The effect of an educational intervention to improve tuberculosis infection control among nurses in Ibadan, South-West Nigeria: a quasi-experimental study

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Research article

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Abstract

Background: Nurses are particularly vulnerable to acquiring TB because they are in the frontline of patient care. There is inadequate implementation of cost-effective TB infection control (TBIC) measures at most health facilities. Training has been shown to be effective in improving the knowledge and work practices of nurses. This study sought to utilize a mixed-approach educational intervention to improve the TBIC-related knowledge and practices of nurses in two secondary health facilities in Ibadan, South-West Nigeria.

Methods: This quasi-experimental study involved 200 (100 each in the intervention and comparison groups). Baseline data was collected in May 2014. This was followed by training of the nurses in the intervention group. After 6 months, the second wave of data was collected and the nurses in the comparison group also received the training after this. The final wave of data collection took place 12 months after the commencement of the study. Mean scores of the nurses were determined and comparison made between both groups at different time points using independent t -test.

Results: The nurses in both groups were statistically comparable in their socio-demographic characteristics and baseline mean knowledge (68.6% and 67.7%) and practice scores (79.1% and 80.6%) respectively. After the intervention group received the training, there were appreciable improvements in the post-intervention scores of the group at 6 months (knowledge-85.9%; practice-98.5%), which were significantly different from those of the comparison group (knowledge-69.5%, practice-78.8%). A large effect size was demonstrated in the improvement in knowledge score in the intervention group at 6 months compared with the other group (Cohen's d = 1.7). Similarly, there were improvements in the scores of the nurses in the comparison group at 12 months after the group had also received the training (knowledge-88.2%, practice-93.5%). At this point, the mean scores between both groups were no longer significantly different.

Conclusions: The improvement in post-intervention scores implies that the mixed-approach educational intervention adopted in this study was effective in improving TBIC among the nurses. It also underscores the importance of continuous training/retraining of nurses and other healthcare workers in improving and sustaining TBIC at health facilities.

Background

Globally, TB was the leading cause of death due to an infectious disease[1]. It is caused by a microorganism called *Mycobacterium tuberculosis (*MTB) and commonly affects the lungs (pulmonary TB or PTB). PTB constitutes about 85% of all TB cases [2]. TB can also affect other organs in the body (extrapulmonary TB): the lymph nodes, abdomen, bones and joints, pericardium, pleura, genitourinary system and meninges; and can be generalized. PTB is the most important source of TB transmission as MTB is carried in air-borne droplets or aerosols produced when a person infected with PTB coughs, sneezes, spits, talks or sings. TB is preventable and there is affordable and effective treatment for it. In

2017, an estimated 10 million new cases of TB were recorded globally, with the African region accounting for 25% of these cases.

Nigeria is the most populous country in Africa, with a 2017 estimated population of about 182 million people [1]. It ranks sixth among the countries with the highest TB burden in the world and is included in three World Health Organization (WHO) lists of 30 high burden countries for TB, TB/HIV and MDR-TB for the period 2015–2020, as well as being one of the ten countries accounting for 80% of the global TB case finding gap. The country reported 418,000 incident TB cases in 2017, with an incidence rate of 219/100,000 [1]. TB was successfully treated in 86% of all cases registered in 2016. Approximately 155,000 people died from TB in the country in 2017, and about 23% of these deaths (35,000) occurred in TB/HIV co-infected people. It has an MDR-TB/RR-TB prevalence of 4.3% and 25% among new cases and previously treated cases respectively [1]. With an estimated national HIV prevalence of 3.0% among adults aged 15–49 years and 3.2 million people living with HIV (PLHIV), it has the second largest HIV burden in the world [3,4].

The transmission of TB in health facilities, known as nosocomial TB transmission, poses a particular challenge for healthcare workers (HCWs) worldwide. The increased risk of nosocomial TB transmission among HCWs has been well-documented and the incidence of TB disease in HCWs are generally higher than in the general population [5–8]. This risk is worsened by the increased exposure of HCWs to infectious TB patients, especially when there is inadequate implementation of TBIC measures [9–11]. Effective TBIC requires strict adherence to recommended control measures. Because of the diversity of the risk factors for the transmission of TB in health facilities, WHO has advocated for the adoption of several TB infection control measures [12]. These include: (i) Managerial measures, which are concerned with the establishment of a facility infection control committee, assessment of the risk of TB transmission in the facility and the development of infection control policies and plan (ii) Administrative measures, which are considered the first priority even in resource-limited settings as they have the greatest impact on preventing nosocomial TB transmission; these ensure prompt identification of coughing patients at triage, their movement to a separate area in the clinic, promotion of cough etiquette and fast-tracking coughing patients for prompt diagnosis and treatment (iii) Environmental control measures, which are aimed at reducing the number of infectious droplet nuclei in the environment by maximizing natural ventilation (keeping windows and doors open); the use of fans, complex and expensive mechanical ventilation (negative pressure); as well as ultraviolet germicidal irradiation (UVGI) to kill MTB organisms; and (iv) Personal protection equipment (PPE) e.g. particulate respirator; because it is expensive and specialized skill is required for its use, it is usually limited to high-risk areas such as MDR-TB treatment centre and bronchoscopy suite. Since it is not feasible to implement expensive technologies such as mechanical ventilation, isolation rooms, ultraviolet gamma irradiation (UVGI) and respirators in most low- and medium-income countries (LMIC), it has been recommended that simple, practical and cost-effective interventions be adopted to reduce the exposure of HCWs to infectious TB patients in these settings [13]. These measures have been successfully implemented in most high-income countries and in some resource-limited settings [14]. Poor implementation of the recommended control measures by HCWs has however been reported [15–17]. The adoption and implementation of TBIC

practices by HCWs are known to be positively influenced by good knowledge regarding occupational TB exposure [17,18]. HCWs have been shown to have varying levels of knowledge and practice concerning TBIC and a good understanding of TBIC does not necessarily translate into adequate TBIC practices [11,19]. In addition to poor knowledge, weak managerial support, poor funding, lack of space and inadequate staffing have been identified as barriers to implementation of TBIC [20].

Surveys have been conducted in Nigeria to assess the level of implementation of TBIC practices in health facilities, which has been found to be generally poor, and despite the availability of national guidelines for the implementation of TBIC, administrative measures are yet to be put in place in most facilities providing care for TB patients [16,20–22]. Nursing staff are at high risk of acquiring TB because they are in the frontline of patient care and are frequently exposed to patients with infectious TB disease [23,24]. They also play a critical role in curbing the spread of TB in health facilities. It is therefore imperative that they be empowered with the necessary knowledge and skills to perform this function. The role of training in enhancing work performance of nurses cannot be overemphasized. It ensures the acquisition of new knowledge and skills that can be effectively applied in work practices. Previous studies have noted post-training improvements in nurses' knowledge and practices regarding general infection control [25–27].

The aim of this study was to utilize a mixed-approach educational intervention to improve the TBIC-related knowledge and practices of nurses in two secondary health facilities in Ibadan, Nigeria.

Methods

Study design and setting

A quasi-experimental (pre- and post-test) design, with switching replication, was used for this study. There was an intervention group and a comparison group. A self-administered structured questionnaire was used to determine the nurses' knowledge and practices concerning TBIC. It was administered to both groups before the intervention (baseline, T0), after which the intervention group was exposed to the educational programme. The same cohorts of nurses in both groups were followed up and the questionnaire was again administered 6 months later (T1) as illustrated below (Figure 1). After the second data collection wave, for public health and health systems considerations, the comparison group also received the training. Then six months later, final data collection was conducted (T2).

Figure 1: Flow diagram of the study

The study was conducted in Ibadan, the capital city of Oyo State, South-West Nigeria. It is the third largest metropolitan area in Nigeria, and the largest by geographical area (3,080 km^2) with an estimated 2011 population of about 3,034,206 (density of 985/km^2) [28,29]. Oyo State has the third highest TB burden in Nigeria, with 6901 cases reported in 2017 [30].

Study population and sample

Nurses who work at two secondary health facilities in two local government areas (LGAs), Ring Road State Hospital (Ibadan South-West LGA) and Adeoyo Maternity Teaching Hospital (Ibadan North LGA) were purposively selected to constitute the study population. The LGAs are non-contiguous and were selected to avoid the effect of contamination. Ibadan North has one tertiary health facility, one public secondary and 11 primary health centres (PHCs) while there are 3 public secondary facilities and 26 PHCs in Ibadan South-West. From available administrative data at the study sites, 173 and 217 nurses respectively at these facilities made up the study population (total = 390). With an expected moderate effect size (ES>0.50<0.80) in the TBIC knowledge of the nurses, a significance level of 5% and power of 80%, the study required at least 32 participants in each group [31]. However, because of the public health and health system considerations of the educational intervention, all available nurses at the study sites were encouraged to participate in the study. One hundred (100) nurses were eventually enrolled into the study at each site (total = 200).

Educational intervention

A mixed-approach educational intervention was implemented. This approach to training has been proven to be more effective in improving knowledge and altering professional practice of nurses and other HCWs [26,32]. The training, which took place over a 3-hour period, consisted of didactic lectures using Microsoft PowerPoint presentations prepared using WHO and CDC materials on TBIC; a 14-minute video presentation titled, *Implementing TB Infection Control in Outpatient Settings,* produced by CDC; as well as sessions for general discussion and practical demonstration [33–35]. A session on hand hygiene was incorporated into the training as this has been recommended by WHO for implementation in the context of general infection control [12]. To serve as reminders, printed copies of the lecture, as presented, were provided to the nurses after the training session. Also, CDC-designed educational materials (signages, posters and stickers on TBIC workplace practices) were conspicuously displayed at the facility after the training. Adjustments in the training time was made to accommodate the nurses' work schedule in order to train every one of them: 5 training sessions were held for a group of 18–25 nurses each time, including sessions that were conducted in the evening for the nurses on night shift. Generally, the educational materials covered the following topics concerning TB: cause, transmission, symptoms and signs, infectiousness, risk factors and TB infection control measures. The comparison group also received the same training 6 months after the intervention group, with the same process being repeated.

Study instrument

The self-administered questionnaire used for this study had a section on socio-demographics, as well as scales on the TBIC-related knowledge and practices of the nurses. These scales were adapted from an instrument used by Kanjee et al. [15] to study TBIC in a high drug-resistance setting in South Africa. The knowledge scale contained 33 items, with each having response options of "true", "false", or "I don't

know”. Each correct answer had a score of “1” and an incorrect answer, "0” while "I don‘t know” was considered an incorrect answer. The knowledge and practice scales had a maximum possible scores of 33. The TBIC practice scale had 6 items which measured self-reported frequency of adherence to various TBIC practices. It was scored using a 5-point Likert-type scale: “never” (1 point), “rarely” (2), “sometimes” (3), “often” (4), and "always" (5), giving it a maximum possible score of 30.

Data collection

Two research assistants and a supervisor were recruited and trained for the study. After explaining the purpose of the study to the participants, each of them that consented to take part in the study received a copy of the information leaflet, consent form and study questionnaire. After signing the consent, the self-administered questionnaire was issued out to each participant and returned after completion in May 2014 (wave 1). Six months after the training was conducted on the intervention group, the questionnaire was again administered on both groups in November 2014 (wave 2). After this, the comparison group received the intervention. At the end of another six months (i.e. 12 months after commencement of the study), the questionnaire was administered on both groups again in May 2015 (wave 3).

Statistical analysis

Data collected was analyzed using SPSS Statistics version 24. Descriptive statistics were used to show the socio-demographic characteristics of the nurses and their levels of knowledge and practice regarding TBIC. Independent *t*-test and chi-square test (χ^2) respectively were utilized for comparison of the continuous and categorical variables between the intervention and comparison groups. The knowledge and practice scores were presented as percentages (%). In addition, they were categorized into “good” and “poor” scores using cut-off points of 80% and 100% for knowledge and practice respectively. The cut-off for good practice score was set at 100% because optimal performance of TBIC measures is essential to minimize the nurses’ risk of contracting TB. Independent *t*-test was also utilized to demonstrate significant differences between the mean scores of both groups at different time points. The level of statistical significance was set at $p<0.05$. The effect size (Cohen’s *d)* was calculated using the 6th month measurement to demonstrate the magnitude of the change in the knowledge score of the intervention group resulting from the educational programme.

Ethics considerations

The study was approved by Sefako Makgatho Health Sciences University Research Ethics Committee (MREC/H/271/2013: PG) and Oyo State Ministry of Health Research Ethical Review Committee in Nigeria (AD 13/479/557). Permission was obtained from Oyo State Hospitals Management Board and the management of Adeoyo Maternity Teaching Hospital and Ring Road State Hospital, both in Ibadan, Oyo State, Nigeria. Participation in the study was completely voluntary and measures were taken to ensure

privacy and confidentiality of the participants, and written informed consent was obtained from each participant.

Results

At baseline, completed questionnaires were collected from 100 nurses in each groups (total = 200). During the wave 2 data collection, there were 82 (82% response rate) and 80 (80%) respondents in the intervention and comparison groups respectively. The number of respondents reduced further to 67 (intervention group) and 68 (comparison group) at wave 3.

Socio-demographic characteristics of participants

Table 1: Socio-demographic characteristics of participants

	Intervention group	Comparison group	Test value	df	95% CI	*p*-value
	n=100	n=100				
Continuous Variables						
Age						
Mean (SD)	43.9 (8.88)	43.6 (9.11)	*t*=0.28	198	-2.15, 2.87	0 .78
Experience						
Mean (SD)	19.6 (9.66)	19.0 (9.81)	*t*=0.44	198	-2.11, 3.33	0.66
Categorical Variables	n (%)	n (%)				
Sex						
Female	96 (96)	98 (98)				0.68*
Male	4 (4)	2 (2)				
Age category						
=<44 years	50 (50)	52 (52)	χ^2=0.08	1		0.78
>44 years	50 (50)	48 (48)				
Experience category						
=<20 years	54 (54)	57 (57)	χ^2=0.18	1		0.67
>20 years	46 (46)	43 (43)				
Professional rank						
Junior category	40 (40)	42 (42)	χ^2=0.08	1		0.77
Senior category	60 (60)	58 (58)				
Marital status						
Married	90 (90)	93 (93)	χ^2=0.58	1		0.45
Unmarried	10 (10)	7 (7)				

* Fisher's *p*-value

Table 1 shows that the nurses had mean ages of 43.9 years (intervention group) and 43.55 years (comparison group). The mean ages were not statistically significantly different between both groups, $t(198) = 0.28$, $p < 0.78$. Also, the mean lengths of work experience (19.6 and 19.0 years in the intervention and comparison groups respectively) were not significantly different, $t(198) = 0.44$, $p < 0.66$. Furthermore, the sex distribution was not significantly different between both groups (Fisher's *p*-value = 0.68), although females were in the majority (96% and 98% respectively). The participants were also comparable, with no

statistically significant differences, on account of their professional rank (χ^2 (4) = 1.76, p = 0.78) and marital status (Fisher's p-value = 0.85). Age, years of work experience, professional rank and marital status were each further classified into dichotomous categories. Using the Chi-square test, the nurses in both groups were statistically similar in terms of these categories: age category (χ^2 (1) = 0.08, p = 0.78), experience category (χ^2 (1) = 0.18, p = 0.67), professional rank (χ^2 (1) = 0.08, p = 0.77) and marital status (χ^2 (1) = 0.58, p = 0.45). Equal proportions of younger and older nurses (using an approximate median age of 44 years) were present in the intervention group (50%) while more of them were younger in the comparison group (52%). Taking an approximate median work experience of 20 years, more nurses had less than 20 years' work experience in both groups (54% and 57% respectively). There were more nurses in the senior category (Principal Nursing Officer and above) in both groups (60% and 58% respectively). Also, there were more married nurses than those that were unmarried (90% and 93% respectively).

Scores of respondents at different time points

Table 2: Scores of respondents at different time points

	Intervention group	Comparison group			
Scores			t-value	95% CI	*p*-value
Baseline, T0	**n=100**	**n=100**			
Mean knowledge % (SD)	68.6 (9.83)	67.7 (10.9)	0.62	-1.99, 3.80	0.54
Mean practice % (SD)	79.1 (15.1)	80.6 (15.5)	-0.66	-5.70, 2.83	0.51
6 months, T1	**n=82**	**n=80**			
Mean knowledge % (SD)	85.9 (9.26)	69.5 (10.3)	10.7	13.4, 19.5	0.00*
Mean practice % (SD)	93.5 (8.32)	78.8 (11.4)	9.39	11.6, 17.8	0.00*
12 months, T2	**n=67**	**n=68**			
Mean knowledge % (SD)	84.8 (11.8)	88.2 (9.70)	-1.85	-7.10, 0.24	0.07
Mean practice % (SD)	90.7 (10.3)	93.5 (7.85)	-1.83	-6.00, 0.24	0.07

*statistically significant

As illustrated in Table 2, the nurses in the intervention group had a higher mean knowledge score (68.64%) at baseline than those in the comparison group (67.73%), although the scores were not statistically significantly different between both groups, $t(198) = 0.62$, $p < 0.54$. Similarly, there was no significant difference between the mean practice scores,although this was higher in comparison group (80.57%), compared to the intervention group (79.13%), $t(198) = -0.66$, $p < 0.51$. After the training had been received by the intervention group (but not by the comparison group), data collected at 6 months showed that the mean knowledge score in the intervention group improved from 68.6% at baseline to 85.9% while in the comparison group, it moved only slightly from the baseline reading of 67.7% to 69.5%.

The mean knowledge scores were statistically significant difference between both groups at 6 months, $t(160) = 10.7$, $p < 0.00$. Similarly, the mean practice score of nurses in the intervention group improved from 79.1% at baseline to 93.5% while there was decrease in the comparison group from 80.6% to 78.8%. The difference in the mean practice scores between both groups was also statistically significant at 6 months, $t(160) = 9.39$, $p < 0.00$. After the comparison group had also been trained, measurement taken at 12 months revealed that the mean knowledge score in the comparison group increased to 88.2% from 69.5% recorded at 6 month. There was a slight reduction in the mean knowledge score of nurses in the intervention group from 85.9% at 6 months to 84.8%. The difference between the mean knowledge scores of nurses in both groups at 12 months was however not statistically significant, $t(133) = -1.85$, $p = 0.07$. Likewise, the mean practice score increased in the comparison group to 93.5% from the 6 months score of 78.8 % while nurses in the intervention group experienced a slight decrease from 93.5% at 6 months to 90.7%. The difference in the mean practice scores between both groups at this time was also not statistically different, $t(133) = -1.83$, $p = 0.07$.

Score categories of respondents at different time points

Table 3: Score categories of respondents at different time points

	Baseline, n (%)		6 months, n (%)		12 months, n (%)	
	Good	Poor	Good	Poor	Good	Poor
Knowledge						
Intervention group	12 (12.0)	88 (88.0)	59 (72.0)	23 (28.0)	43 (64.2)	24 (35.8)
Comparison group	9 (9.0)	91 (91.0)	10 (12.5)	70 (87.5)	53 (77.9)	15 (22.1)
Practice						
Intervention group	4 (4.0)	96 (96.0)	44 (53.7)	38 (46.3)	22 (32.8)	45 (67.2)
Comparison group	8 (8.0)	92 (92.0)	6(7.50)	74 (92.5)	36 (52.9)	32 (47.1)

Table 3 shows that at baseline, using cut-off scores of 80% (knowledge) and 100% (practice) to categorize the scores of the nurses, only a small minority of them in both groups had good scores on both scales: knowledge (12% and 9% respectively) and practice (4% and 8% respectively). At 6 months, the proportion of nurses in the intervention group (which had earlier received the training) that had good scores increased on both scales to 72% and 53.7% respectively. These proportions were higher than those of nurses with good scores in the comparison group at 6 months. After the training was received by the comparison group, the proportion of nurses in this group with good knowledge score at 12 months rose to 77.9% from 12.5% recorded at 6 months. There was also an improvement in the proportion with good practice score from 7.50% at 6 months to 52.9%. However, there was a reduction in the proportion of nurses in the intervention group that had good knowledge score from 72.0% at 6 months to 64.2%. Similarly, the proportion with good practice score fell from 53.7% to 32.8%.

Effect size determination at 6 months

Effect size for the knowledge scores resulting from the intervention received by nurses in the intervention group compared with those in the comparison group was calculated using

Cohen's d = $Mean_1$-$Mean_2$/Pooled Standard Deviation = (85.9–69.5)/9.8 = 1.7.

According to Cohen's classification, a large effect size (1.7) was produced on the knowledge score by the intervention [32].

Discussion

This quasi-experimental study was conducted to determine the effect of an educational programme aimed at improving TBIC among nurses at two secondary health facilities in Ibadan, Oyo State, Nigeria. The nurses in both groups were comparable in their socio-demographic characteristics and their mean knowledge and practice scores at baseline. Using the cut-off points of 80% and 100% for good knowledge and practice scores respectively, the majority of nurses in both groups had poor scores on the TBIC-related knowledge and practice scales at baseline. In the intervention group, only 12% of them had good knowledge score while 4% had good practice score. The comparison group had only 9% of the nurses with good knowledge score and 8% had good practice score.

The poor levels of baseline TBIC knowledge and practice found in this study are consistent with reports from other studies in Nigeria, where generally, poor levels concerning TBIC have been demonstrated among HCWs [16,20–22]. This also agrees with reports from other countries such as Russia and Georgia [18,36]. On the contrary, "good" or "adequate" TBIC knowledge among HCWs were observed by previous investigators, even though lower cut-off points were used in these studies. For instance, Using a lower cut-off (70%) than that used in the present study to categorize good knowledge, Bhebhe et al. reported that 89.2% of HCWs in their study in Lesotho had "appropriate" TBIC knowledge [9]. Even the mean score of 61.5% reported by them was lower than 68.6% and 67.7% observed in the present study. Similarly, 69 % of the HCWs in the study by Buregyeya et al. were said to have adequate TBIC knowledge, based on a lower cut-off of 70% [37].

Most of the studies from LMIC are in support of the results of the current study regarding the baseline TBIC practices. Researchers have reported inadequate implementation of TBIC measures South Africa, Lesotho, Ethiopia, among others [9–11,15,38]. In contrast, an overall "good" TBIC practice was reported by Temesgen and Demissie in another study in Ethiopia, using a lower cut-off point of 50%, although implementation of "specific practices" was noted to be poor [39]. It must be noted that TBIC guidelines had just been released Nigeria at the time of the study and the implementation was still in its early stages [16,21]. The finding of high proportions of nurses with poor levels of knowledge and practice at baseline in this study is therefore not unexpected.

After the training for the nurses in the intervention group, there was considerable improvement in the mean scores for knowledge and practices at 6 months, as well as in the proportions that had good scores on the two scales. The nurses in the comparison group, where the intervention had not taken place at the time, only had a slight improvement in their mean knowledge score while there was a slight drop in their mean practice score. The differences in the mean scores between nurses in the two facilities were statistically significant on the two scales at 6 month after the intervention group had received the training. These findings suggest that the education intervention had indeed contributed to improving their knowledge and practices, considering that at baseline, their scores were not statistically significant different. A large effect size of 1.7 on the knowledge scale resulted from the training received by nurses in the intervention group measured at 6 months. This finding concurs with earlier reports by other investigators who noted improvements in knowledge and practices among nurses in Nigeria and elsewhere after an educational intervention [25–27,40,41]. After the educational intervention was implemented in the comparison group, there were similar improvements in the mean scores of the nurses in this group at 12 months on both knowledge and practice scores. In the intervention group, there were slight reductions in the mean scores at 12 months. The increase in the mean scores of the comparison group on both scales was enough to ensure that the scores were not statistically significantly different from those of the intervention group at 12 months. This shows that the implementation of the intervention activities in the comparison group had resulted in the group catching up with the intervention group on the scores. The post-intervention increase in the mean scores of both groups observed in the present study (6 months for the intervention group and 12 months for the comparison group) is in alignment with the findings in a study conducted by Buregyeya et al. in Uganda, where most of the HCWs had correct TBIC knowledge, beliefs and practices after national TB guidelines had been introduced and training on TBIC had taken place in the few years preceding the study [37]. Although information on the pre-training levels was not provided, the investigators reported that those that did not receive the training had poor knowledge and practices concerning TBIC.

At 12 months, the nurses in the intervention group experienced a slight decline in both mean knowledge and practice scores. This is consistent with findings from similar follow-up studies involving nurses where their scores dropped slightly in follow-up (wave 3) measurement after an appreciable improvement recorded in the immediate post-intervention measurement (wave 2) [26,27]. This however contrasts with a report by Price which showed a good retention of the positive improvement 12 months later [42]. The decline in scores in the present study suggests a loss of knowledge and a tendency to revert to old practices with the passage of time and emphasizes the need for retraining and continuous professional education for the nurses as this is necessary to reinforce important TBIC messages and the practice of infection prevention skills [43].

Limitations Of The Study

The nurses in the study reported their TBIC practices using self-administered questionnaires. Direct observation of the practices could not be carried due to reasons of time and the cost of engaging several

research personnel as observers. Self-reports tend to be exaggerated by respondents (social desirability bias), as previously observed in the study by Engelbrecht et al. [17,44].

Conclusions

This study revealed that the mixed approach used in this educational intervention was effective in improving the nurses' post-intervention TBIC knowledge and practices. This approach, which incorporates didactic lectures, video presentation, discussion and demonstration, as well as the use of TBIC educational materials, is recommended for the planning of TBIC-related training and retraining for nurses and other HCWs, as part of continuous professional development. This will enhance the acquisition and retention of knowledge and skills that are necessary to minimize the risk of HCWs contracting TB and improving TBIC at health facilities.

Abbreviations

CDC: U.S. Centers for Disease Control and Prevention; CI: confidence interval; DOTS: directly observed treatment short-course; HCW: healthcare worker; HIV: Human Immunodeficiency Virus; LGA: Local Government Area; LMIC: low- and medium-income countries; MDR-TB: multi-drug resistant tuberculosis; MTB: *Mycobacterium tuberculosis;* OR: Odds Ratio; PHC: primary health centre; PLHIV: people living with HIV; PPE: personal protective equipment; PTB: pulmonary tuberculosis; RR-TB: rifampicin-resistant tuberculosis; UVGI: ultraviolet germicidal irradiation; WHO: World Health Organization.

Declarations

Ethics approval and consent to participate

The study was approved by Sefako Makgatho Health Sciences University Research Ethics Committee (MREC/H/271/2013: PG) and Oyo State Ministry of Health Research Ethical Review Committee in Nigeria (AD 13/479/557). Permission was obtained from Oyo State Hospitals Management Board and the management of Adeoyo Maternity Teaching Hospital and Ring Road State Hospital, both in Ibadan, Oyo State, Nigeria. Participation in the study was completely voluntary and measures were taken to ensure privacy and confidentiality of the participants, and written informed consent was obtained from each participant.

Consent for publication

Not applicable.

Availability of data and material

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Competing interests

No competing interests declared.

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Author's contribution

PAA conceived the study, conducted the field work, analyzed the study data and drafted both the original thesis report and the manuscript.

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Figures

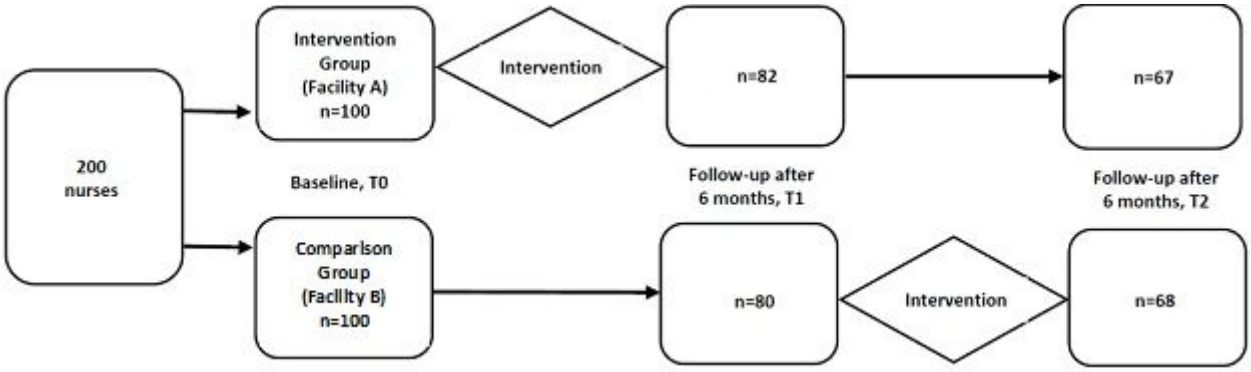

Figure 1

Flow diagram of the study

Supplementary Files

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- Appendix1StudyQuestionnaire.docx