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Original Article

Burden of nosocomial tuberculosis and effect of educational intervention on infection prevention and control among healthcare workers in Kaduna state northwest, Nigeria

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ABSTRACT

Objectives: Tuberculosis (TB) is one of the top ten leading causes of death from a single pathogen, caused by *Mycobacterium tuberculosis* (MTB) affecting the lungs and other parts of the body, pulmonary TB and extrapulmonary TB. TB is the increased rate of transmission among healthcare workers (HCWs), especially in developing nations, due to resource constrained. The study assessed the burden of nosocomial TB and the effect of educational intervention on infection prevention and control among HCWs in Kaduna State.

Material and methods: Records of health facilities offering TB services were reviewed and cross-sectional survey designs were used to obtain pre- and post-intervention data from health workers for this study. All healthcare personnel providing TB care services in healthcare facilities across Kaduna State were included in the study population. A multi-stage purposive sampling procedure was adopted for the selection of the healthcare facilities. The educational intervention using World Health Organization guidelines on TBIC was provided among HCWs. The HCW's knowledge of TBIC was assessed post-intervention. However, post-intervention was also conducted after 6 months to determine the effect of the training intervention. Data were collected using a checklist to determine the case fatality and incidence rate of TB. An adopted questionnaire was used to assess the level of knowledge on TBIC among HCWS during pre- and post-intervention. Descriptive statistics and *t*-tests were used to analyze the data (x = 0.05).

Results: The incidence and case fatality due to TB among HCWs in Kaduna State was 0.158% and 30%, respectively. The effect of the educational intervention was statistically significant at (0.001). Despite the low incidence of TB among HCWs, the case fatality is high among this cohort.

Conclusion: However, educational intervention in TB infection prevention and control is effective in reducing nosocomial TB among HCWs. A prospective cohort study is recommended to document the actual TB burden among HCWs in the state.

Keywords: Nosocomial transmission, Burden of tuberculosis, Healthcare workers

INTRODUCTION

Nosocomial tuberculosis (TB) has been reported in sub-Saharan Africa to result in significant morbidity and mortality in patients and healthcare workers (HCWs) due to poor provision and implementation of TB infectious control.[1] HCWs remained susceptible to developing TB despite the decline of the disease in the general population.[2] The transmission of occupational TB is on the increase among nations with limited resources and a high burden of TB/human

immunodeficiency virus (HIV). The median annual incidence of occupationally acquired TB was 5.8% in low-income countries compared to 1.1% in high-income countries due to poor implementation of the World Health Organization (WHO) guidelines on infection prevention and control.[3] The attributable risk for TB disease in HCWs, compared to the risk in the general population, ranged from 25 to 5361/100 000 per year.[4] Carelessness of health professionals to seek medical attention, poor working environment, inadequate personal protective equipment, fear of discrimination, inconsistent supervision and surveillance, medical conditions such as cancer and diabetes mellitus, and other risky lifestyles like alcoholism increase the associated risk factors for developing active TB among frontline HCWs globally.[5] It documented that DOT's centers are widely available across Kaduna State, this implies that a significant number of HCWs were exposed to developing nosocomial TB if not adequately trained on TBIC using WHO guidelines.[6]

Insufficient training on tuberculosis infection prevention and control (TBIPC) is the documented reason that determined the high TB rate among HCWs in the developing world.[7] Due to the importance of training HCWs on TBIC in reducing the burden of nosocomial TB, the training has been made the general responsibility of public and private organizations.[8] It is recommended that educating health professionals in the prevention and control of infection should be made periodic to ensure implementation and updated knowledge of these guidelines.[9] The lack of comprehensive reports on the incidence of active TB among HCWs in Nigeria is a documented reason for increasing the transmission of occupational TB among these cohorts in the Country.[10] Infected HCWs should be encouraged to repotting themselves for the effective treatment of TB using the WHO End-TB strategy.[11] The study is aimed to assess the burden of nosocomial TB and the effect of educational training among HCWs in Kaduna State, Nigeria.

MATERIAL AND METHODS

Study design

Records of Health facilities offering TB services were reviewed from 2006 to 2020, and cross-sectional survey designs were used to obtain pre- and post-intervention data from health workers for this study [Annexure 1].

Population of the study

Medical personnel, pharmacies, health records officers, community health, environmental health, X-ray technicians, and medical laboratories that provide TB treatment services through DOTs from both public and commercial facilities in Kaduna State are included in the study population.

Study area

Kaduna State, which occupies 46,053 km² overall, is situated in Nigeria's northwest geopolitical zone. The state's population is expected to be 8,397,541 throughout its 23 local government area (LGA) in 2017, up 3.0% from the 6,113,503 national predictions from 2006 (National Bureau of Statistics [NBS], 2017). Agricultural activities are the major source of income in the state. Six LGAs were selected for the conduct of this study, including Kubau and Zaria from Zone A, Igabi and Kaduna North from zone B, and Kauru and Kachia were also selected from zone C, respectively. However, 36 health facilities were also selected, six from each of the selected LGA.

Data source

Primary data were collected from HCWs using a questionnaire to assess the HCW's level of knowledge on TBIC at pre- and post-intervention from the health facilities, educational intervention was provided among HCWs using the WHO guidelines on TBIC, and the secondary data were collected using a checklist from the TB central register to determine TB burden.

Study size

The study was conducted among 36 healthcare facilities providing TB care services in Kaduna State, Nigeria.

Sample size determination

An appropriate sample size was calculated based on the following assumptions:

- 27.8% prevalence of TB among HCWs, this was adopted from South
- Africa due to the low prevalence of TB among HCWs in Nigeria. The sample size was determined using the Yamane formula for sample size determination.

Where,

Z = 1.96.

P = 0.278 (27.8% prevalence).

e = 0.05 (precision rate).

n = 306.

+ 10% non-response rate = 31.

306 + 31 = 339.

n = 339.

Sampling methods

A multistage purposive sampling procedure was used. The first stage stratified the state according to the three senatorial

districts. The second stage selected 36 health facilities, both public and private, from six (6) selected local governments and two (02) LGAs per senatorial district, considering urban and rural characteristics using purposive sampling. The third stage has purposively selected 339 HCWs working at the DOT's clinic.[2]

Data collection

Data were collected using a checklist on the record of TB among HCWs from 2006 to 2020 across the 36 health facilities to determine incidence and case fatality rates. However, to provide educational intervention, a training tool was adopted from the WHO guideline on TBIC. Data were also collected using a questionnaire during pre- and post-intervention to determine the significance of the training intervention after 6 months. Other data on the provision and implementation of TBIC were also collected using a questionnaire.

Data analysis

Secondary data collected from the TB central register using a checklist were analyzed using an epidemiological formula to determine incidence and case fatality rate, and the result was presented in proportion/percentage. All data collected on the effect of educational intervention were cleaned and entered into the statistical package of social science software version 23.0. The sociodemographics of the respondents and other factors that were nominal data were presented as counts and percentages. Paired *t*-test was used to compare the difference between the pre- and post-intervention knowledge and practices. The chi-square test was used to determine the level of statistical significance and drivers of the knowledge of TBIC.

Ethical clearance

Ethical clearance/approval was obtained from the Kaduna State Ministry of Health Research Committee, Health Research and Ethical Committee, National TB and leprosy training center Zaria and Lead City University Research Ethical Committee (LCU/REC/22/103). The study has no harm on the participants. The participants were informed of their willingness and right to participate or withdraw from the study. The participants benefited from the free educational training provided by this study.

RESULTS

Demographic characteristics of respondents

A total of 325 respondents were interviewed, out of which 171 (52.6%) were male 175 (53.8%) were between the ages of 25 and 34, with a mean age of 31.51 ± 8.24. Among these health workers, 220 (67.7%) are married, 158 (48.6%) have National certification examination (NSE)/ Ordinary nationa diploma (OND) degrees, 136 (41.1%) have higher degrees and only 31 (9.5%) have a secondary school certificate and below. More than 50% of the respondents were either laboratory personnel 93 (28.7%) or community HCWs 87 (26.8%). The result of this analysis also shows that the majority of the respondents were community health workers, 87 (26.8%), while only 21 (6.5%) were doctors, respectively. About 36.6% of the respondents were from the general outpatient department, while 46 (14.2%) were from the DOTS centre [Table 1]. The majority of the respondents, 51.4%, were from urban settings, while 48.6% were from rural healthcare facilities [Table 1].

The result of the analysis shows that 6325 TB cases were documented among the general population from 2006 to 2020, 5811 were declared cured, 481 were satisfied death, 33

Table 1: Demographic characteristics of the respondents.

Variable	Frequency	Percent
Age group		
Mean age (±SD)	31.51±8.24	
24 and below	49	15.1
25–34	175	53.8
35–44	71	21.8
45 and above	30	9.2
Sex		
Male	171	52.6
Female	154	47.4
Marital status		
Single	96	29.5
Married	220	67.7
Others	9	2.8
Education qualification		
Secondary and below	31	9.5
OND/NCE	158	48.6
Higher	136	41.8
Cadre		
Doctors	21	6.5
Nurse	59	18.2
Laboratory personnel	93	28.7
Community health	87	26.8
Environmental	30	9.2
Medical records	25	7.7
Health attendant	35	10.8
Unit		
GOPD	119	36.6
Laboratory	43	13.2
DOTs	46	14.2
Record	25	7.7
Ward	55	16.9
Others	37	11.4
Facility setting		
Urban		51.4
Rural		48.6

Source: Researcher's Survey (2022). SD: Standard deviation, OND: Ordinary national diploma, NCE: National certification examination, GOPD: General outpatients department, DOTs: Directly observed therapies.

were lost to follow-up, 362 were TB/HIV co-infected, 10 cases were reported among HCWs, two cases were TB/HIV co-infected among TB in HCWs, seven were declared cured, and three cases were satisfied death [Table 2].

This result shows that 6325 active cases were diagnosed among general populations, including HCWs, from 2006 to 2020, out of which 5811 were declared cured, 481 were satisfied with death, and 33 were lost to follow-up. Out of the 6325 cases, only 10 (0.16%) were HCWs, out of which 2 (20%) cases were TB/HIV co-infection, 7 (70%) were declared cured, and three were satisfied cured [Figure 1].

The overall result of this analysis shows that only 6% and 22% have good implementation and adequate provision of TB infection prevention and control [Figure 2].

Table 2: Confirmed TB record in Kaduna State from 2006 to 2020.

Total number of confirm TB case	6325
Cured	5811
Death	481
Lost to follow-up	33
TB/HIV Co-infection	362
TB in HCWs	10
TB/HIV in HCWs	2
TB Cured in HCWs	7
TB Death in HCWs	3

Source: Researcher's survey (2022). TB: Tuberculosis, HIV: Human immunodeficiency virus, HCWs: Healthcare workers

The result of this analysis shows that only 29.8% have good knowledge of TB infection prevention and control during pre-intervention, while 70.2% have good knowledge at post-intervention [Chart 1].

DISCUSSION

The study findings revealed that among HCWs in Kaduna State, only ten out of the 6325 confirmed cases of TB were reported as active TB cases. This suggests that the incidence rate of TB among HCWs in the state is approximately 0.158%. The study's results are in line with similar research conducted in Egypt, which reported a 0.5% prevalence of TB among HCWs.[12] In addition, a separate study conducted in Uganda documented a prevalence rate of 1.7% of TB among HCWs.[13] Ethiopia reported a prevalence rate of 1.4%.[14] Another study in Nigeria has reported a 1.5% prevalence of active TB among HCWs.[15] Furthermore, a study in Nigeria documented different incidence rates of TB among HCWs, with rates of 3.3% and 2.2% reported by acid-fast bacilli and culture methods, respectively.[1] In Zambia, a study reported a prevalence of 38.3% of active TB among bedside contacts.[16] In South Africa, a significant prevalence of 27.8% of TB was reported among HCWs.[17] These variations in prevalence and incidence rates can be attributed to differences in study design, such as prospective cohort studies, as well as differences in the reporting systems for TB cases among HCWs across Egypt, Ethiopia, Uganda, and Nigeria. In a recent study conducted in Kaduna State, Nigeria, a prevalence

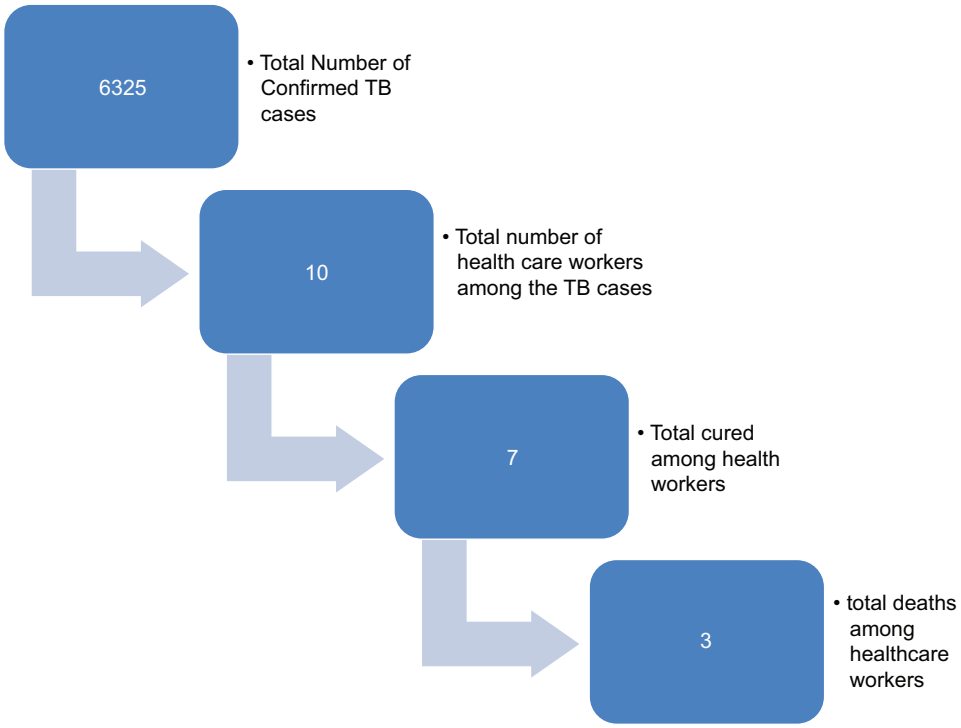

Figure 1: Confirm tuberculosis (TB) cases among general populations. Source: Researcher's survey (2022).

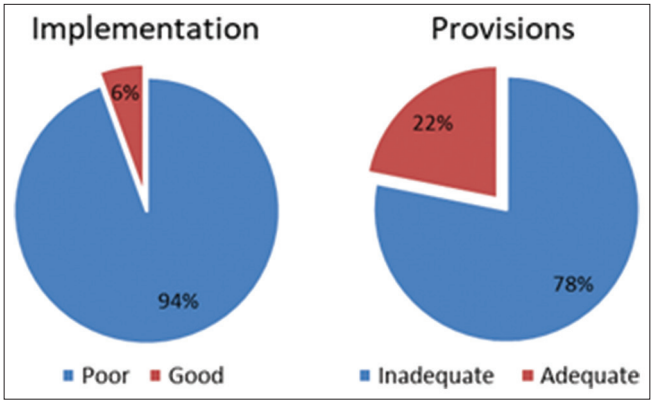

Figure 2: Provision and implementation of World Health Organization guideline on tuberculosis infectious control. Source: Researcher's survey (2022).

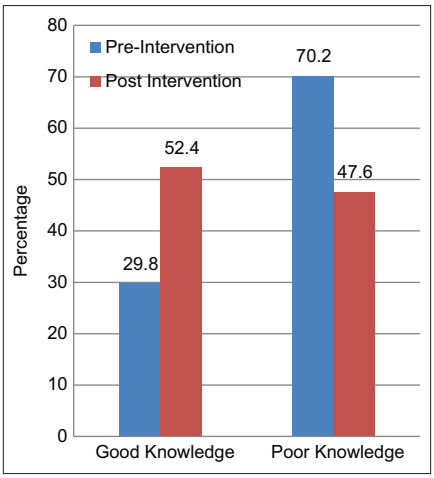

Chart 1: Knowledge of tuberculosis infection control (pre and post intervention scores). Source: Researcher's survey (2022).

of 0.158% of active TB among HCWs was reported, aligning with the earlier finding.[18]

Among HCWs, ten cases of TB were confirmed; out of these, three individuals were declared dead, implying a case fatality rate of 30% due to TB in this cohort. This high case fatality rate was likely due to the prevalent HIV infection among the HCWs. This finding is consistent with a study conducted in Malawi, which reported an overall case fatality rate of 24% due to TB among HCWs.[19] Another study in South Africa documented a 13% death rate due to TB among HCWs.[20] In contrast, a study in Nigeria reported a lower death rate of 6.3% due to TB among HCWs.[1] Furthermore, two studies, one in South Africa and another in Taiwan, both reported 0% death rates from TB in HCWs.[21,22] The differences in TB-related mortality among HCWs across these studies can be attributed to the presence or absence of HIV co-infection. A recently published study documented 30% of deaths due to TB among HCWs in Kaduna State.[18]

The results of this study indicated that the provision and implementation of the WHO guidelines on TB infection prevention and control (TB IPC) was insufficient. This finding is similar to a study in Mozambique that reported inadequate implementation of infection control measures due to a lack of clear training on the TB IPC guidelines.[23] Likewise, a study in South Africa found poor implementation of TB IPC practices due to a lack of training.[24] Another study conducted in Ethiopia attributed the lack of proper TB IPC practices to insufficient infrastructure and resources. A systematic review also documented that the provision and implementation of TB IPC measures are frequently inadequate across various settings.[25] Another study identified poor implementation of TB IPC measures in health settings in Bangladesh.[26] It is documented from a study that only less than half of the HCWs had good practices of TB infection control;[27] it is also reported from a study that the proportion of proper TBIPC practices among public HCWs was low.[28] Another study in Lagos, Nigeria, documented poor provision of TB infection control equipment.[29] Consistent with these findings, a recent study in Kaduna state, Nigeria, also reported insufficient provision and implementation of the WHO guidelines on TB infection prevention and control.[2]

The results of this study show that the training interventions provided on the WHO guidelines for TB infection control were statistically significant when comparing the pre-intervention and post-intervention overall scores. This finding is in line with a study that reported improvement in post-intervention scores, implying that the educational intervention adopted for this study was effective in improving TBIC among the nurses.[30] Similarly, another study found that the training intervention led to improved knowledge of symptoms, prevention, diagnosis, and treatment of TB among community health workers.[31] Additional studies documented that educational interventions increased staff knowledge of TB infection prevention and control and that such interventions are significant in preventing TB transmission among HCWs.[32] Another study reported that educational intervention is significant in preventing TB among HCWs.[33] Consistent with these findings, a recent study conducted in Kaduna state, Nigeria, identified that providing educational training on TB infection control using the WHO guidelines is an effective way to reduce nosocomial (hospital-acquired) TB.[34,35]

Decision rule

If the *P*-value is greater than the critical value (0.05), we fail to accept the null hypothesis; hence, otherwise. Since the majority of the *P*-value satisfies otherwise (i.e., <0.005), then the decision rule is to reject the null hypothesis (H_0), which states that there is a significant difference between the pre and post-test.

Annexure 1: STROBE Statement–Checklist of items that should be included in reports of cross-sectional studies.

	Item No	Recommendation	PageNo
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract (*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	1–2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	3–4
Objectives	3	State specific objectives, including any prespecified hypotheses	4
Methods			
Study design	4	Present key elements of study design early in the paper	4
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	4
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	4
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	4
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	4–5
Bias	9	Describe any efforts to address potential sources of bias	
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	
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding (*b*) Describe any methods used to examine subgroups and interactions (*c*) Explain how missing data were addressed (*d*) If applicable, describe analytical methods taking account of sampling strategy (*e*) Describe any sensitivity analyses	5
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study – for example, numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analyzed	5
		(b) Give reasons for non-participation at each stage	5
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (e.g., demographic, clinical, and social) and information on exposures and potential confounders (b) Indicate number of participants with missing data for each variable of interest	
Outcome data	15*	Report numbers of outcome events or summary measures	
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (e.g., 95% confidence interval). Make clear which confounders were adjusted for and why they were included (*b*) Report category boundaries when continuous variables were categorized (*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	6
Other analyses	17	Report other analyses done – for example, analyses of subgroups and interactions, and sensitivity analyses	
Discussion			
Key results	18	summarize key results with reference to study objectives	7
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	10
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	10
Generalizability	21	Discuss the generalizability (external validity) of the study results	11

Annexure 1: STROBE Statement–Checklist of items that should be included in reports of cross-sectional studies.

	Item No	Recommendation	PageNo
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	12

*Give information separately for exposed and unexposed groups. 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

Limitations of the study

The limitations of this research study include challenges with data quality and poor/improper documentation of confirmed TB cases among HCWs. The educational intervention was provided at each senatorial district due to the inability to gather all the participants at the same venue as the result of distance and fear of insecurity.

Interpretation

Despite the high fatality rate due to TB among healthcare workers, the incidence rate remained low due to poor documentation in Kaduna State. The provision of educational intervention on TBIC using the WHO guideline is an effective way to reduce nosocomial TB among HCWs.

Recommendation

Educational training and retraining of HCWs on WHO TBIC should be provided to all HCWs providing TB care services through DOTs. Records of active TB cases in HCWs should be properly documented so as to document the actual TB burden among HCWS. The provision and implementation of TBIC guidelines should be adequately provided across all health facilities providing TB care services.

CONCLUSION

Providing adequate educational training intervention is a way to reducing the burden of tuberculosis among healthcare workers in Kaduna State, Nigeria.

Acknowledgments

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Ethical approval

The authors declare that they have taken the Institutional Ethical Committee approval and the approval number is LCU/REC/22/103.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

Use of artificial intelligence (AI)-assisted technology for manuscript preparation

The authors confirm that there was no use of artificial intelligence (AI)-assisted technology for assisting in the writing or editing of the manuscript and no images were manipulated using AI.

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