ORIGINAL ARTICLE

HEARING EVALUATION OF NIGERIAN PRISON INMATES: A CROSS-SECTIONAL SURVEY

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ABSTRACT

Background: Prisoners, due to confinement are isolated from contact with the society and access to many of the facilities, including medical care. This study aimed to evaluate the hearing threshold of inmates of Kaduna convict prison. **Method:** It was a cross-sectional study of prison inmates at the Kaduna convict prison between April 2017 and February 2019. Ethical approvals were obtained from relevant bodies and all consented inmates aged 18 – 55years in the Kaduna convict prison were enrolled. Equal number of control matched for age and gender were enrolled from the communities in Kaduna North Local Government Area. Data were collated using a structured questionnaire. A diagnostic Pure Tone Audiometry was performed to assess their hearing threshold. Statistical Package for Social Sciences (SPSS) version 20.0 was used for analysis. **Results:** Four hundred and thirty inmates and equal number of control group were enrolled. The mean age for the inmates and controls were 30.2±7.5 and 30.4±8.02 years respectively. There were 383 males and 47 females in both groups. Among the 860 ears of the inmates, 238(27.7%) ears had hearing loss while in the control group, 95/ (11.1%) ears had impaired hearing. Conductive hearing loss was the commonest among the inmates 111(46.6%) while sensorineural was commoner among the controls 57(60.0%). The mean pure tone average among the inmates was 25.6±11.3dBHL and 26.1±11.2dBHL on the right and left ears respectively while in the control group, it was 18.4±7.8dBHL on the right and 17.9±7.9dBHL on the left. **Conclusion:** This study revealed that hearing loss was more prevalent among prison inmates than the general population. In majority of the inmates, the hearing loss was mild, conductive and mostly affecting all the frequencies.

Keywords: Hearing threshold, Kaduna, Nigeria, Prison inmates

Access this article online

Quick Access Code

WEBSITE: www.kjmsmedicaljournal.com

DOI: 10.36020/kjms.2020.1402.002

INTRODUCTION

Prisoners, due to confinement are isolated from contact with the society and access to many of the facilities, including medical care. Major studies on health of prison inmates were undertaken in developed countries but there is paucity of data on health of prisoners in the developing world.[1] Most

prisons were constructed to maximize public safety, not to minimize the transmission of disease or to efficiently deliver health care.[2] The modern prison in Nigeria has remained a symbol of colonial legacy, which forms the basis of the Nigerian penal system inherited from our colonial masters, Britain. Imprisonment serves the functions of; protection of society, prevention of crime, retribution against criminals, rehabilitation and training of convicted offenders, the assurance of justice and re-integration of the imprisoned back into the society.[3,4] The Prisons in most developing countries such as Nigeria are always overcrowded; and this overcrowding, couple with other factors such as poor hygiene, nutrition and risky behaviours exposes the inmates to numerous otologic diseases leading to hearing impairment.[3] The ear is the organ of hearing. It is functionally divided into conductive parts consisting of the external ear, tympanic membrane, ossicles, auditory tube and labyrinthine fluids as well as perceiving apparatus which consist of the organ of Corti, auditory division of the vestibulocochlear nerve and central connections.[5] This study aimed to evaluate the hearing threshold of inmates of Kaduna convict prison.

MATERIALS AND METHOD

A cross-sectional study of prison inmates at the Kaduna convict prison carried out between April 2017 and February 2019. Ethical approval was obtained from Kaduna State Ministry of Health (Protocol number: MOH/ADM/744/Vol.1/461) and the National Headquarters of the Nigerian Prison Service (Protocol number: NPS.536/5.3/T2/67). All consented inmates aged 18 – 55years in the Kaduna convict prison were enrolled and an equal number of age and gender matched controls were enrolled from communities in Kaduna metropolis. Inmates who did not consent, those above 55 years of age and those inmates who cannot be accessed for safety reasons (Hardened criminals, condemned criminals on death row) were excluded from the study.

The sample size was determined using the Fisher formula for cross sectional study [6]: $n = Z^2 pq / D^2$ Where n = minimum sample size, z = normal standard deviate which is 1.96 (at 95% confidence interval). P = prevalence of otologic diseases among prison inmates. No such study has been conducted in Nigeria. Hence, the prevalence of 50% was used for calculating the minimum sample size. Therefore: P = 0.5, Q = 1 – p, Q = 1 –0.5 = 0.5, D = Degree of precision, set at5% = 0.05, $n = 1.96^2$ x 0.5x0.5 / 0.05^2 = 3.8416 x 0.25/ 0.0025 = 0.9604/0.0025. N = 384.16= 384. Four hundred and thirty prison inmates were enrolled for this study with equal number of controls from communities within Kaduna metropolis. The selection of the subjects was done by simple random sampling while the controls were selected by convenient sampling. At the time of first visit, there were two thousand and fifty six inmates consisting of one thousand and six convicted and one thousand and fifty inmates awaiting trial in the Kaduna convict prison.

Data was collated using a structured pretested questionnaire. Participants had thorough physical examination of the ear. Otoscopic examination was done to assess the external auditory canal for wax impaction, foreign bodies, obstructive bony projections in the external auditory canal as well as assess the tympanic membrane for perforation, fluid level and infection. Those with impacted wax or foreign bodies had it removed by either using Jobson-Horne probe or by syringing and had pure tone audiometry done during the next visit (usually one week after cleaning the ear).

Pure Tone Audiometry (PTA) was performed using the ascending (modified Hughson-Westlake) method to assess hearing thresholds among the participants. The Audiometric test was performed in a quiet room after assessing the ambient noise of the environment with a sound level meter (Model TES1350A made in Taiwan). A calibrated portable audiometer (Graphic Digi IS Clinical Audiometer) was used for the procedure. It was carried out at frequencies of 250, 500, 1000, 2000, 4000, 6,000 and 8000 Hz for Air Conduction (AC), and 500,1000, 2000, 4000 Hz for Bone Conduction (BC), after explaining the

procedure to the participants. Pure Tone Average (PT_{AV}) in dBHL was calculated for each ear by calculating the arithmetic mean of the hearing levels at 500Hz, 1000Hz, 2000Hz and 4000Hz, and appropriately interpreted[7]. The Pure Tone Average was used to categorize the inmates and the controls based on their hearing threshold as no or very slight hearing impairment when the hearing threshold is ≤ 25dBHL, mild hearing impairment (26 -40dBHL) in the better ear, moderate hearing impairment (41 - 60dBHL) in the better ear, severe impairment (61 - 80dBHL) in the better ear or profound hearing impairment (> 81dBHL)[8] in the better ear. Conductive hearing loss was diagnosed when the air conduction thresholds were more than 25dBHL while the bone conduction threshold was less than 25dBHL. Mixed hearing loss was diagnosed when pure-tone air-conduction thresholds were poorer than bone-conduction thresholds by more than 10dB[9] but both thresholds were higher than 25dB with an air bone gap. Sensorineural hearing loss was considered when the air and bone conduction thresholds were within 10dB of each other and thresholds were higher than 25dB HL in accordance with the WHO classification for hearing based on decibel of hearing level (dBHL).[8] The collated data was analysed using the Statistical Product and Service Solutions (SPSS) version 20.0 (IBM SPSS®)

RESULTS

Four hundred and thirty prison inmates and equal number of controls were enrolled in this study. There were 383 (89.1%) males and 47 (10.9%) females in both the inmates and controls giving a male:female ratio of 8.1:1. The mean age for the prison inmates and the controls were 30.2±7.51 and 30.4±8.02 years respectively, (age range 18 - 53 years). The age difference was not statistically significant (χ^2=1.850, p=0.925). Table 1 below shows the socio-demographic profile of the participants.

The mean pure tone average among the inmates was 25.6±11.3dBHL and 26.1±11.2dBHL on the right and left ears respectively while in the control group, the mean pure tone average was 18.4±7.8dBHL on the right and 17.9±7.9dBHL on the left.

Table 2 below shows that 238 ears of prison inmates had hearing loss 238(27.7%) while 95 ears of the controls had hearing loss 95(11.1%).The difference was statistically significant (χ^2=54.141, p=0.0001).

Of the 238 ears with hearing loss among the prison inmates, 111(46.6%) had conductive hearing loss, 70(29.4%) had sensorineural and 57(24.0%) had mixed hearing loss. Of the 95 ears with hearing loss among the controls, conductive, sensorineural and mixed hearing loss accounted for 19(20.0%), 57(60.0%) and 19(20.0%) respectively. Majority of the hearing loss for both inmates 155(65.1%) and controls 55(57.9%), had mild degree hearing loss. Table 3 below shows details of the type, degree and frequencies involved for both the inmates and the controls.

In terms of side of ear involvement among the inmates, the left ears were more affected 128 (29.8%) than the right ears (110(25.6%). Table 4 below shows details of the side of the ears affected for both inmates and controls

Table 1: Socio-demographic Profile of the inmates and controls

	Inmates		Controls		χ^2	P value
Age group	**Frequency**	**Percent**	**Frequency**	**Percent**		
18 - 29	245	57.0	236	54.9	**1.850**	**0.925**
30 - 39	125	29.1	117	27.2		
40 - 49	53	12.3	68	15.8		
50 – 59	7	1.6	9	2.1		
Total	**430**	**100**	**430**	**100**		
Gender						
Male	383	89.1	383	89.1		
Female	47	10.9	47	10.9		
Total	**430**	**100**	**430**	**100**		

Table 2: Hearing threshold of prison inmates and controls

	Inmates		Controls		χ^2	P-value
Hearing loss	**No. of ears**	**Percent**	**No. of ears**	**Percent**		
Present	238	27.7	95	11.1	**54.141**	**0.0001**
Absent	622	72.3	765	88.9		
Total	860	100	860	100		

Table 3: Pattern of hearing loss among prison inmates and controls

	Inmates		Controls	
Type of hearing loss	**No. of ears**	**Percent**	**No. of ears**	**Percent**
Conductive	111	46.6	19	20.0
Sensorineural	70	29.4	57	60.0
Mixed	57	24.0	19	20.0
Total	**238**	**100**	**95**	**100**
Degree of hearing loss				
Mild	155	65.1	55	57.9
Moderate	57	24.0	39	41.0
Moderately Severe	16	6.7	1	1.1
Severe	3	1.3	0	0.0
Profound	7	2.9	0	0.0
Total	**238**	**100**	**95**	**100**
Frequencies Affected				
Low Frequency	58	24.4	16	16.8
Mid Frequency	5	2.1	1	1.1
High Frequency	19	8.0	8	8.4
Both Frequencies	156	65.5	70	73.7
Total	**238**	**100**	**95**	**100**

Table 4: Side of the ears affected for both inmates and controls

	Inmates		Controls	
	Right Ear	Left Ear	Right Ear	Left Ear
Audiometric Findings	**Frequency (%)**	**Frequency (%)**	**Frequency (%)**	**Frequency (%)**
Type of hearing loss				
Conductive	51(11.9)	60(14.0)	10(2.3)	9(2.1)
Sensorineural	27(6.3)	43(10.0)	28(6.5)	29(6.7)
Mixed	32(7.4)	25(5.8)	11(2.6)	8(1.9)
None	320(74.4)	302(70.2)	381(88.6)	384(89.3)
Total	**430(100)**	**430(100)**	**430(100)**	**430(100)**
Degree of hearing loss				
Mild	71(16.5)	84(19.5)	27(6.3)	28(6.5)
Moderate	27(6.3)	30(7.0)	21(4.9)	18(4.2)
Moderately Severe	6(1.4)	10(2.3)	1(0.2)	0(0.00)
Severe	1(0.2)	2(0.5)	0(0.00)	0(0.00)
Profound	5(1.2)	2(0.5)	0(0.00)	0(0.00)
None	320(74.4)	302(70.2)	381(88.6)	384(89.3)
Total	**430(100)**	**430(100)**	**430(100)**	**430(100)**

Table 5: Mean pure tone thresholds for both inmates and controls

	INMATE GROUP			
	Right Ear		**Left Ear**	
	AC	**BC**	**AC**	**BC**
Frequency	**Mean±SD**	**Mean±SD**	**Mean±SD**	**Mean±SD**
250HZ	27.85±10.35		30.00±15.81	
500 HZ	29.28±16.18	22.85±5.66	31.42±13.45	25.71±5.34
1000 HZ	27.85±12.19	24.28±10.57	30.71±16.69	24.28±10.57
2000 HZ	27.85±12.19	27.14±13.18	29.28±11.70	24.28±12.05
4000 HZ	28.57±18.19	25.00±7.63	28.57±10.29	23.57±10.29
6000 HZ	31.42±15.19		36.42±15.46	
8000 HZ	34.28±14.26		42.85±19.11	
	CONTROL GROUP			
250HZ	25.83±4.91		23.33±6.83	
500 HZ	19.16±3.76	12.50±4.18	15.83±5.84	14.16±2.04
1000 HZ	17.50±5.24	11.67±5.16	16.67±7.53	9.16±3.76
2000 HZ	15.00±5.47	10.83±2.04	15.00±7.07	9.16±3.76
4000 HZ	14.16±5.84	10.83±5.85	13.33±7.53	6.66±5.16
6000 HZ	26.67±11.69		25.00±8.94	
8000 HZ	32.50±14.05		29.16±8.61	

AC = air conduction, BC = bone conduction, SD = standard deviation

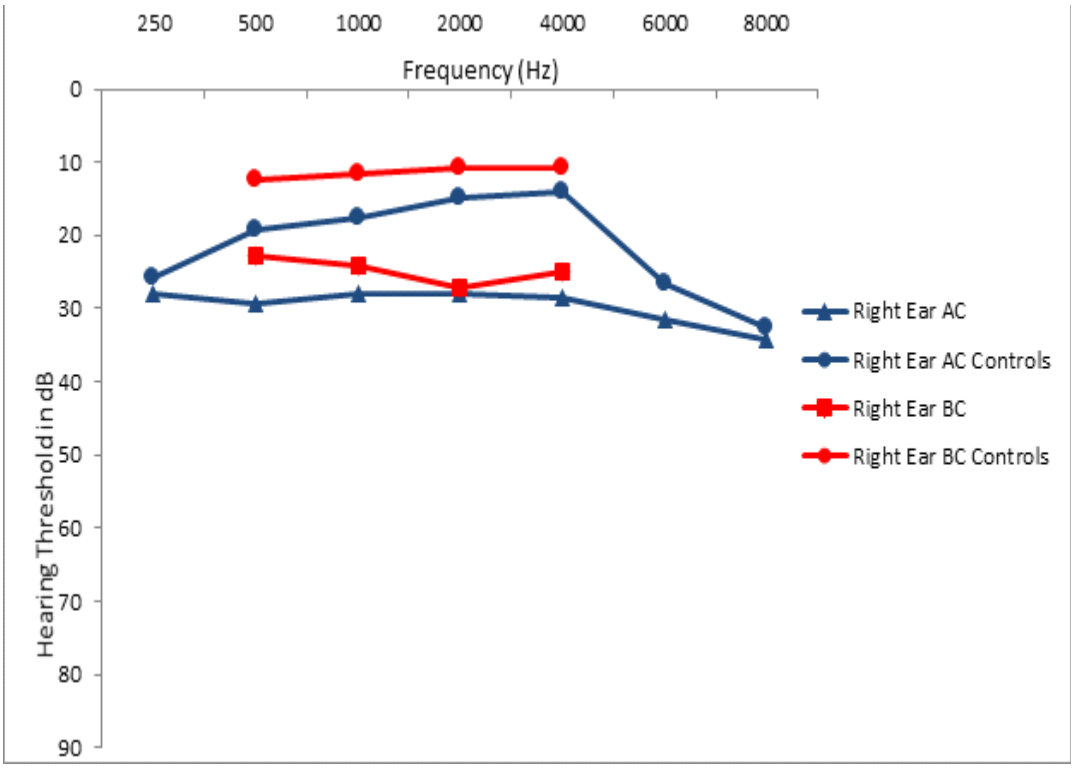

Figure 1: Mean Hearing Threshold for Subjects and Controls (Right Ear)

AC: Air Conduction
BC: Bone Conduction

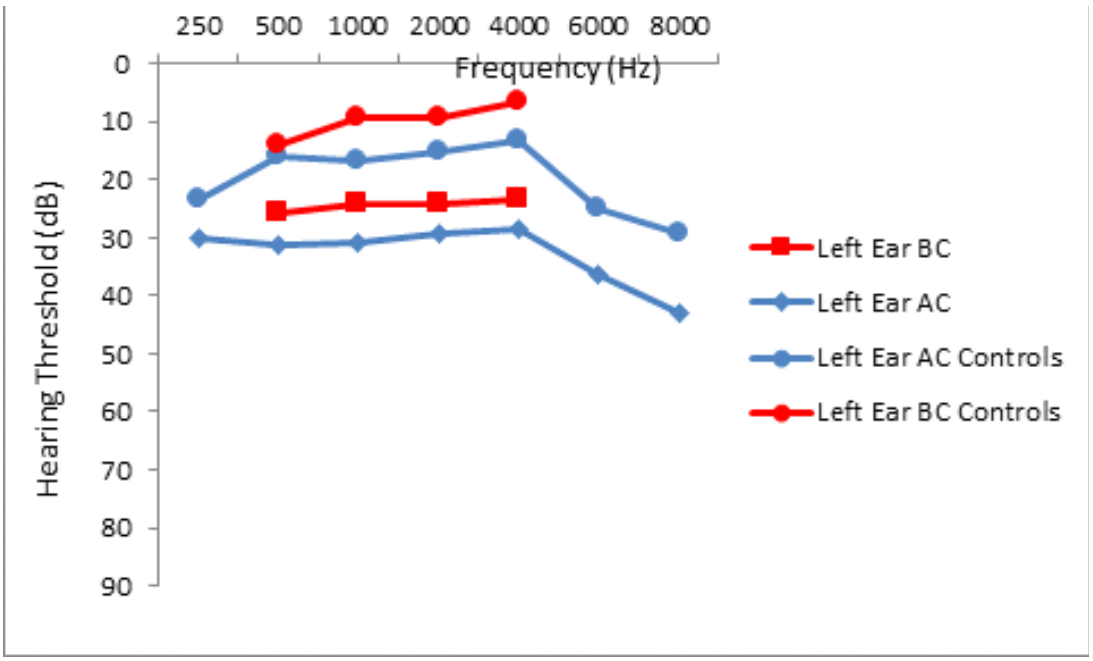

Figure 2: Mean Hearing Threshold for Subjects and Controls (Left Ear)

AC: Air Conduction
BC: Bone Conduction

DISCUSSION

The age range of inmates enrolled for this study was 18 – 53 years with mean age of 30.2±7.5 years. Mc Randle and colleague[10] reported a similar age range of 17 – 56 years with a mean age of 29.9 years in their study titled "hearing loss in two prison populations". Similarly, Quinn and Rance[11] and Vanderpoll and Howard[12] in their different studies of inmates' population also reported age range of 17 - 55 and 20 – 60 years respectively. However, Thomas and Job[1] in India, reported that the age range of the inmates they studied ranged between 18 and 79 years with majority being within the age range of 41 – 60 years, followed most closely by those in the range of 20 – 40 years. Majority of the inmates in this current study were within the age range of 18 – 39 years; this was similar to findings by Quinn and Rance[11] in Australia and Jacobson et al.[13] in USA who reported 18 – 30 years and 18 – 35 years respectively as the most dominant population of the prison inmates they studied. This age group corresponds to the most agile category of most societies. This difference in the age group of the studied inmates might stem from the fact that Thomas and Job[1] assessed inmates with documented otologic complaints at the prison infirmary.

Majority of the inmates 383(89.1%) in this present study were males. Mc Randle et al.[10] in their study of prison inmates also reported a male preponderance 53(72.6%). Other prison inmates' studies that showed male preponderance include Quinn and Rance[11] in Australia 96(88.1%) and Holmes et al[14]. in USA 173(76.6%). The implication of this is that men are more likely to be involved in criminal or violent activities such as armed robbery, sexual abuse, drug trafficking and drug abuse, assaults and other criminal/violent activities than their female counterparts.

The prevalence of hearing loss among the inmates and the general population in this present study were 27.7% and 11.1% respectively and the difference was statistically significant (p=0.0001). The hearing loss being more in the prison population than the general population as noted in the study could be attributed to some predisposing factors among the inmates such as trauma to the ear in form of slap to the ears as volunteered by some inmates. Thomas and Job[1] in India reported that 32(31.4%) of the inmates studied had hearing impairment. Similarly, Mc Randle and Goldstein[10] in USA and Holmes et al[14] also in USA reported that 26/73 (35.6%) and 80/226 (35.4) respectively of the inmates studied failed audiometric screening. Jacobson et al[13] also reported hearing loss in 26 out of the 68 ears (38.2%) of the inmates they studied. The higher prevalence among prison inmates noted in the above studies compared to this present study may be due to the difference in methodology used as well as small sample size in the previously documented studies: all the above studies used smaller sample sizes compared to this current study. Age difference may similarly be a confounding factor for the higher prevalence reported in these studies. For instance, Thomas and Job[1] included older inmates' population (18 – 79 years) and this older population may have presbycusis and other comorbidities such as hypertension and diabetes which are all known causes of hearing impairment. However, Quinn and Rance[11] in their study titled "investigation into hearing impairment amongst indigenous prisoners in the Victorian Correctional System" reported a much lower prevalence among the Victorian indigenous prisoners and Australian adult populations of 6.0% and 3.0% respectively. This low prevalence reported in their study may be explained by the fact that they used better hearing ear in their assessment.

Majority, 155(65.1%) of those ears with hearing loss in this current study had mild degree of hearing loss; and moderate, moderately severe, severe and profound hearing loss accounted for 57(24.0%), 16(6.7%), 3(1.3%) and 7(2.9%) respectively. Vanderpoll and Howard[12] in their study also reported majority of the inmates studied (56.7%) had mild degree hearing loss, while moderate and severe hearing loss accounted for 28.3% and 9.7% respectively. Similarly,

Quinn and Rance[11] in Australia also reported that majority of the inmates with hearing loss in their study had mild degree hearing loss.

Of those inmates with hearing loss in this present study, majority (46.6%) had conductive hearing loss; while sensorineural and mixed hearing loss accounted for 29.4% and 24.0% respectively. This finding was similar to the finding by Quinn and Rance[11] in Australia. However, Thomas and Job[1] in India and Jacobson et al[13] in USA reported that majority of the inmates with hearing loss in their studies had sensorineural hearing loss. According to the study in India, 50.0% of the inmates with hearing loss had sensorineural, 18.8% had conductive and another 18.8 had mixed hearing loss. The reason for this difference may be due to difference in the studied population; they studied inmates with otologic symptoms. Another reason for the difference may be due to overcrowding of prisons in the developing countries such as Nigeria leading to exposure of the inmates to middle ear diseases leading conductive hearing loss.

In this study, the inmates were found to have higher rates of conductive hearing loss than the controls; this might be explained by the preponderance of tympanic membrane perforation among the inmates, more than what obtained in the control population, overcrowding, repeated upper respiratory tract infection leading to middle ear disease.

Of the 238 ears of inmates with hearing loss in this current study, majority, 156(65.5%) had all frequencies affected, followed by low frequency 58(24.4%), high frequency 19(8.0%) and mid frequency affectation 5(2.1%). This pattern was similar in the control group. However, studies from the United States and Australia revealed that higher frequencies were more affected in prison inmates with hearing loss.[10,11,13,14] No documented data available in the English literature on hearing threshold among prison inmates in Nigeria, West Africa and the African continent for comparison with this current study.

CONCLUSION

The findings of this study revealed that hearing loss was significantly more prevalent among prison inmates than the general population. In majority of the inmates at the Kaduna convict prison, the hearing loss was mild, conductive and mostly involving all the frequencies. There is a need for regular ear health care of the inmates as well as a holistic adoption and implementation of a healthy prison concept by decongesting the Nigerian prisons and improve the living condition of the prison inmates.

Acknowledgement:
We want to acknowledge the assistance rendered us by Dr. Umaru Sambo Grema of National Ear Care Centre Kaduna Nigeria for lending us his personal audiometer free of cost. We also want to acknowledge Malam Garba, a theatre attendant at the National Ear Care Centre that served as our research assistant and Malam Tanko Wambai who assisted us with Puretone audiometry on the participants.

Disclosure: The complete work was presented to the National Postgraduate Medical College of Nigeria as a partial requirement for the award of the College Fellowship in Otorhinolaryngology, May 2019.

Competing interests: None

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Cite this article as: Abdullahi Musa Kirfi, Mohammed Bello Fufore, Garba Mohammed Mainasara, Abdulrazak Ajiya, Aliyu Mohammed Kodiya, Onyekwere George Benjamin Nwaorgu. Hearing Evaluation Of Nigerian Prison Inmates: A Cross-sectional Survey. KJMS 2020; 14(2): 106 - 114.