (Stata Corporation Version 14. College Station, Texas 77845, USA)
51
52 145 was used for data analysis. A descriptive analysis was done to determine the characteristics
53
54 146 of the population screened and the prevalence of TB and HIV; overall prevalence and
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57 147 prevalence among subgroups was determined. The prevalence of all forms of TB included
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59 148 bacteriologically confirmed TB and clinically diagnosed TB. Bacteriologically confirmed TB
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3 149 prevalence included those who had a positive GeneXpert or FM result, while patients already
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6 150 on TB treatment at time of screening were excluded from this analysis since data on the type
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8 151 of TB had not been collected. DR TB prevalence included incarcerated people with rifampicin
9
10 152 resistance on GeneXpert. Missing data was excluded from the analysis.
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14 153 Additionally, a chi-square test was done to determine if there was a statistically significant
15
16 154 difference in prevalence of TB and HIV between residents and new entrants into correctional
17
18 155 facilities. New entrants were defined as incarcerated people whose entry point was entry
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20 156 screening from community while residents were defined as those whose entry point was
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22 157 either mass screening or entry screening transfer from other correctional facility.
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27 158 **Patient and Public involvement**

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31 159 The development of the research questions was intended to inform priority setting by the
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33 160 EJJOH project based on the disease burden in correctional facilities. The incarcerated
34
35 161 population were not involved in the design of the project. The correctional health committees
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37 162 constituting of the incarcerated persons, correctional officers and health care workers were
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39 163 involved in the data collection. A representative of the correctional health committee at each
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41 164 correctional facility participated in the dissemination meeting on project findings.
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50 166 **RESULTS**

51 52 53 54 55 167 **Flow diagram and participant characteristics** 56 57 58 59 60

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3 168 Of the total adult and juvenile population of 9,695 in the 13 correctional facilities, 8160
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5 169 (84.2%) were screened for HIV and 8,267(85.3%) were screened for TB (Figure 1). Individuals
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7
8 170 not screened were 1,428 (14.7%) and they constituted those either in court or the farms. Of
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10 171 those screened for HIV, 1170(14.3%) were HIV positive, of which 816 were known positive
11
12
13 172 and 354 were new positives, while 6,990 (85.7%) were HIV negative. Of those screened for
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15 173 TB, 17(0.2%) were already on treatment, 3,076 (37.3%) individuals had symptoms of TB, 5,161
16
17 174 (62.5%) were asymptomatic while 13 (0.2%) had missing data. A total of 4,269 individuals had
18
19 175 documented sputum results. Eighty seven (87) bacteriologically confirmed TB cases were
20
21 176 reported including 25(28.7%) asymptomatic individuals 62(71.3%) symptomatic individuals. A
22
23 177 total of 132 TB cases were identified including 87 (65.9%) bacteriologically confirmed TB
24
25 178 cases, 28 (21.2%) clinically diagnosed TB cases and the 17 (12.9%) that were already on TB
26
27 179 treatment at the time of screening.

32 180 Figure 1: Flow diagram of TB screening and diagnosis

35 181
36 182 Of those screened, 7,805 (94.41%) were adults and 462 (5.58%) were juveniles (Table 1). The
37
38 183 overall median age (interquartile range (IQR)) of the participants was 32 years (IQR 10-93);
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40 184 the median ages for the adults and juveniles were 33(IQR 19-93) and 17(IQR 10-18)
41
42 185 respectively. The males were 8,167 (98.79%), participants with a history of previous TB were
43
44 186 467 (5.65%), resident inmates were 7,767 (93.95%) while new entrants were 497 (6.01%).

50 187 Table 1: Characteristics of population screened

Variable	Participants (n= 8267)
Category of individual	n (%)
Adults	7,805 (94.41%)
Juveniles	462 (5.58%)

Median Age (IQR)	
Overall	32(10-93)
Adults (≥ 19 years)	33 (19-93)
Juveniles (<19 years)	17 (10-18)
Sex	n (%)
Male	8,167 (98.79%)
Female	89 (1.08%)
Missing	11 (0.13%)
History of previous TB	n (%)
Yes	467 (5.65%)
No	7,786 (94.18%)
Missing	14 (0.17%)
Type of screening visit	n (%)
Mass screening	7,602 (91.92%)
Entry screening other correctional facility	165 (2.00%)
Entry screening community	497 (6.01%)
Missing	3 (0.04%)

Abbreviations: IQR- Interquartile range, TB- Tuberculosis

Prevalence of all forms of TB and bacteriologically confirmed TB

The overall prevalence of all forms of TB was 1,598 (1339-1892) per 100,000 population while the overall prevalence of bacteriologically confirmed TB was 1,056 (844-1301) per 100,000 population (Table 2). There was no statistically significant difference in the prevalence of both all forms of TB and bacteriologically confirmed TB between males and females, ($p=0.51$) and ($p=1.00$) respectively. It was the same for adults and juveniles ($p= 0.82$) and ($p= 0.23$) respectively and the new entrants and residents ($p=0.25$) and ($p=0.21$) respectively.

Table 2: Prevalence of all forms of TB and bacteriologically confirmed TB

	Cases/ Participants (n/N)	Prevalence of all forms of TB per 100,000 (CI)	p- value	Cases/ Participants (n/N)	Prevalence of Bacteriologically confirmed TB per 100,000 (CI)	p- value
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Overall	132/8,254 ¹	1599 (1340-1894)		87/8,237 ^{1,2}	1056 (847-1301)	
Sex						
Male	129/8,154	1582 (1322-1877)	0.60	84/8,137	1032 (824-1276)	0.79
Female	1/89	1124 (28- 6102)		1/89	1124 (28- 6102)	
Missing gender	2/11			2/11		
Category of individual						
Adult (≥19 years)	124/7,792	1591 (1325- 1894)	0.82	79/7,775	1016 (805-1265)	0.23
Juvenile (<19 years)	8/462	1732 (750-3383)		8/462	1732 (750-3383)	
Entry point ^{1,3}						
Residents	121/ 7757	1560 (1296- 1861)	0.25	79/7740	1020 (809-1270)	0.21
New entrants	11/494	2227 (1117-3949)		8/494	1619 (702-3166)	

198 Abbreviations: CI- Confidence interval, TB- Tuberculosis

199 Residents include those screened through mass screening and those under entry screening as a transfer from
200 other correctional facility.

201 New entrants include those screened under entry screening from the community (police cells).

202 ¹ Thirteen (13) participants had missing values on TB.

203 ² Seventeen participants were already on TB treatment, bacteriological status unknown

204 ³Three (3) participants had missing values on entry point

205 Prevalence of DR TB

206 Among the bacteriologically confirmed TB cases, the overall prevalence of DR TB was 4.6%
207 (1.3%-11.4%) (Table 3). There was no statistically significant difference in prevalence of DR TB
208 between males and females (p=0.95), between adults and juveniles (p=0.68), between those
209 with and those without previous history of TB (p=0.72) and between the new entrants and
210 residents(p=0.26).

211 Table 3: Prevalence of drug resistant TB

	Cases/ Participants (n/N)	Prevalence of DR TB % (CI)	p-value
Overall	4/87	4.6 (1.3-11.4)	
Sex			
Male	4/84	4.8 (1.3-11.7)	0.95
Female	0/1	0 (0- 97.5) *	
Missing	0/2		
Category of individual			
Adults (≥19 years)	4/79	5.1 (1.4- 12.5)	0.68
Juveniles (<19 years)	0/8	0 (0-3.7) *	
Previous History of TB			
No	3/64	4.7 (1.0-13.1)	0.72
Yes	1/23	4.3 (0.1- 21.9)	
Entry point			
Residents	3/76	3.8 (0.8-10.7)	0.26
New entrants	1/8	12.5 (0.3-52.7)	

Abbreviations: DR TB- Drug Resistant Tuberculosis CI- Confidence interval

Residents include those screened through mass screening and those under entry screening as a transfer from other correctional facility.

New incarcerated individuals include those screened under entry screening from the community (police cells).

* one-sided, 97.5% confidence interval

Prevalence of HIV

The overall HIV prevalence was 14.3% (13.6%-15.1%) (Table 4). The prevalence of HIV among males was 14.1% (13.4%-14.9%) and among females 25.8% (16.6%-35.1%) ($p=0.01$). The prevalence of HIV among adults and juveniles was 15.0% (14.1%-15.7%) and 3.9% (2.3%-6.2%) ($p<0.01$) respectively. There was no statistically significant differences in prevalence of HIV between residents and new entrants ($p=0.05$).

Table 4: Prevalence of HIV

	Cases/ Participants (n/N)	Prevalence of HIV % (CI)	p-value
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Overall	1,170/8,160 ^f	14.3 (13.6-15.1)	
Sex			
Male	1,139/8,061	14.1 (13.4-14.9)	0.00
Female	23/89	25.8 (17.4-36.2)	
Missing sex	8/10		
Category of individual			
Adults (≥19 years)	1,153/7,727	15.0 (14.1-15.7)	0.00
Juveniles (<19 years)	17/433	3.9 (2.3- 6.2)	
Entry point ^{1,2}			
Residents	1,118/7699	14.5(13.7-15.3)	0.06
New entrants	52/460	11.3 (8.6-14.6)	

225 Abbreviations: CI- Confidence interval, HIV- Human Immunodeficiency virus

226 Residents include those screened through mass screening and those under entry screening as a transfer from
 227 other correctional facility. New incarcerated individuals include those screened under entry screening from the
 228 community (police cells).

229 ¹One hundred and seven (107) participants either opted out of HIV testing or had missing data

230 ²Three (3) participants had missing entry point, 2 of which also had missing HIV status

231 (*) one-sided, 97.5% confidence interval.

232 ** not determined.

233

234 DISCUSSION

235 Statement of principal findings

236 This study found that in Zambian correctional facilities, the prevalence of all forms of TB,
 237 bacteriologically confirmed TB and DR TB were 3.5 times higher(14), 1.7 times higher(14) and
 238 3.5 times higher(15) than the respective prevalence in the general population. Additionally,
 239 the overall prevalence of HIV was 1.3 times higher than the prevalence in the general
 240 population (16) and the prevalence of HIV among females was 1.8 times higher than the
 241 prevalence of HIV among males within correctional facilities. Of the bacteriologically
 242 confirmed TB cases, 28.7% were asymptomatic.

243 **Study findings in relation to other studies**

244 It is noteworthy that there is no statistically significant difference in prevalence of all forms
245 TB and bacteriologically confirmed TB between juveniles and adults and that in fact the point
246 estimates for TB in juveniles were higher; generally older adults have a higher TB burden than
247 adolescents. (17, 18) This suggests that the disproportionate access to TB services and health
248 services in general among juveniles in Zambian correctional facilities reported between 2009-
249 2010 has persisted. (19) Another significant contrast relative to the general population is the
250 absence of a statistically significant difference in prevalence of bacteriologically confirmed TB
251 between males and females. (14) This could be due to absence of gender related differences
252 in exposure to risk factors for TB infection and disease but could also be due to the small
253 sample size and very wide confidence intervals among females.

254
255 In comparison to the 2010-2011 study, the prevalence of all forms of TB has reduced by about
256 75% while the prevalence of bacteriologically confirmed TB has reduced by 50%. (6) The
257 reduction in prevalence of all forms of TB and bacteriologically confirmed TB could be a result
258 of the TB interventions being implemented within the Zambian correctional facilities since
259 2011. This explanation is supported by findings from an observational and modelling study
260 done in Brazil: entry screening, active screening for TB among inmates, TB preventive therapy
261 and annual mass screening independently reduce the incidence of TB in correctional facilities
262 by 10.3%, 35%, 23.5% and 47.5% respectively after a period of 10 years and a combination of
263 these interventions reduces the TB incidence by 79.2% after a period of 10 years. (20)
264 However, it is worth mentioning that though the previous study used a more sensitive
265 algorithm involving x-ray and culture(21, 22) for all inmates, the reduction is so large that it
266 cannot simply be explained by use of different algorithms. Other countries in sub-Saharan

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3 267 Africa with results involving multiple correctional facilities report TB prevalence ranging from
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5 268 457 - 888 per 100,000 population. (23-25) However, a direct comparison to the prevalence
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8 269 reported in the other countries can't be done due to differences in definitions of TB used and
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10 270 differences in prevalence in the general population.
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15 272 The prevalence of DR TB among people with no history of TB is similar to the prevalence
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17 273 among people with previous history of TB, suggesting significant transmission of DR TB either
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19
20 274 in correctional facilities or in the communities where the incarcerated people come from, or
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22
23 275 both. Strengthening TB infection control can reduce transmission of DR TB. (26) In comparison
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25 276 to the 2010-2011 study, the prevalence of DR TB has increased by 667%. (6) The increasing
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27
28 277 trend of DR TB in the Zambian correctional facility setting is also seen at the global and
29
30 278 national levels.(27) The prevalence of DR TB in this study can't be directly compared to other
31
32 279 correctional facility settings since the forms of drug resistance reported are different. (28-30)
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35 280

37 281 Similar to the national picture, the prevalence of HIV was higher among adults than juveniles
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39
40 282 and was higher among females than males. (16) However, the prevalence of HIV in women
41
42 283 relative to the prevalence of HIV in men is much higher in the incarcerated population than
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44
45 284 the general population because women with HIV risk factors like sex worker status, intimate
46
47 285 partner violence, drug and substance abuse are overrepresented in this population. (31)
48
49
50 286 Additionally, women are exposed to sexual abuse while in custody and they have more access
51
52 287 barriers to HIV prevention, testing and treatment services compared to men. (32) Despite the
53
54 288 very high rates of HIV in this group, relative to the study done by Simooya et al in 1999 which
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56
57 289 showed a prevalence of 33% in females, the prevalence of HIV has reduced.(33) There has
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59 290 been a 37.6% reduction in overall prevalence of HIV since the study in 2010-2011. (6) The
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3 291 reduction in prevalence of HIV in correctional facilities is attributable to the reduction of HIV
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6 292 prevalence in the general population(16), the implementation of test and treat across
7
8 293 Zambia(34), entry HIV testing and treatment(6) and use of correctional health committees to
9
10 294 strengthen TB/HIV service delivery at facility level(9). Among African countries with studies
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13 295 involving several correctional facilities, Zambia's prevalence is lower than South Africa's (25)
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15 296 but higher than Burkina Faso and Uganda.

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20 298 The difference in prevalence of TB and HIV between residents and new entrants into
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23 299 correctional facilities was not statistically significant. This is possibly due to the following
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25 300 reasons: a) individuals entering correctional facilities come from socio-economically
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27 301 disadvantaged backgrounds where prevalence of TB and HIV are already high (1); b) there are
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30 302 high rates of recidivism (35); and c) detainees spend long periods in police cells, which have
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33 303 similar conditions to the correctional facilities (36, 37). However, the small sample size and
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35 304 wide confidence intervals especially for the new entrants is a limiting factor for drawing any
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37 305 inferences from this comparison. This finding highlights the contribution of imported TB and
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40 306 HIV cases to the burden of disease in correctional facilities and underscores the importance
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42 307 of entry screening within this setting.

45 46 308 **Strengths and limitations**

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48 309 This study provides the most recent evidence on prevalence of TB and HIV in Zambian
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51 310 correctional facilities. The results of this study are generalizable to the 13 correctional
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53 311 facilities, as a large sample representing 85% and 84% of the 13 correctional facility
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55 312 population, was screened for TB and HIV respectively. By virtue of the data being
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58 313 disaggregated, it provides an opportunity for targeting of interventions that can reduce the
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3 314 burden of both diseases. However, there were variations in the strength of screening
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5 315 algorithms for TB, hence the prevalence of TB could have been underestimated in some
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8 316 correctional facilities. That said, among all forms TB cases, it is possible that some of the
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10 317 clinically diagnosed TB cases might not be true TB cases as there are other differential causes
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13 318 of chest x-ray abnormalities that mimic TB. Inmates in court or on the farms were not
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15 319 screened for TB which could have introduced bias during data collection. Additionally,
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18 320 asymptomatic TB was not consistently screened for.
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24 322 **CONCLUSION**

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28 323 Despite significant progress over the last decade in controlling TB and HIV in Zambian
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30 324 correctional facilities, these continue to be disproportionately affected by both diseases.
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33 325 TB/HIV programs in correctional facilities need further strengthening to include aspects of
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35 326 juvenile specific TB programming, gender responsive HIV programming and holistic integrated
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38 327 service delivery as TB and HIV are not exclusive health concerns of incarcerated individuals.
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40 328 Additionally, there is need to consider use of more sensitive algorithms that include chest x-
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43 329 ray to minimize the risk of missing asymptomatic TB cases. Additional studies are required to
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45 330 determine the true prevalence of asymptomatic TB in correctional facilities, to better
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48 331 understand the reason for high HIV burden among females in correctional facilities and to
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50 332 determine the prevalence of TB and HIV using a sample whose results can be generalized to
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53 333 all the correctional facilities in Zambia.
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334 ETHICS STATEMENT

335 Approval to use the programmatic data was obtained from the University of Zambia
336 Biomedical Research Ethics Committee No: 018-11-18 and the London School of Hygiene and
337 Tropical Medicine Ethics Committee No: 21332. Since data was collected under programmatic
338 conditions, no consent was sought for TB screening and verbal consent and assent were
339 obtained for HIV testing. The EJOH project had obtained permission from the Zambia
340 Correctional service and the Ministry of Community Development and Social services to
341 conduct the screening activities including testing of juveniles. When migrating data from the
342 paper-based registers to the electronic database, participant identifying information was
343 excluded.

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39
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41
42
43 445 showing study sites.
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45 446

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451 AUTHOR CONTRIBUTIONS

452 Conceived and designed the study: MK, SH, CNM, MM. Database design and data curation:
453 PS, JB. Implemented the study: MK, SH, MT, TZ, CNM, MM. Data analysis: PS, MK, FB. Wrote
454 the original draft: MK. Reviewed the manuscript: SH, MT, JB, PS, TZ, FB, CNM, MM. Approved
455 the final version to be published: MK, SH, PS, MT, JB, TZ, FB, CNM, MM.

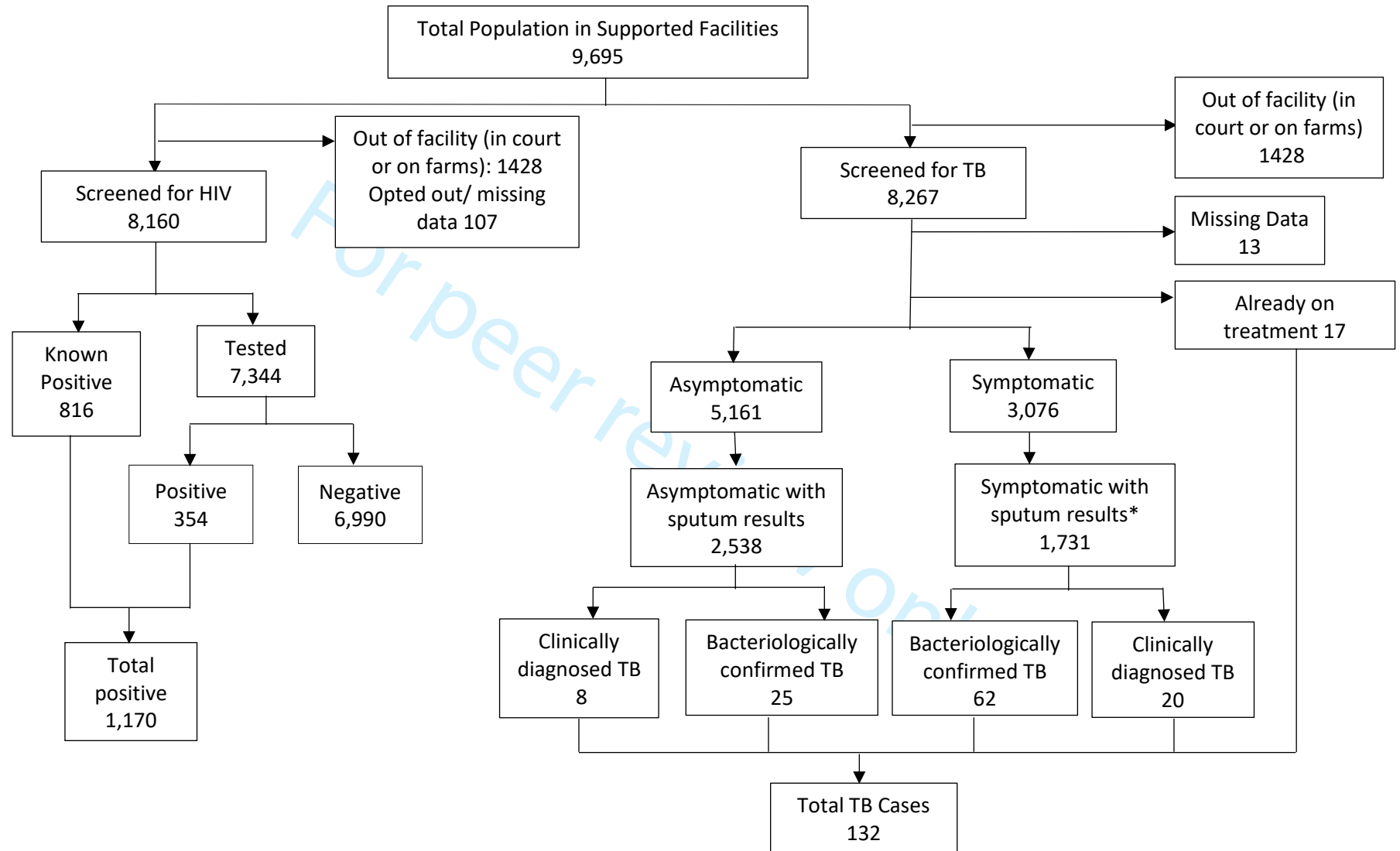
456 The corresponding author attests that all listed authors meet authorship criteria and that no
457 others meeting the criteria have been omitted.

459 CONFLICT OF INTEREST

460 The authors declare no conflict of interest.

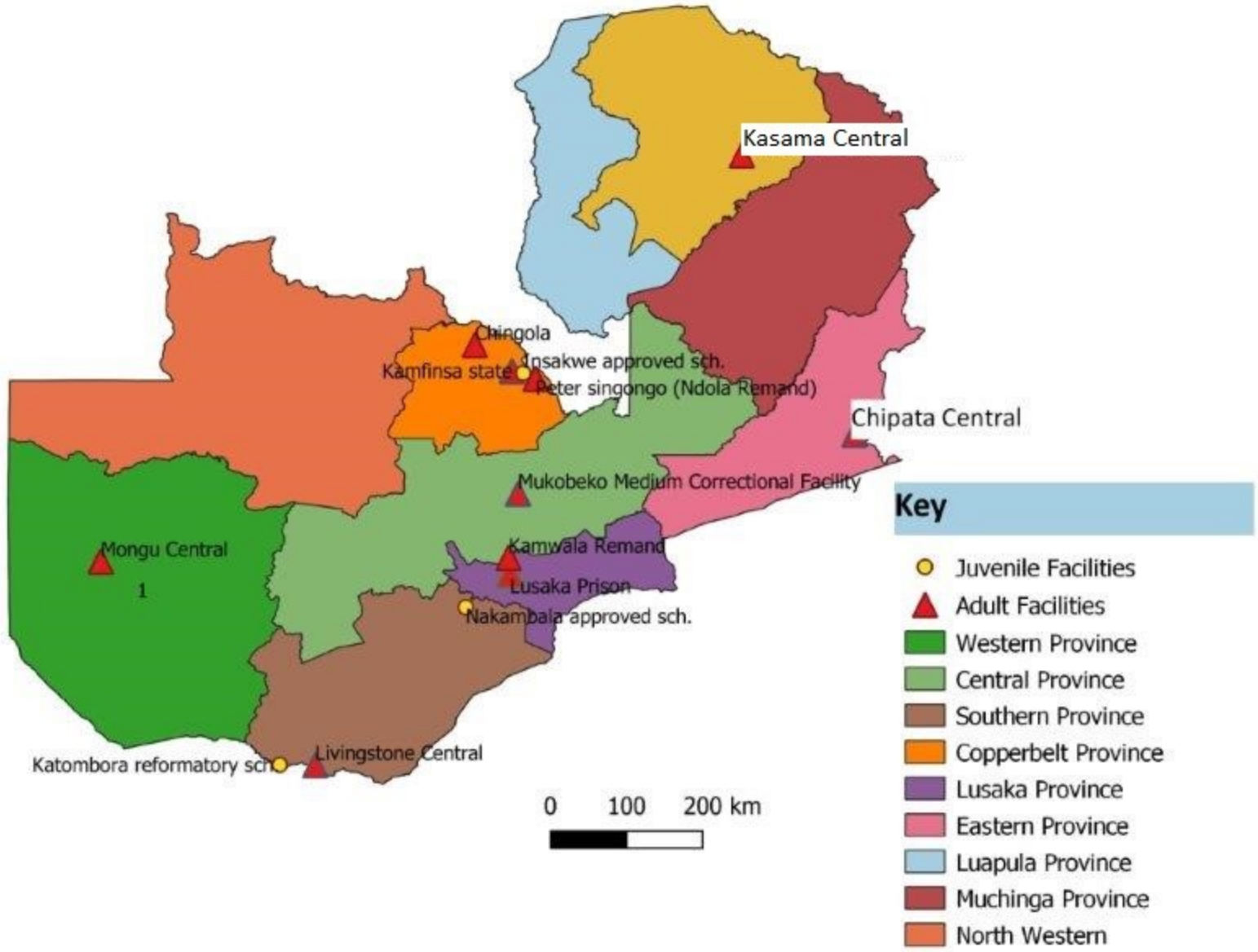
462 DATA SHARING STATEMENT

463 Additional data is available upon request by emailing Monde.Muyoyeta@cidrz.org



HIV- Human Immunodeficiency Virus, TB- Tuberculosis

*All symptomatic patients submitted sputum, however, some correctional facilities only documented results of patients with positive results.



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STROBE Statement—Checklist of items that should be included in reports of *cross-sectional studies*

	Item No	Recommendation	Page No
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	1
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	2,3
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	5,6
Objectives	3	State specific objectives, including any prespecified hypotheses	6
Methods			
Study design	4	Present key elements of study design early in the paper	5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6,7
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants	7,8
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	8,9
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	7,8
Bias	9	Describe any efforts to address potential sources of bias	7
Study size	10	Explain how the study size was arrived at	7
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	8,9
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	8,9
		(b) Describe any methods used to examine subgroups and interactions	8,9
		(c) Explain how missing data were addressed	9
		(d) If applicable, describe analytical methods taking account of sampling strategy	
		(e) Describe any sensitivity analyses	
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	9, 10
		(b) Give reasons for non-participation at each stage	9,10
		(c) Consider use of a flow diagram	10
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	10,11
		(b) Indicate number of participants with missing data for each variable of interest	11-14
Outcome data	15*	Report numbers of outcome events or summary measures	11-14

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Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	
		(b) Report category boundaries when continuous variables were categorized	11-14
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	11-14
Discussion			
Key results	18	Summarise key results with reference to study objectives	14
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	17-18
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	14-17
Generalisability	21	Discuss the generalisability (external validity) of the study results	17
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	21

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at www.strobe-statement.org.