

**Prevalence of Pulmonary Mycobacterial Infections and their Risk Factors among Inmates
of Agodi Custodial Centre Ibadan, Oyo State Nigeria**

**ADEGOKE Olusola Andrew
LCU\PG\002537**

**Being a M.Sc Thesis Submitted to the Department of Biological Sciences, Faculty of
Natural and Applied Sciences, Lead City University,
Ibadan, Oyo State, Nigeria**

**In Partial Fulfilment of the Requirements for the Award of Masters of Science Degree
(M.Sc) in Medical Microbiology**

2023

Certification

This is to certify that **Adegoke, Olusola Andrew** with the Matriculation Number **LCU/PG/002537**, carried out this research work titled “Prevalence of Pulmonary Mycobacterial Infections and their Risk Factors among Inmates of Agodi Custodial Centre Ibadan, Oyo State” in the Department of Biological Sciences, Faculty of Natural and Applied Sciences, Lead City University Ibadan, Oyo State, for the award of Master Degree (MSc.) in Medical Microbiology and this has not been previously submitted.

Toyosi Raheem Phd
(Supervisor)

Date

Dr. Felicia Adesina
(Head of Department)

Date

Dedication

This project is dedicated to God Almighty, my Redeemer who created me for a specific and unique purpose.

Do Not Copy, Lead City University, Nigeria

Acknowledgement

I want to acknowledge Lead City University and members of A-library for their support and knowledgeable impact. University College Hospital, Ibadan particularly South West Zonal Tuberculosis Reference Laboratory where the investigation was carried out and Agodi Custodial Centre for allowing me to use their Inmates samples. I am grateful to the Controller General and the Medical Officers in charge, most especially A.S.C 1 Ilesanmi O.O and A.S.C 1 Ogbolu A.C.

I am grateful to my supervisor Dr. Toyosi Raheem for his time, suggestions, constructive criticism, and corrections to the successful completion of this project. I also acknowledge the effort and support of the Head of Biological Sciences Department, Dr (Mrs) Felicia Adesina, and other lecturers namely Dr. Olagunju, Dr. Bamidele, Dr. Bukola Bamkefa, Dr. Sindiku, Dr. Ekanade and Dr. Bakare, to mention but a few. I am greatly indebted to Dr. Ejilude, my co-supervisor.

My utmost gratitude goes to my late Parents, Pastor and Mrs J. O. Adegoke for their moral and spiritual support during their lifetime. This appreciation will not be complete if I fail to thank my darling wife (Bee) and dear children (Ireoluwa, Oyinlolajesu and Oluwafunmito) for their great support, unquantifiable love and care.

Even though the above-mentioned institutions and persons have assisted in the process of this research work, I alone stand responsible for the errors, if any, found in the work.

Abstract

Prison represents dynamic communities with congregation of risk factors of Mycobacterial infections, other diseases and its transmission. The study determines the prevalence of mycobacterial infections that is yet to be studied in Agodi Custodial Center, Oyo State, Nigeria. A total of two hundred (200) sputum samples were collected from the inmates who have been coughing for weeks or more between January and June, 2022. Structured Questionnaires were administered to the eligible inmates to capture bio-data and TB risk factors. National Tuberculosis and Leprosy Control Program (NTBLCP) Algorithm of test for *Mycobacterium tuberculosis* was strictly followed in addition to genetic relatedness of the isolates which was determined using Phylogenetic analysis. 39.5% of the inmates tested had their average means age to be 29.5 years. Over 67.5% had secondary education as their highest educational qualification. Out of 19.5% that were positive for Gene Xpert MTB/RIF assay 10% were Rifampicin sensitive, 1.5% were Rifampicin resistant and 8.5% were Rifampicin Indeterminate. Respondent educational status ($p=0.000$), HIV status ($p=0.000$), those with cough for two or more weeks ($p=0.008$) and those previously treated for TB ($p=0.002$) respectively were statistically significantly associated with mycobacterial infection. Culture result captured the overall prevalence of mycobacterial infections in Agodi prisons to be 21%. Out of this *Mycobacterium tuberculosis* was 10%, *Mycobacterium bovis* was 5%, Non-Tuberculous Mycobacterium (NTM) was 6% *Mycobacterium fortuitum* dominated among the NTM, *Mycobacterium chelonie* in lesser percentage. The overall anti-TB resistance was found to be 11.5% with Rifampicin resistance 70.0% and 76.6% by LPA (molecular) phenotypic proportion method respectively. The study show that the prevalence of mycobacterial infection with concomitant drug resistance is high among the inmates at Agodi Custodial Center with overcrowding as the most associated factor. Therefore, prison decongestion, architectural design and infection control measures are recommended to stop the high rate of mycobacterial infections.

Key words: Mycobacterial infection, Prison inmates, Tuberculosis, Risk factors, Rifampicin Resistant.

Word Count: 300

Table of Contents

Contents	Page
Title Page	i
Certification	ii
Dedication	ii
Acknowledgement	iii
Abstract	iv
Table of Contents	vi
List of Tables	xii
List of Figures	xiv
List of Acronyms	xv
Chapter One: Introduction	
1.1 Background of the Study	1
1.2 Statement of the Problem	4
1.3 Justification of the Study	4
1.4 Aims and Objectives of the Study	4
1.5 Research Questions	5

1.6	Significance of the Study	5
1.7	Scope of the Study	5
1.8	Limitation of the Study	5
1.9	Operational Definition of Terms	6
	Endnotes	8

Chapter Two: Literature Review

2.1	The Great White Plague Review	10
2.2	Pathogenesis	13
2.3	The Bacteriology	15
2.4	Diagnosis	16
2.4.1	Culture and Sensitivity	16
2.4.2	Culture Media	18
2.4.2.1	Solid Media	20
2.4.2.2	Liquid media	21
2.5	Treatment and Prognosis	22
2.5.1	DOTS Assisted Treatment for Prison Inmates	25
2.6	Epidemiology	26
2.6.1	Current Global Distribution	26
2.6.2	Vulnerable Populations	28
2.7	Global Initiatives	30
2.8	Progress Research and Development	31

2.9	Antibiotic Resistance	32
2.10	Prevention and Control	36
2.11	TB Control in Prison	40
2.12	Case Finding and Screening In Prisons	40
2.13	TB Co-infections in Prison Inmates	42
2.14	A Systematic Review and Meta-Analysis	47
2.15	Prison Judiciary Aspect	49
2.15.1	Prisons Can be Bad for Public Health	50
2.15.2	Human Rights and Prisoners' Instruments and Mechanisms	51
15.3	The Right to Health Care and a Healthy Environment in Prison	52
2.15.4	Health Care in Prison: Equivalence versus Equity	53
	Endnotes	56
 Chapter Three: Methodology		
3.1	Study site	70
3.2	Study materials	70
3.3	Sample analysis	70
3.4	Microscopy	71
3.4.1	Direct Smear Preparation	71
3.5	Gene X/Pert/MTb-Rif Assay	72

3.5.1	Start-up of Gene Xpert Instrument	72
3.5.2	Sample Preparation	72
3.6	Decontamination with n-acetyl l-cysteine- sodium hydroxide	73
3.6.1	Inoculation	74
3.7	Identification	74
3.7.1	Rate of Growth	74
3.7.2	Temperature at which growth occurs	74
3.7.3	Pigment production	75
3.7.4	Niacin Accumulation test	75
3.7.5	68 ⁰ C Catalase test	75
3.7.6	Growth on PNB medium	76
3.7.7	Arysulphatase test	76
3.7.8	Nitrate reduction test	76
3.8	SD Bioline Test	76
3.9	(DST) Drug Sensitivity Testing	77
3.9.1	Proportion Method	77
3.10	Preparation of drug solutions	78
3.10.1	Drug potencies	78

3.10.2 Isoniazid	78
3.10.3 Rifampicin	78
3.10.4 Streptomycin	79
3.10.5 Ethambutol	79
3.11 The proportion method	79
3.11.1 Reading, interpreting and reporting	80
3.12 Line Probe Assay(LPA) For First& Second Line Anti TB Drugs	81
3.12.1 DNA Extraction	81
3.12.2 PCR Amplification (Master Mix Preparation Addition, DNA Addition, Amplification in Thermocycler)	81
3.12.3 Addition of master mix	82
3.12.4 Amplification in Thymocycler	82
3.12.5 Hybridization	83
3.13 Molecular Identification	84
3.13.1 Bacteria DNA Extraction	84
3.13.2 Bacteria DNA PCR Analysis	84
3.13.3 Integrity	85
3.13.4 Sequencing	86
3.14 Data Analysis	86
3.15 Ethical Approval	87
Endnotes	88

Chapter Four: Results and Discussion of Findings

4.1	Results of Findings	92
4.2	Discussion of Findings	89

Chapter Five: Summary of Findings, Conclusion and Recommendation

5.1	Summary of Findings	153
5.2	Conclusion	155
5.3	Recommendation	156
5.4	Contribution to Knowledge	157
5.5	Suggested Areas for Further Research	157

Bibliography	158
---------------------	------------

Appendices	176
-------------------	------------

Bio-data	186
----------	-----

The University Compliance Certification	188
---	-----

List of Tables

Tables Title	Page
4.1 Social-demographic Characteristic	89
4.2 Frequency Distribution of Test Performed	92
4.3 Relationship between Participants' Age and Variables in the Questionnaire	95
4.4 Relationship between Culture and Variables in Questionnaire	98
4.5 Relationship between Gene Xpert and Variables in the Questionnaire 1	101
4.6 Relationship between Gene Xpert and Variables in the Questionnaire 2	104
4.7 Relationship between Gene Xpert and Variables in the Questionnaire 3	107
4.8 Relationship between Direct Stain and Variables in the Questionnaire	110
4.9 Relationship between LPA-RIF and Variables in the Questionnaire	113
4.10 Relationship between LPA -INH and Variables in Questionnaire	116
4.11 Relationship between LPA- FLQ and Variables in the Questionnaire	119
4.12 Relationship between Gene Xpert and Age 1	122
4.13 Relationship between Gene Xpert and Age 2	123
4.14 Relationship between Gene Xpert and Age 3	124
4.15 Relationship between Culture and Age	125
4.16 Relationship between Direct Zn Stain and Age	126
4.17 Relationship between Zn Isolate Age	127
4.18 Relationship between LPA-RIF and Age	128
4.19 Relationship between LPA -INH and Age	129
4.20 Relationship between LPA- FLQ and Age	130
4.21 Mycobacterium Infections	131
4.22 Anti TB Drug Resistance Pattern	132

Table	Title	Page
4.23	Mycobacterium Infections vs Antibiotic Resistant Genes	133
4.24	Phenotypic Characterization of Non Tuberculous Mycobacterium	134
4.25	NCBI Blast Showing the Sequence Identity of the Isolate Sequenced.	136
4.26	Genetic Distance Analysis Showing the Genetic Relatedness between the Isolated Mycobacteria and Reference Sequence Generated from the NCBI Data Base	139

Do Not Copy, Lead City University, Nigeria

List of Figures

Figure	Title	Page
4.1	Agarose Gel Showing the Positive Amplification of the ITS Regions Amplified from the Selected Sample	135
4.2	Sequence Alignment Revealing Location of Nucleotide Changes Along the Edited Sequence	137
4.3	Phylogenic Analysis Showing the Genetic Relatedness between the Isolated Mycobacteria and Reference Generated from the Data Base	138
4.4	>3186 Mycobacterium tuberculosis	140

Do Not Copy, Lead City University, Nigeria

List of Acronyms

Abbreviations	Meaning
ADA	Adenosine Deaminase
AFB	Acid fast Bacilli
AIDS	Acquired Immunodeficiency Syndrome
AMLSCN	Associate Medical Laboratory Science Council of Nigeria
ART	Anti- Retroviral Therapy
ATP	Adenosine Triphosphate
B.C	Before Christ
BACTEC	Becton, Dickinson and Company Technology
BCG	Bacillus Calmette Guerine
BMI	Body Mass Index
BSC	Biosafety Cabinet
C	Control
CDC	Center for Disease Control
CNR	Case Notification Rate
CO ₂	Carbon dioxide
CSF:	Cerebro Spinal Fluid
CTP	Committee for the Prevention of Torture
DNA	Deoxyribonucleic Acid
DOTs	Directly Observed Treatment Short-course
DRC	Democratic Republic Congo
DST	Drug Susceptibility Testing

DT or DP	Degrading Treatment or Punishment
EDTA	Ethylene Di-amine Tetra acetic Acid
EMB	Ethambutol
EPTB	Extra pulmonary Tuberculosis
ESTC	European Standard for Tuberculosis Care
FDA	Food and Drug Administration
FL	First Line
FMLSCN	Fellow Medical Laboratory Science Council of Nigeria
FMOH	Federal Ministry of Health
GAT	Garitfloxacin
HBCs	High burden countries
HIV	Human Immunodeficiency Virus
ICCPR	International Covenant on Civil and Political Rights
ICESCR	International Covenant on Economic, Social and Cultural Rights
IGRA	interferon-gamma release assay
IJPH	International Journal of Public Health
INH	Isoniazid
ITS	Information Technology Solution
IUATLD	International Union Against Tuberculosis and Leprosy Disease
IUATLD;	International Union Against Tuberculosis and Leprosy Disease
LJ	Lowenstein Jensen
LPA	Line Probe Assay
MB	Middle Brook

MDG	Millennial Developmental Goal
MDR-TB	Multidrug Resistant Tuberculosis
MGIT	Mycobacterial Growth Indicator Tube
MGW	Molecular Grade Water
MODS	Microscopic Observation of Drug Sceptibility
MSc.	Master of Science
MTB/RIF	Mycobacterium/Rifampicin
MTBC	Myco-Tuberculous complex
NAAT	Nucleic Acid Amplification Test
NAD	Nicotinamide Adenine Dinucleotide
NALC	N-Acetyl L-Cysteine
NaOH	Sodium Hydroxide
NCBI	National Center for Biotechnology Information
NGO	Non Governmental Organization
NIMR	Nigerian Institute of Medical Research
NRA	Nitrate reductase Assay
NTM	Non Tuberculous Mycobacteria
OADC	Oleic Acid-Albumin-Dextrose-Catalase
PCR	Polymerase Chain Reaction
PH	Puissan de Hydrogen
PLHIV	People Living with Human Immuno-deficiency Virus
PPD	Purified Protein Derivative
PRISMA	Preferred reporting Items for Systematic Reviews and Meta-Analysis

PSQ	Pyrosequencing Degrading Treatment or Punishment
PTB	Pulmonary tuberculosis
PZA	Pyrazinamide
RA	Registered Associate
RNA	Ribonucleic Acid
RR-TB	Rifampicin Resistant Tuberculosis
S	Streptomycin
SARS	Severe Acute Respiratory Syndrome
SDG	Social Developmental Goal
SL	Second Line
SPSS	Statistical Package for Social Sciences
SSA	Sub Saharan Africa
TB	Tuberculosis
TST	Tuberculin Skin Testing
UCH	University college hospital
UHC	Universal Health Coverage
UHC:	Universal Health Coverage
USA	United State of America
WHO	World health organization
XDR-TB	Extensively Drug Resistant Tuberculosis
XXDR-TB	Extremely Drug Resistant Tuberculosis