RESEARCH ARTICLE

REVISED Effect of training of frontline health workers on tuberculosis: a cluster randomized control trial in South Nigeria [version 2; peer review: 1 approved, 1 approved with reservations]

Previously titled: Effect of tuberculosis training on community health workers' knowledge: a cluster randomized control trial in South Nigeria

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Abstract

Background: Intensified efforts to improve tuberculosis (TB) diagnosis, treatment, and prevention are needed to meet global EndTB targets. Community health workers' (CHWs) knowledge with respect to case finding is vital in tuberculosis elimination. This study aimed to determine the effect of tuberculosis training on the knowledge of community health workers in Nigeria.

Methods: As part of a larger multicomponent intervention study, a randomised control trial was conducted with CHWs in 18 primary health care (PHC) clusters in Nigeria. The clusters were allocated to three arms: training and cash incentive (A), training only (B), and control (C) arms. Arms (A) and (B) received training on tuberculosis symptoms, prevention, diagnosis and treatment while the control arm (C) did not receive training. Participants' knowledge on tuberculosis was assessed using questionnaires administered pre- and post-intervention. Data was analyzed using GraphPad Prism. Descriptive data was presented in tables and bivariate data was analyzed using chi square. Statistical significance was set as $P < 0.05$.

Results: There was a significant increase in the total knowledge score (25.4%), knowledge of general symptoms (24.4%), prevention (22.6%) and diagnosis and treatment (30.0%) across all study arms post-

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2. **Chris Lowbridge** , Charles Darwin University, Darwin, Australia

Any reports and responses or comments on the article can be found at the end of the article.

intervention ($p < 0.0001$). Compared with the control arm, the training arm (A) had a higher proportion of good total knowledge score (94.4%) and arm (B) had a lower proportion of good total knowledge score (83.1%) when compared to the control group (93.1%). These were, however, not statistically significant.

Conclusions: An improvement in the CHWs' knowledge of symptoms, prevention, diagnosis and treatment of tuberculosis was observed after a training intervention was done. Integration of routine tuberculosis training is recommended to improve tuberculosis case finding in high burden communities.

Pan African Clinical Trial Registry registration:

PACTR202010691865364 (14/01/2020)

Keywords

Tuberculosis, Community health workers, Patent medicine Vendors, Training, Knowledge

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REVISED Amendments from Version 1

In answer to the reviewer's query on trainer qualifications, we have provided the necessary information on trainers' qualifications. We have also modified the topic to reflect the reviewer's comment.

Any further responses from the reviewers can be found at the end of the article

Introduction

One of the United Nations' Sustainable Development Goals (SDG) as contained in the SDG target 3.3 is to end the tuberculosis epidemic by the year 2030. This End TB Strategy defines as a target for 2030, a 90% reduction in the number of TB deaths and an 80% reduction in the TB incidence rate (new cases per 100 000 population per year) compared with levels in 2015.¹ Progress in global TB elimination which has been inconsistent in recent years has led to intensified efforts to improve TB diagnosis, treatment, and prevention required to meet global targets for 2020–2035.² To achieve these set targets, there's a need for various national tuberculosis programs to have agendas set and implemented towards meeting goals. In 2019 alone, an estimated 1.4 million people died from TB-related illnesses and of the estimated 10 million cases that year, some 3 million went undiagnosed, or were not officially reported to national authorities.³

Diagnosis, treatment and prevention of tuberculosis rests largely on the healthcare workers. Health care workers knowledge and attitude with respect to diagnosis, treatment and prevention of TB is vital in TB elimination.⁴ In Nigeria, the treatment of TB is free at all public health facilities. Successful implementation of directly observed treatment short course (DOTS) is dependent on the ability of the health care system to identify and properly manage TB cases which requires active involvement of the health workers in TB diagnosis and management. TB treatment should include counselling regarding progression of disease and the importance of treatment adherence.⁵

Countries with good TB knowledge scores have been shown to have better TB indices with respect to treatment and prevention. In Iran, 98.4% of healthcare workers had a 'good' score for knowledge of TB with 98.2% who correctly answered that TB transmission is through the respiratory tract, 90% acknowledged TB is a treatable disease, and only 12.6% of them were oblivious that it is caused by a bacterium.⁶ In South India, accurate knowledge of TB was displayed by 86% of healthcare workers.⁷ Good and fair level of knowledge of TB was possessed by 56% and 43.9% of healthcare workers in Thailand.⁸ Studies in South Africa and Mozambique also reported satisfactory level of knowledge of TB among health care workers.^{4,9} In Mozambique, higher knowledge scores were seen among those with greater educational attainment. Knowledge scores were also affected by profession with medical doctors having the greatest knowledge score and midwives having the lowest knowledge scores.⁴

A study in Vietnam also showed that an increased level of TB knowledge among the health staff is correlated with participation in TB training and higher medical education.¹⁰ In South Africa, the mean percentage of correct answers to the 98-item questionnaire administered was 59.5% pre-training and rose to 66.5% after training. Post-training, nurses, doctors and TB support staff showed significant improvements in total mean knowledge scores.¹¹ A study in China that assessed knowledge retention of multidrug-resistant tuberculosis (MDR-TB) health practitioners 1 year after training, also reported an overall positive long-term impact of the training on participants' knowledge.¹² Akande *et al.*, in a study in Nigeria reported a significant increase in the knowledge of TB infection control after the health workers had been trained.¹³

Training of frontline health workers is an important strategy for TB control as efficient human resources development is crucial for facilitating tuberculosis control. In an ideal setting, training on TB should be integrated into the general education of health workers and into health systems. However, in a tuberculosis-endemic and resource-poor country like Nigeria, these systems are too weak to support routine effective tuberculosis control and training services.¹⁴ This study therefore aims to determine the effect of TB training on the knowledge of community health workers in Akwa Ibom state. This will aid in policy making and program designing with regard to TB control in the state.

Methods

This study was registered as a clinical trial with the Pan African Clinical Trial Registry (PACTR202010691865364 on 14th October 2020). This article is reported in line with the Consolidated Standards of Reporting Trials (CONSORT) guidelines.²⁷

Setting

Akwa Ibom State is located in the Southern part of Nigeria, with a population of about 5.4 million people.¹⁵ It has 31 local governments across three senatorial districts. It has 368 primary health centers, unevenly distributed across the local

government areas (LGAs). Akwa Ibom state has a high burden of TB and human immunodeficiency viruses (HIV). At the time of this study, the USAID was carrying out TB control activities in 15 LGAs and TB Reach had projects in 3 of the remaining 16 LGAs. The study population was the 13 LGAs that were not covered by the ongoing TB programs.

Study design

The study was designed as a three-arm parallel cluster randomized control study. We evaluated the effect of cash incentives and training on community health workers' knowledge of TB. The PHCs were grouped in three clusters as shown in [Figure 1](#).

A panel survey was planned but this was not possible as there was large in-and out migration of the patent medicine vendors (PMVs), especially those who originally sent their apprentices to the training. All the HCWs trained in the clusters were followed up for the duration of the study. At endline, we deployed the same method used in recruitment at baseline, targeting all HCWs in the study clusters. This design was used to minimize sampling error and take into account the design effect and prevent contamination across the three study arms. Therefore, participants were selected as two independent cross-sectional samples.

The interest in evaluating both training and cash incentives concurrently informed the choice of a multi-arm cluster randomized trial. It is also documented that sharing a control arm reduces the sample size relative to performing separate 2-arm trials.¹⁶ Cluster randomization was used in this study because the target of intervention was not individual health workers, but the PHC clusters. Each PHC cluster consisted of the PHC facility and its catchment communities. The RCT was conducted in six high TB burden LGAs in the state. The LGAs were selected from the sampling frame of 13 LGAs, with the aid of the State Tuberculosis and Leprosy Control Officer (STBLCO). In each participating LGA, 3 PHC facilities offering DOTS treatment and services were selected by simple random sampling and included in the study, each LGA has 3 clusters. Each PHC plus the catchment communities served as a cluster for this study. All community Health workers (CHWs) (PHC workers and patent medicine vendors) in each cluster were recruited into the study.

The selected LGAs were randomized to one of the three experimental arms by three researchers. Each researcher represented an intervention arm and picked from a box containing the names of the LGAs. Each LGA was assigned to the intervention arm picked by the researcher. All CHWs in the study clusters in each LGA were automatically assigned an intervention arm based on this randomization. Training with cash incentives was study cluster arm A and training only was arm B. The CHWs were recruited with the aid of the facility focal persons, working with the Chairman of the PMVs. All CHWs in the catchment were given an invitation to the training. The Field Coordinator conducted visits to the Facility Heads and Chair of PMV for each cluster. Formal letters were served to the Head of facility in each cluster. He was requested to mobilize all the CHWs in the catchment. He thus directed the Field Coordinator to the Chair of the PMVs who subsequently mobilized all the PMVs for the study. No exclusions were made, except if the person declined to participate. All CHWs in each cluster who participated in the workshop and gave consent were enrolled for the study under Arm A or B depending on their cluster.

Blinding of participants to their allocated arms was not possible. To ensure that participants were blinded to the intervention, the LGAs chosen were spread apart and not contiguous to reduce contamination. Blinding of assessors to the different arms was also not possible.

Figure 1. Allocation of Primary Health Care Centres in the study. CHW = community health workers.

Figure 2. Allocation of Community Health Workers by intervention.

Interventions

A one-day training session was carried out for each of the arms separately. The sessions lasted about 6 hours. The allocation ratio for the three clusters was 1:1:1 as shown in [Figure 2](#).

The training was conducted by the researchers in collaboration with the State Tuberculosis Leprosy and Buruli ulcer Control Program (STBLCP) office. The research team comprised four consultant physicians: one cardiologist, one respiratory medicine physician and two community medicine physicians; three medical officers; and the STBLCP is a physician with post graduate training in tuberculosis. One of the medical officers has specialist training in tuberculosis. Qualifications of the trainers have been included. Prior to the workshop, a Training of Trainers was conducted by the Lead Researcher and the STBLCP State Coordinator and researchers. The Workshop facilitators were trained on the course contents. This was to develop a shared understanding of the aims of the workshop and familiarize them with the contents of the workshop materials. Training manuals were developed specifically for the research and distributed to participants. Facilitators used both the training manuals and power point presentations developed from the manuals. Facilitators used participatory learning methods to deliver the course contents. The contents of the training were based on the module developed for active TB case finding through house-to-house search for community-based organizations (CBOs) and CHWs by the National Tuberculosis and Leprosy Control Program (NTBLCP).¹⁷ The sessions included training on basic symptoms, misconceptions diagnosis and treatment of TB, identification of presumptive TB cases, sputum collection and transportation and linking TB patients to care and treatment.

Participants were also taught how to collect sputum samples by the State Laboratory Focal Person for TB. Sputum cups were donated by the STBLCP program, the researchers procured transportation media (plastic bowls that could contain 4 sputa cups). At the end of the training, each participant was given a container for transporting sputum, 4 sputa cups, a presumptive case referral booklet and information, education and communication (IEC) materials to be used in educating clients.

Participants were instructed to carry out community education campaigns, identify presumptive TB cases in communities, collect sputum and make referrals to the PHC for treatment. The control Arm C had 41 CHWs. They were also requested to organize outreach health education campaigns in the communities. The participants in intervention arm A (85) received a cash incentive of two hundred naira (USD0.78) for every presumptive case referred for screening.

The interventions were carried out between April 2019 and March 2020. The trial ended as scheduled after one year.

Data collection

Data collection was carried out for a period of 12 months starting in April 2019 and ended in March 2020. Data collection was done via quarterly supportive supervisory visits (SSV) made to the trained Community Health Extension Workers (CHEWs), PMVs and CPs. During the quarterly SSVs, data was collected from the CHWs and compared with the facility TB register. The number of presumptive cases referred, and number of outreaches conducted during the quarter were documented.

A pre-intervention assessment of CHWs knowledge on TB was done using a pre-tested self-administered structured questionnaire.²⁷ This was a standardized and validated questionnaire used by the national TB program for the 2017 TB Prevalence survey in Nigeria. The questionnaires were administered just before the training workshop for study arms A and B. However, they were administered at the six PHC facilities for the control arm as there was no training conducted for them.

A post-intervention assessment was also done using the same tool after 12 months, in the PHC facilities in each of the clusters.

Outcome variables

Knowledge of TB was a secondary outcome variable for this study. The total knowledge score was 21. Good knowledge was taken as scores above 11, and poor scores below 11. Knowledge of TB was assessed at individual level and at cluster level. The focus of this paper was the secondary outcome. The secondary outcome measure of knowledge was assessed and analysed both at the individual participant level and cluster level.

Data analysis

Data was collected and entered into a Microsoft excel spreadsheet, version 2013, then collated and analyzed using STATA version 13 and GraphPad Prism version 8. R is an alternative open access software that could be used. The statistician was blinded to the study allocation until the data set was ready for final analysis. Descriptive statistics were carried out using frequencies and percentages and presented using tables. Chi square/Fischer's exact test was used to compare the groups. And mean difference as effect size within each group. A *p* value of less than 0.05 was taken as statistically significant.

Ethics statement

Ethical Approval was sought and obtained from the University of Uyo Institutional Health Ethics Research Board (UUTH/AD/S/93/VOLXXI/253). Approval was also obtained from the State Ministry of Health Ethics Review Board (MH/PRS/99/VOL.5/511). Written and verbal informed consent was obtained from the individual CHWs, the heads of each PHC cluster and the Chairman of each Local Government PMV association. Only CHWs who consented to participate were recruited into the study. All presumptive cases identified were referred for screening and positive cases were linked up to the State TB program for treatment with DOTS.

Table 1. Socio-demographic characteristics of the health workers pre-intervention.

Variables	Training and Cash incentives (n = 85)	Training only (n = 73)	Control (n = 82)	Total (n = 240)	Statistical indices
Sex					Df = 2
Male	38 (44.7)	30 (41.1)	22 (26.8)	90 (37.5)	$\chi^2 = 3.7864$
Female	47 (55.3)	43 (58.9)	60 (73.2)	150 (62.5)	<i>P</i> 0.151
Age (years)					Df = 2
≤30	32 (37.7)	39 (53.4)	44 (53.7)	115 (47.9)	<i>P</i> 0.108 [†]
31-40	38 (44.7)	24 (32.9)	34 (41.5)	96 (40.0)	
≥41	15 (17.6)	10 (13.7)	4 (4.9)	29 (12.1)	
Level of education					Df = 2
Primary	1 (1.2)	4 (5.5)	0 (0.0)	5 (2.1)	<i>P</i> 0.389 [†]
Secondary	54 (63.5)	43 (58.9)	58 (70.7)	155 (64.6)	
Tertiary	30 (35.3)	26 (35.6)	24 (29.3)	80 (33.3)	
Job title					Df = 4
PMVs	68 (80.0)	57 (78.1)	64 (78.0)	189 (78.8)	<i>P</i> 0.936 [†]
Health workers	15 (17.7)	14 (19.2)	14 (17.1)	43 (17.9)	
Others	2 (2.3)	2 (2.7)	4 (4.9)	8 (3.3)	
Duration at the current position					Df = 8
<1 year	12 (14.1)	15 (20.5)	8 (9.8)	35 (14.6)	<i>P</i> 0.035 ^{*†}
1-4 years	26 (30.6)	29 (39.7)	22 (26.8)	77 (32.1)	
5-9 years	16 (18.8)	16 (21.9)	34 (41.5)	66 (27.5)	
10-14 years	17 (20.0)	4 (5.5)	10 (12.2)	31 (12.9)	
≥15 years	14 (16.5)	9 (12.3)	8 (9.8)	31 (12.9)	
Type of facility					Df = 4
PHC	17 (20.0)	16 (21.9)	16 (19.5)	49 (20.4)	<i>P</i> 0.0001 ^{*†}
Chemist shop	44 (51.8)	56 (76.7)	66 (80.5)	166 (69.2)	
Others	24 (28.2)	1 (1.4)	0 (0.0)	25 (10.4)	
Had workshop on TB					Df = 2
Yes	15 (17.7)	21 (28.8)	36 (43.9)	72 (30.0)	$\chi^2 = 9.7982$
No	70 (82.3)	52 (71.2)	46 (56.1)	168 (70.0)	<i>P</i> 0.007 [*]
Have access to TB guideline					Df = 2
Yes	11 (12.9)	21 (28.8)	26 (31.7)	58 (24.2)	$\chi^2 = 8.0613$
No	74 (87.1)	52 (71.2)	56 (68.3)	182 (75.8)	<i>P</i> 0.018 [*]

*Statistically significant.

[†]Fishers exact.

Df = degrees of freedom.

Results

A total of 240 CHWs were recruited at baseline and 153 trained, 85 in arm A and 73 in arm B, while 82 were recruited in the control arm²⁶. At the end of the trial 72, 77 and 72 were analysed in arms A, B and C, respectively, to give a total of 221. Over the 12-month period of intervention, some CHWs retired, relocated and transferred out of the catchment area intention-to-treat analysis was done.

Most of the CHWs in this study were female (62.5%), aged 30 years or less (47.9%), and had secondary level of education (64.6%). PMVs made up the majority of the health workers (78.8%), and over half (69.2%) worked at patent medicine shops. Most had worked at their current position for 1-4 years (32.1%). There was statistically significant difference in the duration at current position ($P = 0.035$) and type of facility of CHWs ($P = 0.000$) across the three arms. Also, a significantly higher proportion of CHWs in the control group (43.9%) had previously attended a TB workshop and had access to TB guidelines (31.7%) compared to their counterparts in other groups (Table 1).

Table 2 shows the sociodemographic characteristics across the three arms post-intervention. Most participants were aged 31-40 years (44.3%), female (53.4%), had secondary level of education (64.3%) and had worked for 1-4 years at their current position (38.0%). The majority were PMVs (77.4%), and worked at patent medicine stores (52.9%). There was a statistically significant difference in the duration of current job of the CHWs across the three arms ($P 0.006$), and in the type of health facility across the three arms ($P 0.001$).

There was a significant increase in the total knowledge score of the respondents at end line ($P 0.0001$), with the respondents at baseline having a mean knowledge score of 11.8 (3.2) and at end line 16.8 (2.5). There was also statistically significant difference in the different categories of knowledge tested at baseline and at end line (Table 3).

Table 4 compares the knowledge of tuberculosis across the three arms of the study. There was statistically significant relationship seen between respondents' knowledge of diagnosis ($P 0.0001$), knowledge of prevention ($P 0.014$) and the total knowledge score ($P 0.0480$); and the different study arms.

Table 2. Socio demographic characteristics of participants at endline.

Variables	Training and cash incentive (n = 72)	Training only (n = 77)	Control (n = 72)	Total (n = 221)	Statistical indices
Sex					Df = 2
Male	32 (44.4)	39 (50.6)	32 (44.4)	103 (46.6)	$\chi^2 = 0.7762$
Female	40 (55.6)	38 (49.4)	40 (55.6)	118 (53.4)	$P 0.8762$
Age (years)					Df = 6
≤30	24 (33.3)	36 (46.8)	23 (31.9)	83 (37.6)	$\chi^2 = 6.2618$
31-40	36 (50.0)	26 (33.8)	36 (50.0)	98 (44.3)	$P 0.395$
≥41	12 (16.7)	15 (19.5)	13 (18.1)	40 (18.1)	
Level of education					Df = 4
Primary	3 (4.2)	3 (3.9)	0 (0.0)	6 (2.7)	$\chi^2 = 4.8985$
Secondary	44 (61.1)	46 (59.7)	52 (72.2)	142 (64.3)	$P 0.298$
Tertiary	25 (34.7)	28 (36.4)	20 (27.8)	73 (33.0)	
Duration of current job					Df = 8
Less than 1 year	7 (9.7)	16 (20.8)	1 (1.4)	24 (10.9)	$\chi^2 = 21.6794$
1-4 years	31 (43.1)	28 (36.4)	25 (34.7)	84 (38.0)	$P 0.006^*$
5-9 years	16 (22.2)	14 (18.2)	16 (22.2)	46 (20.8)	
10-14 years	8 (11.1)	7 (9.1)	18 (25.0)	33 (14.9)	
15 years and above	10 (13.9)	12 (16.6)	12 (16.7)	34 (15.4)	
Job title					Df = 4
Health workers	13 (18.1)	8 (10.4)	11 (15.3)	32 (14.5)	$\chi^2 = 5.9548$
PMVs	52 (72.2)	60 (77.9)	59 (81.9)	171 (77.4)	$P 0.203$
Others	7 (9.7)	9 (11.7)	2 (2.8)	18 (8.4)	
Type of health facility					Df = 4
PHC	14 (19.4)	13 (16.9)	12 (16.7)	39 (17.7)	$\chi^2 = 123.9411$
Medicine store	52 (72.2)	7 (9.1)	58 (80.6)	117 (52.9)	$P 0.0001^*$
Others	6 (8.3)	57 (74.0)	2 (2.8)	65 (29.4)	

*Statistically significant.
Df = degrees of freedom.

Table 3. Respondents' knowledge score at baseline and at end line.

Knowledge score	Baseline (n = 240)	End line (n = 221)	Difference (95%CI)	Statistical indices
General symptoms Mean (SD)	4.5 (1.8)	5.6 (1.4)	1.1 (0.7-1.4)	$P < 0.0001^*$
Prevention score Mean (SD)	5.3 (1.4)	6.5 (1.4)	1.2 (0.9-1.5)	$P < 0.0001^*$
Diagnosis & treatment score	2.0 (1.0)	2.6 (0.9)	0.6 (0.4-0.9)	$P < 0.0001^*$
Total score Mean (SD)	11.8 (3.2)	14.8 (2.5)	3.0 (2.4-3.6)	$P < 0.0001^*$

*Statistically significant.

SD = standard deviation; CI = confidence interval.

Table 4. Knowledge of tuberculosis (TB) across the three intervention groups post intervention.

	Training & cash incentives (n = 72)	Training (n = 77)	Control (n = 72)	Total (n = 221)	Statistical indices
General knowledge					Df = 2
Poor	13 (18.1)	15 (19.5)	11 (15.3)	39 (17.7)	$\chi^2 = 0.4645$
Good	59 (81.9)	62 (80.5)	61 (84.7)	182 (82.3)	$P > 0.793$
Knowledge of diagnosis					Df = 2
Poor	32 (44.4)	44 (57.1)	18 (25.0)	94 (42.5)	$\chi^2 = 15.8869$
Good	40 (55.6)	33 (42.9)	54 (75.0)	127 (57.5)	$P < 0.0001^*$
Knowledge of prevention					Df = 2
Poor	17 (23.6)	17 (22.1)	5 (6.9)	39 (17.7)	$\chi^2 = 8.4774$
Good	55 (76.4)	60 (77.1)	67 (93.1)	182 (82.3)	$P > 0.0140^*$
Total score					Df = 2
Poor	4 (5.6)	13 (16.9)	5 (5.9)	22 (10.0)	$P > 0.0480^{*†}$
Good	68 (94.4)	64 (83.1)	67 (93.1)	199 (90.0)	$F = 9.23$
Mean (SD)	14.5 (2.1)	14.1 (2.6)	15.8 (2.6)	14.8 (2.5)	$P < 0.0001^*$

*Statistically significant.

SD = standard deviation; Df = degrees of freedom.

Post-intervention, a higher proportion of the respondents in the control group had good knowledge of diagnosis and treatment (75%) and prevention (93.1%) compared to the training and cash incentives group (55.6% and 76.4%, respectively). These were statistically significant at $P > 0.0224$ and $P > 0.0096$ respectively (Table 5).

At endline, a higher proportion of the respondents in the control group had good knowledge of diagnosis and treatment (75%) and prevention (93.1%) compared to the training only group (42.9% and 77.1%, respectively). These were statistically significant at $p = 0.0109$ and 0.0001 , respectively (Table 6).

Table 5. Knowledge of tuberculosis (TB) among the training and cash incentive arm and control arm post-intervention.

Knowledge score	Training and CCT (n = 72)	Control (n = 72)	Statistical indices
General knowledge			Df = 1
Poor	13 (18.1)	11 (15.3)	$P > 0.8235^†$
Good	59 (81.9)	61 (84.7)	
Knowledge of diagnosis and treatment			Df = 1
Poor	32 (44.4)	18 (25.0)	$P > 0.0224^{*†}$
Good	40 (55.6)	54 (75.0)	
Knowledge of prevention			Df = 1
Poor	17 (23.6)	5 (6.9)	$P > 0.0096^{*†}$
Good	55 (76.4)	67 (93.1)	
Total score			Df = 1
Poor	4 (5.6)	5 (5.9)	$P > 0.9999^†$
Good	68 (94.4)	67 (93.1)	

*Statistically significant.

†Fishers exact.

Df = degrees of freedom.

Table 6. Knowledge of tuberculosis (TB) among the training only arm and control arm post-intervention.

Knowledge score	Training only (n = 77)	Control (n = 72)	Statistical indices
General knowledge			
Poor	15 (19.5)	11 (15.3)	Df = 1
Good	62 (80.5)	61 (84.7)	P 0.5252 [†]
Knowledge of diagnosis and treatment			
Poor	44 (57.1)	18 (25.0)	Df = 1
Good	33 (42.9)	54 (75.0)	P 0.0109 ^{*†}
Knowledge of prevention			
Poor	17 (22.1)	5 (6.9)	Df = 1
Good	60 (77.1)	67 (93.1)	P 0.0001 ^{*†}
Total score			
Poor	13 (16.9)	5 (5.9)	Df = 1
Good	64 (83.1)	67 (93.1)	P 0.0706 [†]

*Statistically significant.

[†]Fishers exact.

Df = degrees of freedom.

Table 7. Knowledge of TB among the training and CCT arm pre- and post-intervention.

	Training and cash incentives		Difference (95% CI)	Statistical indices
	Baseline (n = 85)	Endline (n = 72)		
General symptoms Mean (SD)	5.0 (1.7)	5.5 (1.3)	0.5 (0.1-1.0)	Df = 155 T test = -2.0406 P 0.0430 [*]
Prevention score Mean (SD)	6.3 (1.3)	6.4 (1.4)	0.1 (-0.33-0.53)	Df = 155 T test = 0.4607 P 0.6456
Diagnosis and treatment Mean (SD)	2.6 (0.9)	2.6 (0.9)	0.0 (-0.28-0.28)	Df = 155 T test = 0.000 P 1.0000
Total score				
Poor	34 (40.0)	4 (5.6)	0.7 (-0.02-1.42)	Df = 1 P 0.0001 ^{*†} P 0.0001 [*]
Good	51 (60.0)	68 (94.4)		
Mean (SD)	13.8 (2.4)	14.5 (2.1)		

*Statistically significant.

[†]Fishers exact.

SD = standard deviation; CI = confidence interval; Df = degrees of freedom.

Table 8. Knowledge of tuberculosis (TB) among the training only arm pre- and post-intervention.

Knowledge score	Training only		Difference (95% CI)	Statistical indices
	Baseline (n = 73)	End line (n = 77)		
General knowledge score Mean (SD)	4.0 (1.8)	5.6 (1.54)	1.6 (1.06-2.14)	Df = 148 T test = -5.8595 P 0.0001 [*]
Prevention score Mean (SD)	5.8 (1.1)	6.2 (1.21)	0.4 (0.03-0.77)	Df = 148 T test = 2.1247 P 0.0353 [*]
Diagnosis and treatment score Mean (SD)	2.2 (0.9)	2.3 (1.0)	0.1 (0.20-0.41)	Df = 148 T test = -2.9254 P 0.5215
Total score				
Poor	43 (58.9)	13 (16.9)	2.1 (1.9-3.00)	Df = 1 $\chi^2 = 28.2827$ P 0.0001 [*] P 0.0001 [*]
Good	30 (41.1)	64 (83.1)		
Mean (SD)	12.0 (3.0)	14.1 (2.6)		

*Statistically significant.

SD = standard deviation; CI = confidence interval; Df = degrees of freedom.

Table 9. Knowledge of TB among the control arm pre- and post-intervention.

Knowledge	Control		Difference (95% CI)	Statistical indices
	Baseline (n = 41)	Endline (n = 72)		
General symptoms Mean (SD)	4.3 (1.7)	5.7 (1.38)	0.8 (0.81-1.98)	Df = 111 T test = 2.3453 P 0.0001*
Prevention score Mean (SD)	6.0 (1.5)	7.1 (1.3)	1.1 (0.55-1.65)	Df = 111 T test = 3.9285 P 0.0001*
Diagnosis and treatment Mean (SD)	2.6 (0.9)	3.0 (0.8)	0.4 (0.08-0.72)	Df = 111 T test = 2.4414 P 0.0162*
Total score				
Poor	20 (48.8)	5 (5.9)		Df = 111
Good	21 (51.2)	67 (93.1)		$\chi^2 = 26.5383$
Mean (SD)	12.9 (2.8)	15.75(2.78)	2.1 (1.3-2.9)	P 0.0001* P 0.0001*

*Statistically significant.

SD = standard deviation; CI = confidence interval; Df = degrees of freedom.

At baseline, CHWs who were in the training and CCT arm had a mean total knowledge score of 13.8 (2.4), and at end line, 14.5 (2.1), and this difference was statistically significant (P 0.0001). The difference in mean general knowledge score at pre- and post-intervention was also statistically significant (P 0.0430) (Table 7).

Table 8 shows the knowledge score of the health care workers that were in the training only arm at baseline and at endline. The mean general knowledge score, prevention score and total knowledge score showed a statistically significant increase at the end of the study compared to baseline (P 0.0001, 0.0353 and 0.0001, respectively).

In the control arm, the mean total knowledge score increased by 2.1 (95% CI:1.3-2.9) at endline, and this increase was statistically significant (P 0.0001). Significant increases were also noticed in the different categories of knowledge assessed for at endline compared to baseline (Table 9).

Discussion

This randomized control trial aimed to assess the effect of tuberculosis training on community health workers knowledge on TB in Akwa Ibom state. Overall, there was improvement in the respondents' knowledge post-intervention, compared to the baseline knowledge. The CHWs were comparable in their socio-demographic characteristics at baseline and at endline. It is worthy of note that a significant proportion of CHWs in the control arm had previously received training on TB, and had access to TB guidelines. This may be due to the attention the state has been receiving as a result of the high prevalence of HIV/AIDS, and consequently TB.

This study found a significant increase in CHW's TB knowledge post intervention when compared to the baseline. The highest increase was noticed in knowledge of prevention, followed by knowledge of general symptoms. At baseline, the mean knowledge score of the CHWs was just above the average, increasing by a score of three at end line assessment. This corroborates with others studies that found an increase in knowledge of TB immediately after training and even long after training was done.^{13,18,19} Training was found in Abia state, Nigeria, to not only improve knowledge among Health workers, but to also improve all indicators of the Finding TB cases Actively, Separating safely, and Treating effectively (FAST) strategy which include the time to diagnosis (the time between when patient presents to the health facility to when a diagnosis of TB is made), time to treatment which the time between making a diagnosis and commencement of TB treatment, number of presumptive TB and Drug Resistant TB (DRTB) cases identified and number of TB and DRTB cases commenced on treatment.²⁰

Comparing the three arms of the study post-intervention, it was observed that knowledge of diagnosis, prevention and the total knowledge score was significantly different across the three arms. Furthermore, the control arm was seen to have a higher mean knowledge score when compared to the arms that received training. This may have been an effect of previous training that the health workers in the control arm had received, as well as the fact that they reported having more access to TB guidelines. This finding was noticed during data analysis, despite earlier attempts to control for such contamination in the study. In a similar study among HIV infected people in Minna, training was shown to significantly improve the knowledge of the participants in the intervention group compared to the control group.²¹ In contrast, a similar study by

Rakhshani *et al.* reported a significant increase in end line knowledge of malaria in the intervention group when compared to the control group.²² More participants from the training and cash incentives arm in the present study however had good knowledge scores when compared with those in the control arm, though this finding was not statistically significant.

This study compared the knowledge of CHWs in each arm at baseline and at endline. Among the participants in the training and cash incentives arm and in the training only arm, there was a significant increase in the mean total score between the baseline and post intervention. This is similar to results obtained in Turkey where training intervention increased the primary healthcare workers' knowledge on immunization. Furthermore, the study reported a significant increase in the vaccination coverage rate in the community after the training intervention.²³ Training intervention is therefore be effective in increasing knowledge and effecting behavior change. This is corroborated by other studies.^{21,22}

Training community health workers on TB is essential to achieving TB control as they are the frontline health workers in the communities and are at a better position to identify TB cases. In a study in Southern Mozambique, health workers were seen to have poor knowledge of TB, and consequently low practice competency.²⁴ Wu *et al.* found a decline in health workers knowledge one year post intervention, compared to the immediate post intervention period, though it was still higher than the pre-intervention knowledge.¹⁸ This therefore implies that training of health care workers should not be a one-time event, but a continuous process if TB control is to be achieved. Experiences in Kyrgyzstan¹⁴ and the Democratic Republic of Congo show that periodic training and supervision in the field can improve healthcare workers' TB knowledge and skills.²⁵

Limitations

This study had some limitations. Firstly, though this study was planned as a panel survey, this could not be carried out. This is because some of health workers in the different communities may have resigned or moved away, while others took up these positions. Therefore, not all those that were trained at baseline could participate in the post intervention assessment. Also, a few CHWs were transferred in and were part of the post intervention assessment since it was a cluster sampling.

Another limitation was the selection bias seen in the study. The control arm had more exposure to TB training as evidenced by the baseline characteristics like exposure to workshops and access to TB guidelines were significantly higher among the control group. The control arm was likely to have had previous trainings on TB and had access to TB guidelines which may have affected the study results. This is because random allocation of PHCs to the different arms was carried out prior to the pre-intervention assessment.

Conclusion

This study was conducted to determine the effect of TB training on the knowledge of community health workers in Akwa Ibom state, Nigeria. Patent Medicine Vendors formed two thirds of the CHWs mobilized, indicating they were readily available in the communities. We found a significant improvement in the CHWs knowledge of symptoms, prevention, diagnosis and treatment of TB after the training intervention was done. We thus recommend the integration and use of PMVs in the delivery of interventions in the community. Furthermore, integration of routine TB training for all categories of CHWs will improve TB case finding and notification, improving TB indices in the communities and the country.

Data availability

Underlying data

Dryad: Improving Tuberculosis Case Finding in Akwa Ibom State, Nigeria. <https://doi.org/10.5061/dryad.tht76hf07>.²⁶

The project contains the following underlying data:

- Readme_Improving Tuberculosis case finding in Nigeria
- TB community data Post intervention
- TB Community data pre-intervention
- TB Health care workers Baseline
- TB Health care workers endline
- TB study Outcome (summary)

Data are available under the terms of the [Creative Commons Zero “No rights reserved” data waiver](#) (CC0 1.0 Public domain dedication)

Extended data

Zenodo: Improving Tuberculosis case finding in Nigeria. <https://doi.org/10.5281/zenodo.5062448>.²⁷

This project contains the following extended data:

- Ethical_Approval_2_SMOH.jpg
- Ethical_Approval_TB_1.pdf
- FINAL_RESEARCH_PROTOCOL_FOR_TB_STUDY.docx.docx
- Questionnaires_for_the_TB_Study.zip
- Training_Kit.zip
- TrialApprovalLetter3.pdf

Reporting guidelines

Zenodo: CONSORT checklist for ‘Effect of tuberculosis training on community health workers’ knowledge: a cluster randomized control trial in South Nigeria’. <https://doi.org/10.5281/zenodo.5062448>.²⁷

Data are available under the terms of the [Creative Commons Attribution 4.0 International license](#) (CC-BY 4.0).

Acknowledgements

The Team acknowledges Mr. Edidiong Umoh and Mrs Ekom Ekwo of the Health Systems Research Hub, University of Uyo for their support in executing the entire project.

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[Publisher Full Text](#)

Open Peer Review

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Version 2

Reviewer Report 19 May 2022

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Chris Lowbridge

Global and Tropical Health, Menzies School of Health Research, Charles Darwin University, Darwin, NT, Australia

Thank you for the opportunity to review this manuscript. TB remains an important public health challenge in Nigeria, and I appreciate the authors' work to address this issue. I believe that there are a number of points that must be addressed before this manuscript can be indexed. I have detailed these, as well as some further suggestions for the authors' consideration below.

Points that must be addressed:

1. Introduction, paragraph 3: It is stated, "Countries with good TB knowledge scores have been shown to have better TB indices with respect to treatment and prevention". However, as best I can see, none of the sources provided clearly support that statement. This statement should be supported with evidence.
2. Introduction, paragraph 3: Please check the references cited here. Where you refer to Iran, the cited reference refers to Iraq. Where you refer to South India, the cited reference refers to South Africa. Where you refer to Thailand, the cited reference refers to Ethiopia. There appear to be other mismatched references throughout also. Please check and ensure the in-text citations refer to the correct sources, for example, ref 18 in the discussion, paragraph 2.
3. Methods, data collection: You refer to the collection of data via supervisory visits, including use of the TB register, number of presumptive cases referred and number of outreaches conducted. However, these data do not seem to be used at all in this study as the results refer only to the knowledge questionnaire data. I would suggest removing references to these other data.
4. Methods, outcome variables: You refer to TB knowledge as being a secondary outcome variable for this study. However, what is the primary outcome variable? If the secondary outcome is "the focus of this paper", would it not then be the primary outcome?

5. The research question and hypothesis should be clearly stated.

6. Limitations: I would suggest that a major limitation of this study is that it looks only at the outcome of healthcare worker knowledge, it is unable to determine the impact of a one-off training on healthcare worker practice/adherence to guidelines, nor impact on key TB program indicators, such as case finding targets or treatment outcomes.

7. Conclusion: I feel the recommendations made are not fully supported by the data presented. While your results show a significant improvement between pre- and post-test scores in each group, there is no significant difference between the intervention groups and the control group. Further, while the improvement in each group was statistically significant, it is unclear whether it is a meaningful improvement, and as per the previous point - the data are not able to determine the impact of the intervention on practice or TB program outcomes.

Suggested improvements:

1. Throughout the manuscript, you sometimes use TB and sometimes tuberculosis. I suggest consistent use of one or the other. The same applies for other acronyms.

2. I believe the methods section could be more clear, in particular your description of the intervention.

Is the work clearly and accurately presented and does it cite the current literature?

Partly

Is the study design appropriate and is the work technically sound?

Partly

Are sufficient details of methods and analysis provided to allow replication by others?

Yes

If applicable, is the statistical analysis and its interpretation appropriate?

Yes

Are all the source data underlying the results available to ensure full reproducibility?

Yes

Are the conclusions drawn adequately supported by the results?

No

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Tuberculosis, epidemiology, implementation research, communicable diseases, field epidemiology, public health

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have

significant reservations, as outlined above.

Author Response 17 Jul 2022

Christie Akwaowo

Thank you very much for the valued suggestions. We will work on them.

Christie Akwaowo

Competing Interests: No competing interests were disclosed.

Reviewer Report 01 April 2022

<https://doi.org/10.5256/f1000research.78537.r121995>

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Angela Oyo-Ita

Department of Community Medicine, University of Calabar Teaching Hospital, Calabar, Nigeria

Amendments by the Authors noted. There are a few areas that need to be addressed:

1. The title was corrected to read "front line health workers" in place of "community health workers." However, the text still reads "community health workers": consistency should be maintained in the text.
2. Table 2 should be deleted.
3. Table 4 is not necessary as the data have been presented in subsequent tables that compare the different interventions with the control.
4. Table 7 has a title implying the comparison is between intervention and control arms but it is actually pre- and post-comparison; let this be corrected.
5. It is implied in the discussion that the observed impact in the control was from "contamination". It is rather a selection error than contamination. The statement should be deleted.

Is the work clearly and accurately presented and does it cite the current literature?

No

Is the study design appropriate and is the work technically sound?

No

Are sufficient details of methods and analysis provided to allow replication by others?

No

If applicable, is the statistical analysis and its interpretation appropriate?

No

Are all the source data underlying the results available to ensure full reproducibility?

No

Are the conclusions drawn adequately supported by the results?

No

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Public health

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.

Version 1

Reviewer Report 04 October 2021

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Angela Oyo-Ita

Department of Community Medicine, University of Calabar Teaching Hospital, Calabar, Nigeria

This was a randomized control trial to study the effect of training and or incentive on the knowledge of community health workers. The participants were health workers in formal (community health workers) and informal (patent medicine vendors, PMVs) settings. The title could be amended to read "Effects of training of frontline health workers' on tuberculosis: a cluster-randomized control trial in South Nigeria".

A succinct description of the intervention should be provided.

- What were the qualifications of the trainees? This is particularly needed as apprentices were sent by some of the PMVs for the training.
- How many training sessions were held?
- Were the follow-up training sessions repeats of the initial training?

- What was the level of participation of the trainees?
- What training method(s) was adopted?
- The average period of exposure of the trainees should also be indicated.

The attrition rate should be indicated and the reasons highlighted.

Though the intervention sites were said to be contiguous, the result seems to indicate that there may be some level of contamination as the impact on the control was substantial.

The second socio-demographic table is not needful. Intention to treat analysis should be presented.

Discussion should proffer possible reasons for the increase in the knowledge in the control arm.

Is the work clearly and accurately presented and does it cite the current literature?

Yes

Is the study design appropriate and is the work technically sound?

Yes

Are sufficient details of methods and analysis provided to allow replication by others?

No

If applicable, is the statistical analysis and its interpretation appropriate?

Partly

Are all the source data underlying the results available to ensure full reproducibility?

Yes

Are the conclusions drawn adequately supported by the results?

Partly

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Public health

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

Author Response 17 Oct 2021

Christie Akwaowo

This was a randomized control trial to study the effect of training and or incentive on the

knowledge of community health workers. The participants were health workers informal (community health workers) and informal (patent medicine vendors, PMVs) settings. The title could be amended to read "Effects of training of frontline health workers' on tuberculosis: a cluster-randomized control trial in South Nigeria".

Response: The title has been amended accordingly.

What were the qualifications of the trainees? This is particularly needed as apprentices were sent by some of the PMVs for the training.

Response: The trainees were Community Health Workers and patent medicine vendors.

How many training sessions were held? Were the follow-up training sessions repeats of the initial training?

Response: One training session was held. This has been highlighted in the paper.

What was the level of participation of the trainees? What training method(s) was adopted?

Response: A participatory method of training was adopted and the trainees were involved in the interactive session. This has been highlighted in the paper.

The average period of exposure of the trainees should also be indicated.

Response: This has been indicated in the paper.

Though the intervention sites were said to be contiguous, the result seems to indicate that there may be some level of contamination as the impact on the control was substantial.

Response: The intervention sites were non-contiguous, however, the possible source of contamination has been highlighted.

The second socio-demographic table is not needful. Intention to treat analysis should be presented.

Response: We beg to differ, we think that information captured on this table has not been replicated elsewhere and should be retained.

Discussion should proffer possible reasons for the increase in the knowledge in the control arm.

Response: This had been highlighted and also included in the limitations.

Competing Interests: No competing interests were disclosed.

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