Occurrence of *Mycobacterium tuberculosis* Complex among inmates in Kurmawa Prison, Kano, Nigeria

Chado, Y, M. and *Aminu, A. I.
Department of Microbiology, Faculty of Life Sciences, Bayero University, Kano Nigeria.
*Correspondence author: aishatuaminuibrahim@gmail.com, 0805403326

Abstract: The occurrence of Tuberculosis (TB) in prisons is a major public health threat in Nigeria, where inadequate TB screening generates poor data of the infection. The study was aimed to determine the occurrence of *Mycobacterium tuberculosis* among inmates in Kurmawa prison, Kano, Nigeria. A cross-sectional study was conducted among 150 inmates and sputum samples were collected and examined using standard mycobacteriological procedures. Results revealed that out of the 150 sputum samples processed, 7 (4.7%) were identified as *M. Tuberculosis* positive with 1 out of 19 (14.3%) females and 6 out of 131 (4.6%) males infected ($p>0.05$). Inmates in the age group ≥48 years were more infected ($p>0.05$). The results also revealed that prevalence of TB was insignificantly higher in convicted inmates (6.1%), students (33.3%), widows (20%), inmates with non-formal education (5.7%), rural inmates (8.2%), HIV positive inmates (25%), inmates that smoke (5.1%), inmates that consume alcohol (5.9%), inmates with abnormal nutrition (9.4%) and inmates that were not on drug abuse (4.9%) ($p>0.05$). The prevalence was also insignificantly higher among those inmates coughing between 2-4 weeks (6.1%), that have contact with TB inmate after incarceration (6.4%) that stayed in the prison for 25-30 months (25%) and 31-36 months (21.4%). Only 1 (14.3%) of the inmates infected with TB had multidrug resistant (MDR) TB. The study identifies the need for creation of TB diagnostic and treatment centers in prisons, with emphasis on screening of not only new prisoners for tuberculosis on entry, but the entire prison population including prison staffs periodically.

Key words: Tuberculosis, Prevalence, Inmates, Kurmawa Prison.

INTRODUCTION

Tuberculosis (TB) is an infectious bacterial disease caused not only by *Mycobacterium tuberculosis* (MTB) but by a large group of other mycobacteria referred to as *Mycobacterium tuberculosis* complex (MTBC) that comprises; *Mycobacterium africanum*, *Mycobacterium bovis*, *Mycobacterium canettii*, *Mycobacterium microti*, *Mycobacterium orygis*, *Mycobacterium caprae*, *Mycobacterium pinnipedii*, *Mycobacterium surricattae* and *Mycobacterium mungi* (Floyd, 2014; Alli *et al*., 2011).

Tuberculosis is one of the 10 causes of death, and leading cause from a single infectious agent (*Mycobacterium tuberculosis*), ranking above HIV/AIDS (WHO, 2018). The disease can affect anyone anywhere, but most people who develop TB (about 90%) are adults with a male: female ratio of 2:1, and case rates at national level vary from less than 50 to more than 5000 per 1million population per year (WHO, 2018). Globally, an estimated 1.7 billion people are infected with *M. tuberculosis* and almost 90% of cases each year are in 30 high TB burden countries (WHO, 2018).

Factors known to contribute to the transmission of MTB strains and hamper TB control are overcrowding, delayed case detection, poor contact tracing, inadequate treatment of infectious cases, high turnover of inmates, and poor implementation of TB infection control (IC) measures (Stuckler *et al*., 2008).

Tuberculosis is one of the major diseases of public health importance especially in prisons where case-finding rate has been low and is posing specific challenges in numerous geographical areas, particularly in low and middle-income countries (LMICs) where more than 80% of the global TB burden reside (WHO, 2018). Prisons are considered reservoirs promoting transmission of *Mycobacterium tuberculosis* (MTB) within their walls, as well as to the community at large and transmission occurs through prison staff, visitors, and released inmates (Baussano *et al*., 2010). The WHO established five facts of Pulmonary TB spread which include: Prisons receive TB, Prisons concentrate TB, Prisons disseminate TB, Prisons make TB worse,

and Prisons export TB (Azuogu and Eze, 2018).

It has been reported that Nigeria has 227 prisons spread across the country with about 54,000 inmates of various categories (Ogundipe, 2011). These lockups and their large inmate population do not enjoy comparable healthcare services with the outside prison population because of the absence of linkages between national health and prison health services (Ahmed *et al.,* 2016). Ahmed *et al.* (2016) identified the need for constant monitoring and evaluation of the health status of inmates in correctional facilities in Nigeria during their periods of incarceration so as to remind policy makers of the potential risks that such facilities pose as reservoir of diseases to the nation. The International center for prison studies (2013) earlier stated that inmates are often admitted to cells without being given a health check and are mixed together in confined settings ideal for the spread of tuberculosis infection. This study, therefore, aimed at determining the occurrence of *Mycobacterium tuberculosis* among inmates in Kurmawa Correctional facility, Kano, Nigeria (formerly referred to as Kurmawa Prison).

MATERIALS AND METHODS

The study was a cross sectional study conducted at Kurmawa Correctional facility (medium security penitentiary) located in Kano municipal in Kano state, North Western Nigeria. The state is a densely populated commercial area and the facility was built in the early 1910, to accommodate a maximum capacity of 750 prison inmates. As a provincial prison, it accommodates all classes of prisoners including the condemned criminals. The total number of inmates as at the time of this study (2019) was 2256 inmates.

Permission for the study was sought from Kano prison authority and an ethical approval was also obtained from the Ethical Review Committee of Aminu Kano Teaching Hospital. All inmates who presented symptoms that include prolong cough, fever and weight loss among others and were suggestive of tuberculosis were included in the study upon their consent. Inmates that were unable to produce sputum and/or unwilling to give written informed consent were excluded. The HIV status of the participants was obtained from their records.

A total of 150 sputum samples were collected based on the 12.26% prevalence rate of tuberculosis infection reported by Ejah *et al*. (2018) in previous study in Benue state using an Open Epi statistical software Version 2.3.0.

Two early morning spot sputum samples were collected from the inmates using labeled, sterile screw cap sputum containers, and then transported in cold boxes within an hour of collection to Aminu Kano Teaching hospital and processed according to standard mycobacteriological procedures. The sputum samples were decontaminated and concentrated according to the method described by (Kent and Kubica, 1985) using N-acetyl-L-cysteine (NALC)-NAOH method. Fivemls of sputum was transferred into a labeled 50 mls sterile screw-capped conical centrifuge tube, an equal volume of 4% NAOH and 2.9% sodium citrate containing 0.5% NALC were added to each tube containing the sputum sample. The tubes were vortexed for 20 seconds at 2500RPM and repeated three (3) times at regular interval of 5 minutes. Each tube was inverted 5 times to ensure NALC-NAOH comes in contact with the entire surface of the tube. The tubes were allowed to stand at room temperature (20-25^{o}C) for 15 minutes for decontamination. Phosphate buffer solution (pH 6.8) was added up to 45 mls to reduce the action of NAOH and lower the viscosity of the mixture. The tubes were recapped and inverted several times to mix the contents, then centrifuged for 15minutes at 3000rpm. The supernatant were carefully dispensed into discard jar containing Lysol solution, the resulting sediments were then re-suspended with 2 mls of phosphate-buffer saline (PBS).

The suspensions were used to prepare smears for detection of Acid fast bacilli

(AFB) and culture on Lowenstein Jensen media.

Following decontamination and concentration, the slides were stained using the ZN staining technique. The stained slides were then examined under 100x objective using oil immersion for the presence of AFB which appeared pinkish in colour, while non-AFB appeared blue.

Isolation of Mycobacteria was also done using Lowestein-Jensen (LJ) media (Difco. TM Lowenstein Medium Base lot 3023218, ref 24442) which was prepared according to the method described by Kent and Kubica (1985). Exactly, 37.2g of LJ powder was suspended in 600ml of purified water containing 12 mls glycerol. It was mixed thoroughly and heated with frequent agitation then boiled for 1 minute to completely dissolve the powder. The suspension was autoclaved at 121^{o}C for 15minutes then allowed to cool to 45-60^{o}C. For LJ media with pyruvate, 2.4 mls of the pyruvate was added, after the LJ was constituted and autoclaved, then allowed to cool. One litre of fresh, uniform egg suspension (approximately 20 eggs) prepared under aseptic conditions was then added to both media (i.e. LJ media with glycerol or pyruvate). The media were then mixed and dispensed into 15mls sterile tubes and allowed to coagulate in a slanting position at 85^{o}C for 45 minutes in an insipissator.

Following media preparation, the decontaminated-digested sediments of the sputum samples were then inoculated into the prepared LJ media in duplicates for each sample. It was then incubated aerobically at 37^{o}C for 8 weeks. The tubes were observed daily for the first week of incubation and weekly thereafter till eight weeks.

The isolates obtained from above were identified as MTBC using "SD BIOLINE TB Ag MPT 64 Rapid®". The test identifies *M. tuberculosis* complex (MTBC) and uses mouse monoclonal anti-MPT64 which has sensitivity and specificity of 98.6% and 100% respectively. The cassette was removed from the foil pouch and placed on a flat dry surface thus exposing the sample well. For each sample, one hundred microlitres (100µl) of the isolates was then added into the sample well. After 15minnutes of sample application, appearance of two colours (purple) bands ("T" test band and "C" control band) within the result window was considered a positive result. Samples that were confirmed as being MTBC were then used for further analysis. The susceptibilities of all the isolates of *M. tuberculosis* were examined against three first line-anti tuberculosis drugs that include Isoniazid (INH), Rifampicin (RIF) and Ethambutol (EMB) using the proportional method (NTBLCP, SOP, 2011). The critical concentration of each drug used in the assay was INH (0.2µ g/ml), RIF (40µg/ml) and EMB (2µg/ml) and were determined using the standard as described by the NTBLCP SOP (2012) manual. The inoculum was prepared by directly suspending colonies of MTBC isolates grown for approximately three weeks on Lowenstein Jensen drug free slopes to a turbidity equivalent to 1.0 MacFarland standard. The standardized suspension was further diluted to 10^{-1}, 10^{-2}, 10^{-3} and 10^{-4}. Two types of slopes (-a drug free slope and a drug containing slope) were prepared. The drug containing slopes were prepared by adding critical concentrations of the drugs (40µg/ml-RIF, 0.2µg/ml-INH and 2µ g/ml-EMB) to 200 mls of LJ medium contained in tubes. Subsequently, for each sample the 10^{-2} standardized MTBC suspension from above was inoculated on the drug-containing slopes. Three drug-free LJ slopes were inoculated with 10^{-2}, 10^{-3}, 10^{-4} MTBC suspension. Furthermore, the drug-susceptible MTB reference strain ATCC 27294 (H37Rv) was used as a control. The slopes were incubated at 37°C and read after 4 to 6 weeks. After 28 days incubation, inoculated slopes were observed for growth. An isolate was considered resistant if the proportion of bacilli resistant to the critical concentration of the drug exceeded or equal to 1(Kent and Kubica, 1985).

A questionnaire was also administered to the participants and was used to assess some of

the risk factors associated with the prevalence of TB among inmates.

Date generated from the study was analyzed and presented using percentages and chi square and was considered significant at $p<0.05$.

RESULTS

The result of the study revealed that out of the 150 sputum samples obtained from the inmates and processed for the presence of *Mycobacterium tuberculosis*, 145 (96.7%) of them gave an interpretable results, while the remaining 5 (3.3%) of the samples were contaminated on the LJ medium (Table 1). The study further revealed that 7 (4.7%) of the prison inmates were infected with *Mycobacterium tuberculosis*, and 6 (4.0%) were culture and AFB positive while only 1 (0.7%) was AFB negative but culture positive (Table 1). Also, all the 7 positive TB isolates were confirmed as MTBC by the SD BIOLINE.

The study showed that among the studied inmates, 131 (85.7%) were males with 6 (4.6%) of them being infected with TB (Table 4.2). Whereas 19 (14.3%) of the studied inmates were females with only 1 (5.3%) infected with TB ($p>0.05$) (Table 2). Table 2 shows that inmates in the age groups 18-47 years constitute most of the studied cases. The tuberculosis infection status of the studied groups however, shows that inmates in the age group ≥48 years had the highest infection rate of 9.09% followed by the age group 18-23 years (6.52%) and the age group 24-29 years (4.65%), the least prevalence was found in age group 30-35 years ($p>0.05$).

Table 3 shows that, TB prevalence was highest among convicted prison inmates with a prevalence of 6.1%, followed by those on awaiting trial (4.1%). None of the four condemned prison inmates had TB (Table 3).

Table 4 shows the drug susceptibility profile of the 7 isolates that have been confirmed as MTBC using the SD BIOLINE, where 1 (14.3%) isolate was identified as MDR-TB and the other 2 (85.7%) as drug susceptible TB.

Table5 describes the distribution of risk factors associated with TB among the studied prison inmates. The Table shows that prevalence of TB was insignificantly associated with occupation ($p>0.05$), marital status ($p>0.05$) and educational level of infected inmates ($p>0.05$) although infection rate was highest in students (33.3%), in widows (20%) and inmates with non-formal education (5.7%). Likewise, Table 5 further shows that the prevalence rate of TB among the inmates regarding the place of residence before incarceration, HIV status, smoking, alcohol consumption and malnutrition was insignificantly higher in rural inmates (8.2%) ($p>0.05$), HIV positive inmates (25%) ($p>0.05$), inmates that smoke (5.1%)($p>0.05$), inmates that consume alcohol (5.9%)($p>0.05$), and inmates with abnormal nutrition (9.4%)($p>0.05$). However, the infection rate was found to be significantly higher in inmates that were not on drug abuse (4.9%)($p<0.05$).

Table 5 further shows that TB prevalence was insignificantly higher among those inmates coughing between 2-4weeks (6.1%)($p>0.05$), those that have contact with TB inmate after incarceration (6.4%) ($p>0.05$)and those that stayed in the prison for 25-30 months (25%) ($p>0.05$) and 31-36 months (21.4%) ($p>0.05$).However, Inmates that share cell with a TB patient have lower rates (4.1%) than inmates that do not share cell with TB inmate (6.9%)($p>0.05$).

Table 1: Acid Fast Bacilli, Culture and SD BIOLINE Status of the Sputum Samples

Sample	Contaminated		Interpretable		AFB+Cult+		AFB-Cult+		Prevalence		SD Bioline+	
	No	(%)	No	(%)	No	(%)	No	(%)	No	(%)	No	(%)
150	5	(3.3)	145	(96.7)	6	(4.0)	1	(0.7)	7	(4.7)	7	(100)

Key: + = positive, - = negative, AFB = Acid Fast Bacilli, Cult = Culture

Table2: Distribution of *M. tuberculosis* among the Studied Inmates Based on Sex and Age

Variable	No studied	No infected with TB (%)	X^2	df	P-value
Sex					
Male	131	6 (4.6)	0.01577	1	0.9001
Female	19	1 (5.3)			
Total	**150**	**7 (4.7)**			
Age					
18-23	46	3 (6.52)	1.785	5	0.8780
24-29	43	2 (4.65)			
30-35	30	1 (3.33)			
36-41	14	0 (0)			
42-47	06	0 (0)			
≥ 48	11	1 (9.09)			
Total	**150**	**7 (4.70)**			

Table 3: Distribution of *M. tuberculosis* among prison inmates based on conviction status

Conviction status	No. Screened	No infected with TB (%)
Not convicted (Awaiting trial)	97	4 (4.1)
Convicted	49	3 (6.1)
Condemned	4	0 (0)
Life imprisonment	0	0 (0)
Total	**150**	**7 (4.7)**

Table 4: Drug susceptibility profile of *M. tuberculosis* isolated from prison inmates.

Type of drug Susceptibility	Number of isolates(%) (n=7)	Susceptibility profile		
		INH	RIF	ETH
Drug Susceptible TB	6 (85.7%)	S	S	S
Multidrug resistant TB	1 (14.3%)	R	R	S

Key: TB=Tuberculosis, INH=Isoniazid, RIF=Rifampicin, ETH=Ethambutol, S=Sensitive, R=Resistant.

Table 5: Distribution of some risk factors associated with the prevalence of TB among prison inmates

Risk factors	No studied	No infected with TB (%)	X^2	df	P-value
Occupation					
Civil Servant	08	0 (0)	6.105	5	0.2961
Farmer	20	2 (10.0)			
Business Man/women	110	4 (3.6)			
House wife	05	0 (0)			
Student	03	1 (33.3)			
Unemployed	04	0 (0)			
Total	**150**	**7 (4.7)**			
Marital status					
Married	54	2 (3.7)	2.216	2	0.3302
Single	91	4 (4.4)			
Widow	05	1 (20.0)			
Total	**150**	**7 (4.7)**			
Educational level					
Primary	21	1 (4.8)	0.7144	3	0.8698
Secondary	63	3 (4.8)			
Tertiary	13	0 (0)			
Non formal	53	3 (5.7)			
Total	**150**	**7 (4.7)**			
Residence before Incarceration					
Rural	61	5 (8.2)	2.597	1	0.1070
Urban	89	2 (2.3)			
Total	**150**	**7 (4.7)**			
HIV Status					
HIV +	4	1 (25.0)	2.928	1	0.0870
HIV -	146	6 (4.1)			
Total	**150**	**7 (4.7)**			
Smoking					
Yes	99	5 (5.1)	0.08814	1	0.7666
No	51	2 (3.9)			
Total	**150**	**7 (4.7)**			
History of Alcohol Consumption					
Yes	17	1 (5.9)	0.05743	1	0.8106
No	133	6 (4.5)			
Total	**150**	**7 (4.7)**			

Table 5 continue

Malnutrition					
Abnormal	32	3 (9.4)	1.789	1	0.1811
Normal	118	4 (3.4)			
Total	**150**	**7(4.7)**			
Drug Abuse					
Yes	47	2 (4.3)	0.02376	1	0.8775
No	103	5 (4.9)			
Total	**150**	**7 (4.7)**			
Duration of cough (weeks)					
2-4	49	3 (6.1)	0.3135	1	0.5755
>4	101	4 (4.0)			
Total	**150**	**7 (4.7)**			
Contact with TB					
Before incarceration	41	0 (0)	2.590	1	0.1076
After incarceration	109	7 (6.4)			
Total	**150**	**7 (4.7)**			
Shared cell with TB patient					
Yes	121	5 (4.1)	0.360	1	0.5484
No	29	2 (6.9)			
Total	**150**	**7 (4.7)**			
Duration of incarceration (Months)					
≤6	49	1 (2.4)	12.018	8	0.1504
7-12	36	1 (2.8)			
13-18	11	0 (0)			
19-24	10	0 (0)			
25-30	04	1 (25.0)			
31-36	14	3 (21.4)			
37-42	01	0 (0)			
43-48	05	0 (0)			
>49	20	1 (5.0)			
Total	**150**	**7 (4.7)**			
Ventilation status of the cell					
Closed	0	0 (0)			
Open	150	7 (4.7)			
Total	**150**	**7 (4.7)**			

DISCUSSION

The findings of this study revealed that the prevalence of TB among inmates of Kurmawa Correctional facility in Kano, Nigeria was 4.7%. The findings of this study clearly indicate that individuals at the facility are at risk of acquiring TB infection from the infected inmates. These findings are consistent with previous observations that the scourge of TB in prisons remains persistent problem as observed by Margolis *et al*. (2013). The observation of this study is comparable to 4.5% observed among inmates from Jos central prison (Ahmed *et al*., 2016), 4.9% in a prison in Ethiopia (Zerdo *et al*., 2014), 4.5% in a prison in Tajikistan (Winetsky *et al*., 2014) and 3.5% in South Africa (Telisinghe *et al*., 2014). It is however, lower when compared with previous report observed from North Gonder Zone (5.3%). On the other hand, the prevalence rate observed in this study was higher than those reported by other studies of 2.4% in Kuje prison Abuja (Lawal *et al*. 2009), 1.8% in Aba Federal prison (Chigbu *et al*., 2010),0.9% in Ghana with (Kwabla *et al*., 2015) and 2.0% in Uganda (Owokuhaisa *et al*., 2014).

Contrary to the reports of WHO (2018), this study indicated that females were more infected than males. It also contradicts the report Ahmed *et al*. (2016) who reported that, males have a higher prevalence of tuberculosis in prison inmates in Jos, North central Nigeria. Beza *et al*. (2017) also had similar reports in prison settings of East Gojjam zone, Ethiopia. The contradictory observation in this study compared to other works may be attributed to the fact only one female was found to be infected among the seven positive cases. As such a much more comprehensive survey including large number of samples both males and females is desired to have a much clearer picture on the rate of female prisoners infected with TB.

The study revealed that, there was no significant difference in the prevalence of TB among the inmates with regards to their ages ($p>0.05$), however, inmate in age group ≥48 years had the highest prevalence compared to others. This could be attributed to the level of their immunity to TB infection (WHO, 2016) and could also be attributed to that fact that majority of the prison population likely comprises of people in the older age groups. This observation is similar to that reported by Ahmed *et al*. (2016) in Jos.

Distribution of inmates in the studied facility showed that among the studied participants those awaiting trial constituted more than 50% of the population followed by convicted prisoners. This situation reflects the national trend where awaiting trial persons account for 68.6% of the total Population (Shajobi-ibikunle, 2014). The observation of this study implies that congestion in the prison may favour spread of TB from infected to non-infected inmates and may subsequently spread to the community, thus decongesting the prisons may likely reduce the rate of transmission and may enhance TB control. In an earlier report Adesokan (2014) reiterated that this group of inmates on awaiting trial poses a lot of risk to the general population since they come in contact with many people when they are moved from prisons to court rooms and when they receive visitors ranging from lawyers, human right groups and family members as well.

With regards to occupation, this studies reveals that inmates who were students had the highest prevalence of tuberculosis compared to those who were civil servants, farmers, business men, house wife or unemployed ($p>0.05$). This indicates that the presence of TB among students is a major public health concern as they interact with other individuals at their various learning centres. The findings of this study contradict that of Beza *et al*. (2017) in Ethiopia who reported a higher prevalence of TB among civil servants.

Marital status of the studied participants revealed that, singles among the studied inmates had the highest prevalence of tuberculosis followed by those that are married while widows had the lowest

prevalence (p>0.05). This may be connected to the fact that single individuals may be at high risk of exposure and acquisition of TB by engaging in many social events unlike the married and the widowed that may be reserved. Contrary to the findings of this study, Beza *et al*. (2017) reported higher prevalence among married.

Based on educational level, those inmates with non-formal education had the highest prevalence compared to those with primary or secondary education (p>0.05). This implies that level of literacy may influence the rate of prevalence of TB population. However, contrary to the findings of this study, Beza *et al*. (2017) in Ethiopia showed that inmates with primary education had the highest prevalence of tuberculosis.

In this study, some risk factors such as contact with tuberculosis inmates, malnutrition, drug abuse and duration of cough were some of the risk factors that were found to be insignificantly associated with the prevalence of TB among the studied inmates (p>0.05) in this study.Adesokan (2014) also revealed that risk factors such as lack of BCG immunization, contact with TB patients, prolonged cough and drug abuse were significant for potential transmission of TB within the prison setting. Studies by Lawal *et al*. (2009) also revealed that overcrowding, poor nutrition, poor hygiene and ventilation coupled with long prison sentences promote tuberculosis and further reiterated that these are dominant features of Nigeria prisons and likely explain why 90% of cases of TB among prison inmates were first diagnosed in prison.

Previous studies have established that cigarette smoking is associated with lung infections, predisposing the smoker to tuberculosis infections of all forms (Bai *et al*., 2016; Alavi-Naini, *et al*., 2012; Ariyothai *et al*., 2004). However, the finding of this study shows that there was no significant relationship between cigarette smoking and tuberculosis among studied participants (p>0.05). Similarly, the American addiction centers (2018) and WHO (2017) reported that alcohol abuse increase the risk three times of contracting tuberculosis. However, the findings of this study indicated that alcohol consumption was not significantly associated with tuberculosis among the studied participants (p>0.05). This observation may not be unconnected to the fact that among the community where this study was conducted alcohol consumption is prohibited.

Finally this study revealed that one of the inmates who tested positive had multi-drug resistant TB. This reemphasizes the need to screen all inmates at the initial point of entry into the facility so as to avoid spread of drug resistant bacilli which is more difficult to treat as well as prevent evolution of extensively and totally drug resistant TB. According to Ulmasova *et al*. (2013) different reports showed a higher rate of MDR-TB infection among prison inmates in different parts of the world, particularly in African countries. Earlier, Banu *et al*. (2010) reported that the rate of drug resistance was significantly high among prison inmates in Bangladesh.

CONCLUSION AND RECOMMENDATIONS

The findings of this study revealed that 4.7% of inmates were infected with TB at Kurmawa prison in Kano, Nigeria. The study also revealed that more females were infected with TB than males and those in the age group ≥48 years were more infected (p>0.05).The rate of TB prevalence was insignificantly higher in students, widows, inmates with non-formal education, inmates residing in rural areas and inmates that were smokers. Malnutrition, alcohol consumption, drug abuse and duration of cough were other risk factors found to be insignificantly associated with the prevalence of TB among the inmates. The study finally showed that one of the inmates infected with TB had MDR- TB. The study recommends the creation of TB diagnostic and treatment centers in prisons with emphasis on screening of all new inmates for tuberculosis on entry, and the entire prison population including prison

staff periodically. Finally, there should be contact tracing system that will ensure and secure follow-up of TB cases who were released before completion of their treatment and linking them to the nearest DOTS center.

REFERENCES

Adesokan, H. K., Cadmus, E. O., Adeyemi, W. B., Lawal, O., Ogunlade, C. O., Osman, E. Olaleye, O. D., and Cadmus, S. I. B. (2014). Prevalence of previously undetected tuberculosis andunderlying risk factors for transmission in a prison setting in Ibadan, south-western Nigeria. *African Journal of Medical Sciences,* 43 (Suppl 1): 45–50.

Ahmed, A. B., Bakam, H., Yayock H. C. and Sarki G. M. (2016). Passive surveillance of communicable diseases among inmates of Jos central prison, Nigeria. *International Journal of Research in Medical Science*, 4 (5): 11-13.

Alavi-Naini, R., Sharifi-Mood, B., and Metanat, M. (2012). Association between tuberculosis and smoking. *International journal of high risk behaviors & addiction*, 1(2), 71–74. https://doi.org/10.5812/ijhrba.5215.

Alli, O. A., Ogbolu, O. D. and Alaka, O. O. (2011).Direct molecular detection of *Mycobacterium tuberculosis* complex from clinical samples-An adjunct to cultural method of laboratory diagnosis of tuberculosis.*North American Journal of Medical Sciences*, 3: 281□8.

Ariyothai, N., Podhipak, A., Akarasewi, P., Tornee, S., Smithtikarn, S. and Thongprathum, P. (2004).Cigarette smoking and its relation to pulmonary tuberculosis in adults. *Southeast Asian Journal of Tropical Medicine and Public Health*, 35(1):219-227.PMID: 15272772.

Azuogu, B. N. and Eze, N. C. (2018). Assessment of Knowledge on Preventive and Control Measures of Pulmonary Tuberculosis among Inmates and Staff of Abakaliki Prisons, Nigeria: An Implication for Policy Implementation. *Journal of Advances in Microbiology*, 8 (3): 1-11.

Bai, K-J., Lee, J-J., Chien, S-T., Suk, C-W.and Chiang C-Y. (2016). The Influence of Smoking on Pulmonary Tuberculosis in Diabetic and Non-Diabetic Patients. *PLoS ONE* 11(6): e0156677. doi:10.1371/ journal.pone.0156677.

Banu, S., Hossain, A., Uddin, M. K., Uddin, M. R., Ahmed, T. and Khatun, R. (2010). Pulmonary tuberculosis and drug resistance in Dhaka central jail, the largest prison in Bangladesh.*Public library of Science*, 5: 75-77.

Baussano, I., Williams, B. G., Nunn, P., Beggiato, M., Fedeli, U. and Scano, F. (2010). Tuberculosis incidence in prisons: a systematic review. *Public Library of Science*, 7 (1): e1000381.

Beza, M. G., Hnegnaw, E. and Tiruneh, M. (2017).Prevalence and Associated factors of tuberculosis in Prisons Settings of East Gojjam Zone, Northwest Ethiopia. *International Journal of Bacteriology*, 7: 36-38. https://doi.org/10.1155/2017/3826980.

Chigbu, L. N. and Iroegbu, C. U. (2010). Incidence and Spread of *Mycobacterium tuberculosis*-associated Infection among Aba Federal Prison Inmates in Nigeria.*Journal of Health Population andNutrition* , 28 (4): 327-332

Committee for mycobacterial examination (2000). Anti-mycobacterial testing of *Mycobacterium tuberculosis*, tentative standard M24-T, *PA.National committee for clinical laboratory standards*.

Ejah, E. F., Uniandeyo. A., Akinseye, V. O., Okon, K. O., Kazeem, H. M. and Kudi, C. Y. (2018). Diagnostic performance of GeneXpert and Ziehl-Neelso microscopy in the detection of tuberculosis in Benue state, Nigeria.*Alexandria Journal of Medicine*, 4 (54): 529-533. https://doi.org/10.1016/ajme.2018.09 .002.

Floyd, K. (2014). Global tuberculosis report 2014, 20 Avenue Appia, 1211 Geneva 27, Switzerland: World Health Organization Press.

International Centre for Prison Studies (2013). World prison population list (10th edition). http://www.prisonstudies.org/country /papua-new-guinea.

Kent, P. T. and Kubica, G. P. (1985). Anti-tuberculosis chemotherapy and drug susceptibility, Public health Mycobacteriology: A guide for the level III laboratory. *Center for Disease Control and Prevention,* 1: 159-84.

Kwabla, M. P., Ameme, D. K. and Nortey, P. (2015). Pulmonary Tuberculosis and Its Risk Factors among Inmates of a Ghanaian Prison.*International Journal of Tropical disease and Health*, 9 (3): 1-10.

Lawal, M. A. Omili, M. Bello, T.O. Onuha, L., Haruna, A. (2009). Tuberculosis in a Nigerian Medium Security Prison. 11 (Supplemental): 1-8

Margolis, B., Al-Darraji, H. A. A., Wickersham, J. A., Kamarulzaman, A. and Altice, F. L. (2013). Prevalence of tuberculosis symptoms and latent tuberculosis infection among prisoners in Northeastern Malaysia.*International Journal of Tuberculosis and Lung Disease,* In Press.

Ogundipe, O. M. (2011). Strategies for having total prison decongestion within the context of the proposed criminal justice system reform. Paper presented 1st Nigerian Bar Association Criminal Justice Reform and addiction Conference Abuja.

Owokuhaisa, J, Thokerunga, Eric. And Bazira, J. (2014). Prevalence of Pulmonary tuberculosis among prison inmates at Mbararacentrol prison, South Western Uganda. *Public medicine central, 2* (11): 618-625. Doi:10.9734/AIR/2014/10676.

Shajobi-Ibikunle, D. G. (2014). Challenges of Imprisonment in the Nigerian Penal System: The Way Forward. *American Journal of Humanities and Social Sciences*, 2 (2): 94-104.

Stuchler, D., King, L. P. and Basu, S. (2008). International Monetary Fund Programs and Tuberculosis Outcomes in Post-Communist Countries.*Journal of Public Library of Science,* 5 (7): e143. doi:10.1371/journal.pmed.0050143.

Telisinghe, L., Fielding, K. L., Malden, J. L., Hanifa, Y., Churchyard, G. J. and Grant, A. D. (2014). High Tuberculosis Prevalence in a South African Prison: The Need for Routine Tuberculosis Screening. *Public Library of Science*, 9 (1): e87262. doi: 10.1371/journal.pone.0087262 PMID: 24498059.

Ulmasova, D. J., Uzakova, G., Tilyashayhov, M. N., Turaev, L., van Gemert, W., Hoffmann, H, Zignol, Kremer, K., Gadoev, J., du Cros, P., Muslimova, N., Jalolov, A., Dadu, A., de Colombani, P., Telnov, O., Slizkiy, A., Kholikulov, B, Dara, M. and Falzon, O. (2013). Multidrug-resistant tuberculosis in Uzbekistan: results of a nationwide survey, 2010 to 2011. *Eurosurveilance*, 18 (42): 20609.

Winetsky, D. E., Almukhamedov, O., Pulatov, D., Vezhnina, N., Dooronbekova, A. and Zhussupov, *B.* (2014).Prevalence, Risk Factors and Social Context of Active Pulmonary uberculosis among Prison Inmates in Tajikistan.*Public Library*

of Science, 9 (1): e86046. doi: 10.1371/journal.pone.0086046 PMID: 24465861.

World Health Organization (2016). Global tuberculosis control-survllance, planning, finances WHO report (2016). WHO/HTM/TB/2005349.

World Health Organization (2017). Global Tuberculosis Report 2017. Document WHO/HTM/TB/2017.23. Geneva, World Health Organization, 2017. Available from: http://apps.who.int/iris/bitstream/10665/259366/1/9789241565516-eng.pdf?ua=1. Date last accessed: January 15, 2018.

World Health Organization (2018). Anti- tuberculosis Drug Resistance in the World. Report No.4.prepublication.Available:whqlibdoc.who.int/hq/2018/WHO_HTM_TB_2018.394_eng.pdf, Accessed 5 May 2018.

Zerdo, Z., Medhin, G.,Worku, A. and Ameni, G. (2014). Prevalence of pulmonary tuberculosis and associated risk factors in prisons of GamoGoffa Zone, south Ethiopia: A cross-sectional study. *American Journal of Health Research*, 2: 291–297.