# *Original Research Article*

**Outcome of Tuberculosis Case Surveillance at Kano Central Correctional Center, North-west Nigeria: A Need for Routine Active Case Findings for TB in Nigerian Correctional Centers**


## ABSTRACT

**Aim:** To demonstrate the need for routine active TB case finding in Nigerian correctional centers through a TB case surveillance intervention at the largest correctional centre in the most populous state in Nigeria by KNCV Tuberculosis Foundation Nigeria.

**Study design:** It was a retrospective review of public health intervention data derived from the mass TB screening of Kano central correctional centre inmates in Kano state, Nigeria.

**Methodology**: A digital X-ray with artificial intelligence (AI) was used for mass TB screening of 1,967 consenting inmates at the Kano central correctional centre in Kano state, Nigeria, from 21st September to 2nd October 2020. Participants with CAD4TB score ≥ 60 had a GeneXpert assessment of their sputa for TB diagnosis. Where sputum production was not possible, or GeneXpert result was negative, expert clinical evaluation of the presumptive radiogram was carried out by experienced radiologist. Data from the project were extracted and analysed for this report. Proportions and means were compared with Fisher Exact test and Student t-test, respectively. A p-value of $< 0.05$ was considered statistically significant.

**Results:** Overall, 1,967 inmates were screened for TB and 92 (4.7%) presumptive were identified - males (4.8%, 91/92), females (1.9%, 1/92). Out of the 92 presumptive, 21 males were diagnosed as TB cases giving a TB prevalence of 1.1% among the inmates and 22.8% among presumptive. One of the TB cases had multi-drug resistant TB. The number needed to screen (NNS) was 94. All TB cases were enrolled in treatment.

**Conclusion:** The prevalence of TB at the Kano central correctional centre during the mass TB screening project was high. The National Tuberculosis Control Programme of Nigeria should accelerate the planned paradigm shift from passive to active case-finding for TB in Nigerian correctional centers.

**Keywords:** Mass Screening for TB, Wellness on Wheels Truck, Chest X-ray, CAD4TB, GeneXpert.

## 1. INTRODUCTION

Monitoring of tuberculosis disease in a geographic area or population is an important public health program.[1] Because the incidence of TB in prisons (correctional centers) is generally higher than in the general population,[2] TB case surveillance should be more critical in the overcrowded correctional centres in settings such as Nigeria, with a huge burden of TB infection. Nigeria is the sixth country globally with the largest burden of TB, and ranks second among all nations regarding the global missed TB burden of 2.9 million cases.[3]

Tuberculosis is transmitted through inhaling airborne droplets containing nuclei of tubercle bacilli generated from individuals with the pulmonary disease.[4] Therefore, poor ventilation and reduced immune status of exposed individuals are known predispositions to TB transmission. Unfortunately, these two predispositions are prevalent in Nigerian correctional centres due to overcrowding and inadequate nutrition. Likewise, some independent risk factors for TB in West Africa, such as household crowding, male sex, and smoking, are prevalent in our correctional centers.[5] Furthermore, a longer duration of imprisonment is also associated with TB infection among inmates.[6] Since the risk of re-activation of latent TB is higher among the immunocompromised, the poor nutrition and its attendant low host immunity among prison inmates can also predispose to the re-activation of a latent TB infection.[7]

These prison-related factors and inadequate prison TB services explain the higher risk of developing active TB by inmates when compared with the general population.[8,9] A recent systematic review from Iran shows TB prevalence among inmates ranging from 25/100,000 to 517/100,000.[10] Another study from Romania, which used a one-stop mobile X-ray with computer-aided TB detection software followed by Xpert assessment for presumptive, found a TB prevalence of 97/100 000 of prisoners screened.[11]

In Nigeria, inmates of correctional centres constitute a socially excluded population characterized by overcrowding, poor nutrition, and inadequate health services, making them a vulnerable group that qualifies for active case finding (ACF) for TB. For instance, a symptom-based TB ACF at the Aba prison, Abia State Nigeria, found a TB prevalence of 21.2% among inmates with cough of at least two weeks, which constituted an alarming 1100% increase in TB detection rate in that centre.[12] As in the Aba study, a few other studies among Nigerian prison inmates relied on sputum microscopy and showed a varying TB prevalence of 1.2% to 2.4%.[13,14]

Due to the lack of evidence on TB ACF in most sub-Saharan African (SSA) countries, a recent systematic review has called for increased ACF interventions in SSA prisons, particularly countries included in the three high-burden country lists for TB, TB/HIV, and MDR-TB.[15] Nigeria's inclusion in the three high-burden lists justified the ACF intervention in Nigeria Prisons. The KNCV Tuberculosis Foundation Nigeria (KNCV Nigeria), as part of its active case-finding interventions for TB amongst most at-risk populations in Nigeria, carried out mass screening for TB at the largest correctional centre in the most populous State in Nigeria using a Wellness on Wheels (WoW) truck. The WoW is a mobile TB diagnostic unit housing a digital X-ray with computer-aided TB detection software (CAD4TB) and two GeneXpert instruments. The project findings would drive health policy shift in Nigeria Correctional centres to improve TB prevention and services in centres.

## 2. MATERIAL AND METHODS

### 2.1. Study design:

This was a retrospective review of the active TB case finding intervention data at the Kano Central correctional centre, Kano state, Nigeria. The public health intervention was part of the duty of care of the Kano central correctional center to inmates; however, it was initiated and executed by KNCV Tuberculosis Foundation Nigeria. The project period was from 21st September to 2nd October 2020.

### 2.2. Study setting:

Kano central correctional centre is the largest of 10 prisons in Kano State, Nigeria. It is located in Kurmawa Quarters of Kano City and is managed by the Nigerian Correctional Services. It has 27 cells with a design capacity of 600 inmates;[16] however, at the time of the intervention, there were 2,000 inmates, and each cell accommodated 50 to 140 inmates. It has a medical clinic staffed by two medical practitioners, three nurses, and other support staff. The clinic has an active DOTS service for TB diagnosis and treatment. Passive TB case finding is the routine model in the Nigerian prison health system. The correctional centre reported seven TB cases within the year preceding the intervention.

### 2.3. Study population:

All consenting inmates of the correctional centre were eligible to be screened irrespective of the presence or absence of respiratory and constitutional TB symptoms.

### 2.4. Methods:

The project was conducted using the Wellness on Wheels (WoW) truck, a mobile TB diagnostic unit housing a digital X-ray with computer-aided TB detection software (CAD4TB), and two GeneXpert instruments. The WHO 3b screening/diagnostic algorithm was used for the project.[17] The X-ray and GeneXpert instruments were operated by a radiographer and

laboratory scientists trained by KNCV Nigeria for the project. The KNCV Nigeria team paid an advocacy visit to the management of the correctional center and got their buy-in and support for the TB surveillance project. Following a group education of inmates on the high burden of TB in correctional centres and the need for the project as a means of TB prevention, individual counselling was conducted by the DOTS officer. As shown in the case surveillance flow diagram (Figure 1), all consenting inmates had X-ray screening for TB. Participants with a CAD4TB score of ≥ 60 were defined as presumptive for TB and encouraged to produce quality spot sputum. The spot sputum specimens of the presumptive were processed and assayed the same day with Xpert instruments. Presumptive that could not produce sputum had their chest radiograms sent electronically to two independent Radiologists for clinical review – where there was a discordant report; a third radiologist review served as a tiebreaker. All confirmed TB cases (bacteriological or clinical) were commenced on appropriate TB treatment. The prison authority was also informed of all TB cases for case isolation.

**2.5. Outcome measures:**

The primary outcome measure was the prevalence of TB cases among inmates of Kano Correctional centre, Kano state, Nigeria. The secondary measures were the proportion of TB cases among the presumptive identified after X-ray and the number needed to screen (NNS) to diagnose one person with active TB.

**2.6. CONSENT AND ETHICAL CONSIDERATIONS**

The Nigerian Correctional Service Kano State approved the TB case surveillance intervention as a part of its duty of care for inmates. However, each inmate's consent was obtained during the intervention using the provider-initiated counselling and testing with an opt-out approach.[18,19] Each participant received information on the objectives, procedure, and

benefits of the project, after which s/he proceeded with TB screening using the X-ray if s/he did not specifically decline the intervention. Participants were assured of their confidentiality; however, there was a need to isolate those with TB to protect other inmates. They were informed that their screening results and de-identified bio-data would be used for project results dissemination.

**2.7. Data management:**

Relevant data of participants were retrieved for this report, including age, sex, X-ray CAD4TB scores, Xpert result, clinical X-ray report. The data were extracted into an Excel datasheet and de-identified. Data analysis was conducted with IBM SPSS version 21. Proportions and means were compared with Fisher Exact test and Student t-test, respectively. Results were presented as appropriate using mean ± standard deviation (and range), frequencies, percentages, tables, and chart. A p-value of $< 0.05$ was considered statistically significant.

## 3. RESULTS

There were 2,000 inmates in the correctional centre at the time of the TB-case surveillance program [males: 1,948 (97.4%), females: 52 (2.6%)], which gave an occupancy level of 333.3%. As shown in Table 1, out of all the inmates, 1,967 (98.4%) were screened for TB during the project (males: 97.4%, females: 2.6%). The 33 (1.7%) male inmates that opted out of the project were on death row. No inmate was below 16 years of age. The mean age of all participants was 32.0 ± 11.5 (range: 16 – 89) years. In all, the average age of male participants [31.9 ± 11.4 (range: 16-89) years] was lower than females [36.4 ± 14.9 (range: 18-80) years], $P = 0.003$. The modal age group for all participants, presumptive, and confirmed TB cases were 25 – 34 years (38.0%), 35 – 44 years (29.3%), and 25 – 34 years (38.1%), respectively.

As shown in Table 2, the proportion of presumptive identified among all participants was 4.7% (92/1964). The prevalence of presumptive among male participants was 4.8%, while that of female participants was 1.9%. The observed difference was not significant, OR = 2.6 (95%CI: 0.35 – 18.83), $P = 0.51$.

As shown in Figure 1 and Table 2, all identified presumptive TB were evaluated for TB. Twenty-one TB cases were confirmed during the project, which gave a TB prevalence of 1.1% among all participants, and 22.8% among the presumptive. All confirmed TB cases were males, while the only female presumptive was negative for TB following Xpert assessment. One of the cases had multidrug-resistant TB (MDR TB), and further evaluation showed resistance to a second-line injectable drug, i.e., pre-extensively drug-resistant TB (Pre-XDR TB). All confirmed TB cases were separated from other inmates in different cells and placed on appropriate treatment.

Table 2 also shows that the number needed to screen (NNS) with CAD4TB chest X-ray to diagnose one person with active TB in the Kano central correctional centre was 94. On the other hand, the number needed to test (NNT) to diagnose one TB case for all participants was 5.

## 4. DISCUSSION

In line with the strategic plan of the National Tuberculosis, Leprosy, and Buruli Ulcer Control Programme (NTBLCP) to move from passive to active case-finding in key affected populations, including the prisons, this TB-case surveillance project targeted the largest correctional centre in Kano State, the most populous state in Nigeria. The main finding of the project was a high TB prevalence of 1.1% among all participants and 23% among presumptive in the prison.

The TB prevalence for all participants in this project translates to a case rate of 1,100/100,000 population which is far above the 2019 actual and targeted national TB case notification rates of 60/100,000 and 235/100,000 population, respectively.[20] Also, the TB prevalence among presumptive in this study was similar to the 21% reported from Aba prison in Abia state Nigeria[12] but higher than 9% from Ethiopia.[6] However, these related studies used a symptom-based ACF model, which is associated with more number of missed cases when compared to the CAD4TB chest X-ray used in this project.[21] Furthermore, Xpert testing used for this study is superior to sputum microscopy for the diagnosis of TB.[21]

A prison is considered overcrowded when the occupancy level is above 100%.[23] The Kano central correctional centre occupancy level of 333% during the project was more than twice the national average of 147%[24,] suggesting it might be more crowded than other correctional centres in Nigeria. This finding supports an earlier report of the Service Compact with all Nigerians (SERVICOM) compliance evaluation of the prison, which identified congested cells and poor-quality foods to inmates as part of the weaknesses of the correctional center.[16] Because these two attributes are known predispositions to TB spread in the community; their impacts are likely to be higher in a prison environment which may explain the high TB rate identified by the project. In fact, it has been established

that in countries such as Nigeria, with a high TB prevalence in the general population, TB prevalence in the prisons is as much as 100 times higher than in the outside communities.[23] The increased TB prevalence in the prisons compared to the outside communities is demonstrated in this project and other related studies in Nigerian prisons.[12-14] It is crucial that while efforts are being made to implement the strategies outlined by the United Nations' office on crime and drugs to decongest the prisons,[23] routine TB ACF approaches, including entry and routine mass screening,[15] are implemented in Nigerian Prisons.

It is noteworthy that all inmates that opted out of the TB screening were on death row. This attitude of the death row inmates to TB screening may not be out of place because such inmates are characterized by an increased incidence of psychological disorders, including depression.[25] Major depressive disorder, for instance, is often associated with loss of interest and diminished capacity to think, which might make it difficult for an affected individual to comprehend health information and make an informed choice.[26] Unfortunately, one or more of the death row inmates could harbour active TB, thereby exposing the post-screening TB-free inmates to the risk of tuberculosis infection. Because of the grave public health concern of missing TB case(s) among non-consenting inmates after a mass screening, a mandatory TB screening may therefore be an appropriate approach for inmates in Nigerian correctional centres.

As was the case with Kano central prison, the proportion of female prisoners in Nigerian prisons is low, with an average of 1.9%.[24] Despite this usual lower proportion of female prisoners, this project demonstrated that females were as likely to be TB presumptive as the male inmates (Table 2). Similar gender distribution of presumptive was observed from the ACF study at Aba prison, Nigeria.[12] Therefore, the ACF for TB in correctional centres must target all inmates irrespective of sex. The project found that 94 inmates needed to be tested

to identify an active TB case (Table 2) so, the small number of female inmates in the Kano central prison (n = 52) may explain the finding that all TB cases identified in the project were males. Compared to the Aba prisons' report, where one female TB case was identified, 41 persons needed to be screened for TB symptoms to identify one TB case.[12] Other related studies from Nigeria did not involve all inmates and did not stratify results according to gender.[13,14] A case of MDR-TB was identified during the project, which is not surprising for a country listed among the top MDR-TB high-burden countries. However, because of the difficulty in treating the MDR-TB cases, prevention of its infection and spread within the correctional centre through routine ACF, including routine entrance TB screening, should be a top priority of the National TB programme.

The strength of this project lies in the fact that it is the first mass TB screening in Nigerian correctional centres using digital X-ray with CAD4TB artificial intelligence and Xpert testing for presumptive. However, opt-out of some inmates from the mass screening limited the project because of the possibility of undiagnosed TB cases among the cohort.

## 5. CONCLUSION

The prevalence of TB at the overcrowded Kano central prison during the TB-case surveillance project was high. Though all TB cases were males, inmates' sex had no relationship with the odds of being presumptive. The NTBLCP should accelerate the implementation of its planned shift from passive to active case-finding in Nigerian correctional centers. To minimize missed TB cases, the routine ACF for TB approach should include entry screening and intermittent mass screening using chest x-ray.

**Competing interest disclaimer:**

Authors have declared that no competing interests exist. The products used for this research are commonly and predominantly used in our research area and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for litigation but for the advancement of knowledge. Also, the research was not funded by the producing company; rather, it was funded by the personal efforts of the authors.

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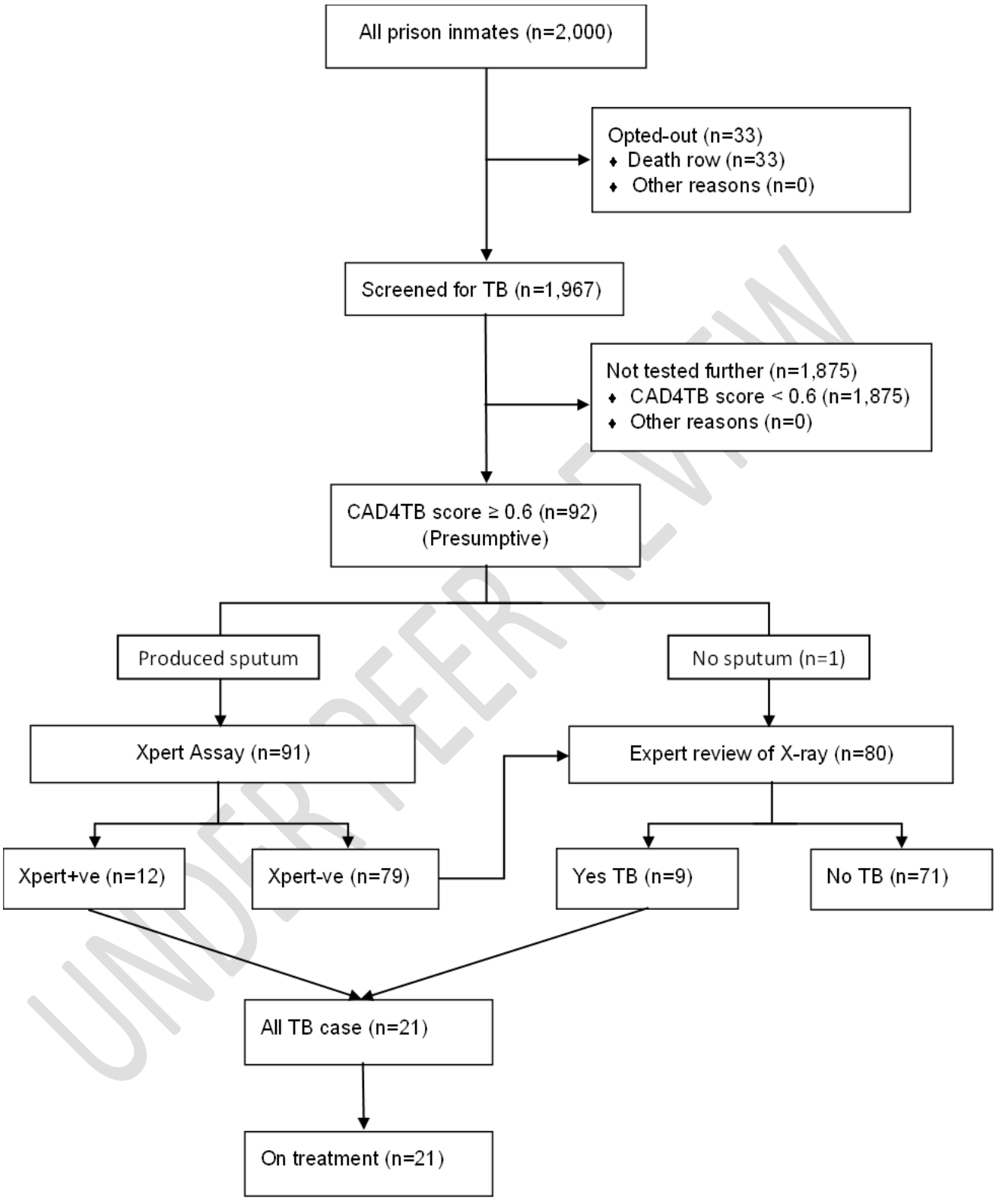
338 **TABLES AND FIGURES**

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340 Figure 1: Kano Central Prison's TB-Case Surveillance Flow diagram

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342 Table 1: Demographic characteristics of inmates screened, presumptive identified and TB
343 patients detected during Kano Central Prison's TB-Case Surveillance

| Category | Inmates screened (*n* = 1967) Freq. *(%)* | Presumptive TB (*n* = 92) Freq. *(%)* | TB patient (*n* = 21) Freq. *(%)* |
|---|---|---|---|
| Gender | | | |
| Male | 1915 (97.4) | 91 (98.9) | 21 (100.0) |
| Female | 52 (2.6) | 1 (1.1) | 0 (0.0) |
| Age (years) | | | |
| 0-14 | 0 (0.0) | 0 (0.0) | 0 (0.0) |
| 15-24 | 504 (25.6) | 8 (8.7) | 2 (9.5) |
| 25-34 | 747 (38.0 | 24 (26.1) | 8 (38.1) |
| 35-44 | 400 (20.3) | 27 (29.3) | 6 (28.6) |
| 45-54 | 190 (9.7) | 20 (21.7) | 4 (19.0) |
| 55-64 | 85 (4.3) | 9 (9.8) | 1 (4.8) |
| 65+ | 41 (2.1) | 4 (4.3) | 0 (0.0) |

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Table 2: The number needed to screen (NNS) and number needed to test (NNT) to diagnose one person with active TB during Kano Central Prison's TB-Case Surveillance

| | Total n (%) | Male n (%) | Female n (%) | *P*-value |
|---|---|---|---|---|
| Persons screened | 1967 (100.0) | 1915 (47.2) | 52 (2.6) | - |
| Presumptive identified | 92 (4.7) | 91 (4.8) | 1 (1.9) | 0.51* |
| Presumptive evaluated for TB | 92 (100.0) | 91 (100.0) | 1(100.0) | 0.51 |
| TB cases diagnosed | 21(22.6) | 21 (22.8) | 0 (0.0) | 1.0 |
| TB patients put on treatment | 21 (100.0) | 21 (100.0) | - | - |
| NNS | 94 | 92 | - | - |
| NNT | 5 | 5 | - | - |

NNS = (Persons screened / TB patients diagnosed)

NNT = (Presumptive patients evaluated for TB / number of TB patients diagnosed)

* OR = 2.6 (95%CI: 0.35 – 18.83)