

RESEARCH

Open Access



Impact of training and case manager support for traditional birth attendants in the linkage of care among HIV-positive pregnant women in Southwest Nigeria: a 3-arm cluster randomized control trial

Adedoyin O. Ogunyemi^{1*}, Kofoworola A. Odeyemi¹, Babasola O. Okusanya², Gbenga Olorunfemi³, Melissa Simon⁴, Mobolanle R. Balogun¹ and Alani S. Akanmu⁵

Abstract

Background Mother-to-child transmission (MTCT) accounts for 90% of all new paediatric HIV infections in Nigeria and for approximately 30% of the global burden. This study aimed to determine the effectiveness of a training model that incorporated case managers working closely with traditional birth attendants (TBAs) to ensure linkage to care for HIV-positive pregnant women.

Methods This study was a 3-arm parallel design cluster randomized controlled trial in Ifo and Ado-Odo Ota, Ogun State, Nigeria. The study employed a random sampling technique to allocate three distinct TBA associations as clusters. Cluster 1 received training exclusively; Cluster 2 underwent training in addition to the utilization of case managers, and Cluster 3 served as a control group. In total, 240 TBAs were enrolled in the study, with 80 participants in each of the intervention and control groups. and were followed up for a duration of 6 months. We employed a one-way analysis of variance (ANOVA) statistical test to evaluate the differences between baseline and endline HIV knowledge scores and PMTCT practices. Additionally, bivariate analysis using the chi-square test was used to investigate linkage to care. Furthermore, logistic regression analysis was utilized to identify TBA characteristics associated with various PMTCT interventions, including the receipt of HIV test results and repeat testing at term for HIV-negative pregnant women. The data analysis was performed using Stata version 16.1.877, and we considered results statistically significant when p values were less than 0.05.

Results At the end of this study, there were improvements in the TBAs' HIV and PMTCT-related knowledge within the intervention groups, however, it did not reach statistical significance ($p > 0.05$). The referral of pregnant clients for HIV testing was highest (93.5%) within cluster 2 TBAs, who received both PMTCT training and case manager support ($p \leq 0.001$). The likelihood of HIV-negative pregnant women at term repeating an HIV test was approximately 4.1 times higher when referred by TBAs in cluster 1 (AOR = 4.14; 95% CI [2.82–5.99]) compared to those in the control group and 1.9 times in cluster 2 (AOR = 1.93; 95% CI [1.3–2.89]) compared to the control group. Additionally, older

*Correspondence:

Adedoyin O. Ogunyemi

aogunyemi@cmul.edu.ng; doyinogunyemi@gmail.com

Full list of author information is available at the end of the article



© The Author(s) 2024. **Open Access** This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if changes were made. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit <http://creativecommons.org/licenses/by/4.0/>. The Creative Commons Public Domain Dedication waiver (<http://creativecommons.org/publicdomain/zero/1.0/>) applies to the data made available in this article, unless otherwise stated in a credit line to the data.

TBAs (OR= 1.62; 95% CI [1.26–2.1]) and TBAs with more years of experience in their practice (OR= 1.45; 95% CI [1.09–1.93]) were more likely to encourage retesting among HIV-negative women at term.

Conclusions The combination of case managers and PMTCT training was more effective than training alone for TBAs in facilitating the linkage to care of HIV-positive pregnant women, although this effect did not reach statistical significance. Larger-scale studies to further investigate the benefits of case manager support in facilitating the linkage to care for PMTCT of HIV are recommended.

Trial registration The study was retrospectively registered in the Pan African Clinical Trial Registry, and it was assigned the unique identification number PACTR202206622552114.

Keywords Case managers, PMTCT, HIV, Nigeria, Traditional birth attendants, Training

Background

The use of traditional birth attendants (TBAs) in antenatal services and delivery is common in Nigeria, and up to 20–60% of births occur in the facilities of TBAs, especially in rural Nigeria [1, 2]. The World Health Organization (WHO) defines a TBA as “a person who assists the mother during childbirth and initially acquired her skills by delivering babies herself or through an apprenticeship to other TBAs” [3]. Despite the essential role TBAs play in the health system, they are perceived to contribute to the high maternal mortality ratio in Nigeria due to some adverse practices and possibly inadequate knowledge [4].

Mother-to-child transmission (MTCT) accounts for 90% of all new paediatric human immunodeficiency virus (HIV) infections in Nigeria and for approximately 30% of the global burden [5, 6]. In developed countries, evidence-based interventions have been introduced to reduce the MTCT of HIV rates to <2%, yet high transmission rates persist in sub-Saharan Africa, possibly due to low rates of access to HIV testing (11.7%) and antiretroviral prophylaxis (17.1%) [7, 8]. Although only 39% of all deliveries take place in the health facility in Nigeria, facility-based antenatal care is still the main vehicle used for PMTCT services in Nigeria [1]. Therefore, it is essential to create interventions to improve non-facility prevention of MTCT of HIV [9, 10].

Previous studies have reported that the involvement of TBAs in HIV prevention and PMTCT programs can reduce new paediatric HIV infections since the majority of paediatric HIV infections in our environment are due to vertical transmission [10–12]. Such TBA engagements include training on HIV counselling and testing and on some PMTCT services, including administering nevirapine syrups to newborns [13]. The challenge with TBAs' involvement in the PMTCT service cascade includes poor linkage to HIV care and inappropriate or non-utilization of current PMTCT guidelines to manage the identified HIV-positive pregnant woman and their exposed infants [14, 15]. To close the ‘linkage to care’ gap, community support services such as the utilization of case managers have been successful in community

antiretroviral services [16, 17]. The case manager makes referrals, coordinates care with facility providers, and manages the exchange of information between providers and human services organizations. This aligns with target two of the Sustainable Development Goal three (SDG 3, target two), which is to end preventable deaths of newborns and children under 5 years of age [18, 19].

According to the WHO, coordination of care is a global priority for reorienting health services to the needs of people [20]. Some studies have demonstrated the successful implementation of training and support from care coordinators in improving medication adherence among individuals with HIV and keeping them engaged and connected to care [21, 22]. However, more research is needed to identify the most efficacious interventions in settings with limited resources. This study compared the effectiveness of usual care (control arm), PMTCT training of TBAs alone versus a combination of training and community support service providers (case managers) to ensure PMTCT care and linkage to PMTCT centres for HIV-positive pregnant women.

Methods

Trial design

This study employed a 3-arm parallel design cluster randomized controlled trial to assess and compare the effectiveness of two interventions. The first arm comprised TBAs who received PMTCT training only (Cluster 1), and the second arm included TBAs who received both PMTCT training and case manager support (Cluster 2). The third group served as the control group and received neither training nor case manager support (Control). The participant allocation ratio across the three arms was 1:1:1.

Study location

The study locations were Ifo and Ado-Odo/Ota Local Government Areas (LGAs) in Ogun State, Southwest Nigeria. Ado-Odo/Ota is the largest LGA out of the 20 LGAs in Ogun State, with an area of 234,647 km², and it is popular for traditional, cultural and historic

festivals, with a population of 526,565 [23]. Ifo LGA is a neighbouring LGA to Ado-Odo/Ota and has an area of 215,055km² and a population of 524,837 [24]. These two LGAs serve as a rural health setting for training doctors and medical students at the College of Medicine, University of Lagos. The 2 LGAs are approximately 46 km apart from each other.

Study population and selection of participants

The TBAs in Ifo and Ado-Odo/Ota LGAs belong to three different associations and have separate meeting times and venues. The associations are registered with the LGA, which provides some regulation to their activities. To limit contamination among the groups, the controls were recruited from Ifo LGA, while the training-only and training plus utilization of case manager groups were from Ado Odo/Ota LGA. These associations are clustered and consist of approximately 100 members each having similar demographic and socioeconomic characteristics but are situated in different geographic wards. The eligibility criteria included registered TBAs aged 18 years or older who recorded two or more births in their birthing homes in the previous month, had proper record documentation and had not received PMTCT training previously.

The research team worked with the medical officer of health (MOH), head of TBA associations and LGA staff in determining TBAs who met the eligibility criteria. After the list had been compiled, all eligible TBAs were invited to participate in the study by sending text messages to their phones. Sixteen staff from the LGA with some health training background were selected and trained to assist with data collection. Twelve of them served as research assistants, and four were trained as case managers (CM). Four research assistants were assigned to the control group, another four research assistants to cluster 1, and four research assistants and four case managers to cluster 2. In each cluster meeting in a central hall at the respective LGAs, the research assistants screened all participants to identify eligible respondents. Subsequently, they were given information about the study and administered consent forms (in English and Yoruba languages) for willing participants to sign as consent to be involved in the study.

Sample size determination

The sample size formula for randomized controlled trials was used to calculate the sample size for each group to achieve a power of 80%, an effect size of 15% and a statistical significance of 0.05 (2-sided) in a superiority trial given that the prevalence of the practice of PMTCT strategies among TBAs was 43.0% from a previous study [25]. A minimum sample size of 42 TBAs per arm was needed,

but this was doubled to 80 TBAs per arm totalling 240 TBAs to allow for robust regression modelling.

Randomization and allocation

After the baseline assessment of the participants, a representative of each of the 3 TBA clusters was invited by the principal investigator to a meeting. At the meeting, each TBA representative picked an opaque sealed envelope from a box that contained an allocation card that indicated the study arm to which the participating TBAs in her association would be assigned. One cluster was randomized to PMTCT training only, another cluster to the training and case managers, while the third cluster of TBAs served as controls that neither had training nor case managers assigned to it.

Meetings were held with TBAs in each of the three groups in equal proportions (80 each), and a research assistant was assigned to each group. The research assistants introduced themselves to the TBAs individually, collected the TBA birthing home details and distributed TBA logs to each TBA. The case managers were assigned to TBAs in cluster 2 only. Additionally, the CMs gave their contact details on how they could be reached by the TBA for ease of contact if they identified a pregnant woman who tested HIV-positive. The TBAs in the training and control clusters were also given the details of six PMTCT centres within the LGAs where referrals should be made, while cluster 2 was asked to contact their case managers in case a pregnant positive woman was identified. Furthermore, an independent research assistant verified the successful referral process by ensuring the coloured plastic bottle covers, initially provided to the TBAs, for the use of HIV-positive pregnant women, were handed over to the laboratory head at any of the designated PMTCT centres. In cluster 2, the TBA informed the case manager when a pregnant woman tested HIV positive. The case manager contacted the HIV-positive pregnant woman and accompanied her to the designated PMTCT centre.

Interventions

The TBAs in cluster 1 received PMTCT training only. This included didactic modules that took place for 2 days. It included topics on the natural history of HIV, antenatal testing, methods of MTCT of HIV, cART (combination antiretroviral therapy) in pregnancy and infant testing. Furthermore, information on PMTCT referral centres within the LGAs, patient confidentiality and the use of the TBA log register (S1 Appendix) were given. Cluster 2 similarly received the above training and case manager support. The case manager was assigned to the TBA and visited the TBAs in their homes monthly to review the TBA logs. Additionally, the TBA was to

inform the case manager if any pregnant woman under their care tested HIV-positive. The case manager would then facilitate linkage support by taking the HIV-positive pregnant woman in cluster 2 to predetermined PMTCT sites within the LGA. The training was conducted in the local language (Yoruba). All three groups were assigned research assistants who reported data from the TBA logs at the end of each month for the period of 6 months.

All TBAs who participated in the study were provided with delivery kits as incentives for their clients. The components of the kit were meant to promote WHO hygienic birth practices, clean delivery and cord care [26]. At baseline and at the end of the study period, PMTCT knowledge and practices were assessed for all TBAs using a pretested, interviewer-administered structured questionnaire in the Yoruba language. TBA logs contained the steps in the linkage cascade according to the WHO guidelines [27–29].

Trial outcomes

Primary outcomes

The proportion of women who were linked to care at the PMTCT centre (i.e HIV-positive pregnant women who present at the PMTCT centre) or a repeat HIV test at term/labour in the case of an HIV-negative pregnant woman. The focal health worker in each of the assigned PMTCT centres was visited at the end of each month during the study to determine the number of coloured plastic bottle covers deposited by the HIV-positive pregnant women who presented at any of the centres. This was thereafter verified by viewing the PMTCT register to determine the date of linkage to care of the pregnant women. The status of a repeat HIV test at term or before delivery was determined after the discharge of the HIV-negative woman by viewing the TBA register.

Secondary outcome

The secondary outcome was to compare study arms with respect to the degree of changes in knowledge and PMTCT practices of TBAs. This was done after the end-of-study data collection.

Training of research assistants

The research assistants and case managers received a 2-day training from an obstetrician on topics including the natural history of HIV, antenatal testing, methods of MTCT of HIV, ARV treatment in pregnancy and infant testing. Furthermore, the four case managers were also trained on strategies for linkage using the national guidelines for HIV prevention, treatment and care [30]. The 12 research assistants were assigned to TBAs in cluster 1 and cluster 2 and control groups to collect data from the TBA log registers on PMTCT activities at the end of

each month for a total of 6 months. The four case managers were assigned to TBAs in cluster 2 only to support PMTCT linkage services of HIV-positive pregnant women.

Data management

The data collection was conducted using a semi-structured interviewer-administered questionnaire adapted from a previous study on PMTCT knowledge and practices among TBAs [25]. The questionnaire consisted of specific sections to assess various aspects of knowledge and practices related to HIV and PMTCT. For the assessment of knowledge about HIV, seven questions were included. Respondents were required to select the correct answer from a list of options, distinguishing between accurate and inaccurate responses. Each correct response was assigned a score of one, while each incorrect response received a score of zero. Participants who provided four or more correct responses, including an accurate description of HIV, were categorized as having HIV knowledge.

Similarly, PMTCT knowledge was evaluated using five questions, which covered topics such as awareness of PMTCT and the modes of transmission of HIV from mother to child. Correct responses to these questions were assessed individually. To assess PMTCT practices among TBAs, specific aspects were examined, including their counselling of pregnant women and their referral of pregnant women for HIV testing. TBAs were encouraged to refer their clients to regulated laboratories for both their initial and repeat HIV testing (when negative), and only HIV test results from such referral laboratories were considered. The receipt of HIV test results was verified through documentation in the TBA registers for pregnant women. Additionally, the linkage to care of pregnant women who tested HIV-positive was confirmed by visiting the designated PMTCT centres. Furthermore, a repeat HIV test at term was defined as a test performed either after the 37th week of gestation and before the delivery process.

Data analyses

The data were analysed using Stata IC version 16.1.877 (StataCorp, USA) statistical software. Frequencies and proportions of participants' sociodemographic characteristics, baseline and follow-up knowledge and practices were computed. One-way analysis of variance (ANOVA) was also conducted for the association between continuous variables and the arm of the study. Univariable and multivariable binary logistic regression analyses were used to adjust for significant differences identified at baseline between the intervention and standard practice arms in the outcome analyses. Variables with a *P* value

<0.2 were utilized to build the model in a backwards elimination technique. Some variables, such as TBA age, level of education, years of practice, HIV and PMTCT knowledge, which could be associated with PMTCT practices were chosen a priori based on a previous study [25]. A two-tailed test of hypothesis was assumed, and the level of significance was set at $p < 0.05$.

Results

Participant flow

The study had a total of 240 TBA participants (80 per cluster) at baseline. They were followed up for 6 months, and at the end, 12 participants (1 in cluster 1, 3 in cluster 2 and 8 in cluster 3) were lost to follow-up (see Fig. 1: Participant flowchart for parallel design, based on CONSORT guidelines for transparent reporting of trials [31]),

and data from 228 TBAs were analysed at the end of the study.

Recruitment

Study participants were recruited in September 2019, and follow-up took place for 6 months as planned between October 2019 and March 2020.

Sociodemographic characteristics of the TBAs

The TBAs were predominantly female, with only 4 males (6.7%) in the study. There were no statistically significant differences between gender (P value=0.78), educational status (P value=0.18) and years of practice (P value=0.42) across the three arms of the study. There was a statistically significant difference ($p=0.04$) in the mean age across the TBA clusters, with TBAs in Cluster 1 having the highest mean age (46.6 ± 7.4 years)

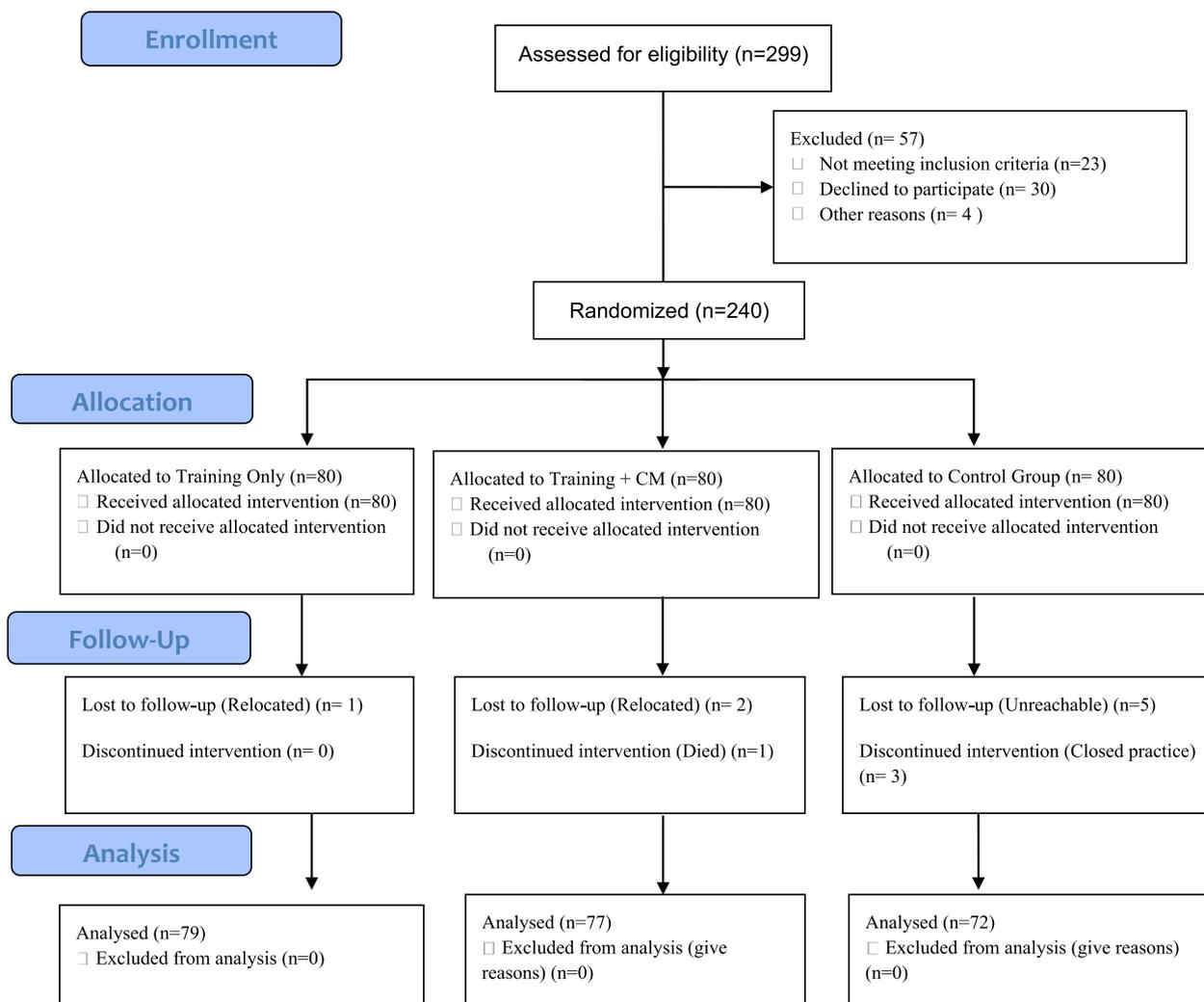


Fig. 1 Participant flowchart for parallel design, based on CONSORT guidelines for transparent reporting of trials.[†] CONSORT-Consolidated Standards of Reporting Trials; CM- Case Manager

and the longest duration of training as a TBA in Cluster 2 (P value = 0.01) (Table 1).

Baseline knowledge and practices regarding HIV and PMTCT of TBAs

At baseline, 64 (80.0%) participants in cluster 1, 65 (81.2%) in cluster 2 and 61 (76.2%) in the control group had correct knowledge of HIV as an infection (P value = 0.72). The lowest proportion was among the control group, but these differences were not statistically significant (P value = 0.72). Similarly, there were no statistically significant differences in the participants' PMTCT awareness (P value = 0.25), transmission of HIV from mother to child at different stages of pregnancy (P value = 0.93), delivery (P value = 0.43) or breastfeeding (P value = 0.42). Approximately a quarter of all TBAs in each of the groups reported that they could conduct the HIV tests by themselves, and about half of the TBAs in each of the clusters kept records of the HIV status of their clients (Table 2).

End-of-study knowledge and practices regarding HIV and PMTCT of TBAs

At the end of the study, only 228 respondents (79 in cluster 1, 77 in cluster 2 and 72 in the control group) were

available to be interviewed (Fig. 1). Correct knowledge about HIV was 100% in clusters 1 and 2 and 98.6% in cluster 3, but this difference was not statistically significant. The knowledge that MTCT of HIV can occur during delivery was highest in TBA respondents in cluster 1 (86.0%) and this difference was statistically significant (p = 0.04). Similarly, participants who referred all their pregnant women for HIV testing was highest among cluster 2 TBAs (p < 0.001). Among the TBA respondents who knew the HIV status of their pregnant women, it was highest (98.6%) in the control group and lowest (94.8%) in cluster 2 but this difference did not achieve statistical significance (p = 0.07) (Table 3).

TBA's PMTCT practices in pregnant women

The data from the TBA log sheets were collected once a month. For a period of 6 months, a total of 2022 pregnant women registered with TBAs. Cluster 2 TBAs referred 99.4% of their clients for HIV tests, which was higher than in the cluster 1 (94.4%) and control (94.4%) groups, and this difference was statistically significant (p < 0.001). In cluster 1, 31% of TBAs referred pregnant women for HIV tests at term (between 37 weeks of gestation and before delivery) if they had initially tested negative during booking." This was higher than that among TBAs in cluster 2

Table 1 Baseline demographic characteristics of the TBAs in the 3 clusters (n = 240)

Variables	Cluster 1 (Training only) n = 80	Cluster 2 (Training + Case Managers) n = 80	Control n = 80	F	p value
Gender					
Female	79 (98.7)	78 (97.5)	79 (98.7)	0.25	0.78
Male	1 (1.3)	2 (2.5)	1 (1.3)		
Age in years					
(Mean \pm SD)	46.4 (7.4)	41.7 (8.3)	44.8 (9.6)	5.96	0.04*
Education					
None	0 (0.0%)	1 (1.2%)	0 (0.0%)	3.31	0.04*
Primary	4 (5.0%)	5 (6.3%)	4 (5.0%)		
Secondary	44 (55.0%)	57 (71.2%)	54 (67.5%)		
Post-Secondary	32 (40.0%)	17 (21.3%)	22 (27.5%)		
Mean years of Practice					
(\pm SD)	16.4 (9.4)	12.7 (7.5)	15.5(9.4)	3.75	0.42
Training duration as a TBA					
(Years)	3.2 (1.1)	3.7 (1.6)	3.0(1.2)	6.09	0.01*
Trainer					
Parent	1 (1.7%)	3 (3.7%)	5(6.3%)	1.38	< 0.001*
Relative	2 (3.3%)	6 (7.5%)	3 (3.7%)		
TBA Expert	18 (30.0%)	45 (56.3%)	30 (37.5%)		
Others	60 (75.0%)	26 (32.5%)	44 (55.0%)		
Total number of pregnant women receiving ANC	876	712	434		

* p -value < 0.05

Table 2 Baseline knowledge and reported practices regarding HIV and PMTCT in the 3 clusters (n = 240)

Knowledge and Practices (Yes/No)	Cluster 1 n = 80 (%)	Cluster 2 n = 80 (%)	Control n = 80 (%)	F	P-value
Correct knowledge of HIV	64 (80.0)	65 (81.2)	61 (76.2)	0.33	0.72
Aware of PMTCT of HIV	74 (92.5)	68 (85.0)	68 (85.0)	1.37	0.25
MTC of HIV is possible	76 (95.0)	76 (95.0)	73 (91.2)	0.64	0.53
MTCT of HIV can occur in pregnancy	48 (60.0)	48 (60.0)	46 (57.5)	0.07	0.93
MTCT of HIV can occur at delivery	38 (47.5)	35 (43.7)	30 (37.5)	0.83	0.43
MTCT of HIV can occur while breastfeeding	44 (55.0)	46 (57.5)	38 (47.5)	0.87	0.42
HTS can prevent MTCT of HIV	45 (56.2)	38 (47.5)	40 (50.0)	1.06	0.34
TBA can conduct HIV test	18 (22.5)	20 (25.0)	20 (25.0)	0.09	0.91
Refer for HIV test					
Yes, for all	70 (87.5)	67 (83.7)	69 (86.3)	0.29	0.91
Yes, for some	7 (8.6)	8 (10.0)	6 (7.5)		
Not at all	3 (3.7)	5 (6.3)	5 (6.2)		
Know HIV status of your pregnant clients					
Yes, for all	75 (93.7)	71 (88.8)	76 (95.0)	0.85	0.47
Yes, for some	3 (3.8)	5 (6.2)	1 (1.3)		
Not at all	2 (2.5)	4 (5.0)	3 (3.7)		
Records for HIV Status	51 (63.7)	45 (56.2)	46 (57.5)	0.53	0.59

Table 3 End-of-study knowledge and reported practices regarding HIV and PMTCT in the 3 clusters

Knowledge and Practices (Yes/No)	Cluster 1 n = 79	Cluster 2 n = 77	Control n = 72	F	p-value
Correct knowledge of HIV	79 (100.0)	77 (100.0)	71 (98.6)	1.08	0.34
Aware of PMTCT	71 (89.9)	71 (92.2)	67 (93.1)	0.27	0.76
MTCT of HIV is possible	76 (96.2)	74 (96.1)	70 (97.2)	0.08	0.92
MTCT can occur in pregnancy	45 (57.0)	42 (54.5)	50 (69.4)	1.98	0.14
MTCT can occur at delivery	68 (86.0)	53 (68.8)	55 (76.4)	3.37	0.04*
MTCT of HIV can occur while breastfeeding	59 (74.7)	63 (81.8)	64 (88.9)	2.55	0.08
HTS can prevent MTCT	47 (59.5)	67 (87.0)	66 (91.7)	15.76	<0.001*
TBA can conduct HIV test	36 (46.1)	19 (24.6)	15 (20.8)	6.99	0.001*
Refer for HIV test					
Yes, for all	53 (67.1)	72 (93.5)	66 (91.7)	9.58	<0.001*
Yes, for some	25 (31.6)	2 (2.6)	3 (4.2)		
Not at all	0 (0.0)	0 (0.9)	3 (4.2)		
Know HIV status of your pregnant clients					
Yes, for all	75 (96.2)	73 (94.8)	71 (98.6)	5.07	0.07
Yes, for some	3 (3.8)	4 (5.2)	1 (1.4)		

*p-value <0.05

(15.8%) and the control group (9.7%), and this difference was statistically significant (P value <0.001) (Table 4).

Association between TBA characteristics and linkage to care in HIV-positive pregnant women

For factors associated with the linkage to care of HIV-positive pregnant women to the PMTCT centres, all 5 (100.0%) of the HIV-positive pregnant women in

cluster 2 were linked to the PMTCT centre compared to 4 (66.7%) in cluster 1 and 1 (25.0%) in the control group. However, this difference was not statistically significant ($\chi^2 = 5.63$, $p = 0.06$). Other characteristics, such as the TBA's age, level of education, years of practice and knowledge of HIV, were not significantly associated with the linkage of care for HIV-positive pregnant women ($p > 0.05$) (Table 5).

Table 4 End-of-study data of the TBA's PMTCT practices among registered pregnant women (over 6 months)

PMTCT data of pregnant women registered for ANC by TBAs	Cluster 1 n = 876 (%)	Cluster 2 n = 712 (%)	Control n = 434 (%)	F	P value
Referral for HIV test at any time during pregnancy (before term or delivery)	826 (94.4)	707 (99.4)	410 (94.4)	15.6	< 0.001*
Referral for HIV test at first visit	556 (67.6)	400 (56.7)	287 (69.7)	13.4	< 0.001*
Test results received	810 (97.9)	688 (97.2)	397 (96.3)	1.38	0.25
Test Result					
HIV Negative	804 (99.3)	683 (99.3)	393 (99.0)	0.15	0.86
HIV Positive	6 (0.74)	5 (0.73)	4 (1.01)		
HIV test repeated at term or before delivery (for initial negative test)	249 (30.9)	108 (15.8)	38 (9.7)	46.0	< 0.001*

*p-value < 0.05

Table 5 Comparison between TBA characteristics and linkage to care among HIV-positive pregnant women

Variables	Linkage to PMTCT centre (n = 15)		χ^2	p value
	No (n = 5)	Yes (n = 10)		
Arms				
Control	3 (75.0)	1 (25.0)	5.63	0.06
Cluster 1 (Training)	2 (33.3)	4 (66.7)		
Cluster 2 (Training + CM)	0 (0.0)	5 (100.0)		
Age group (years)				
20–39	1 (50.0)	1 (50.0)	2.63	0.269
40–59	3 (25.0)	9 (75.0)		
> 60 years	1 (100.0)	0 (0.0)		
Level of Education				
Primary	1 (100.0)	0 (0.0)	3.3	0.192
Secondary	2 (20.0)	8 (80.0)		
Post- Secondary	2 (50.0)	2 (50.0)		
Years of practice				
1–10	2 (50.0)	2 (50.0)	3.75	0.153
11–20	3 (50.0)	3 (50.0)		
Above 20	0 (0.0)	5 (100.0)		
Referral for HIV test at first visit				
No	4 (50.0)	4 (50.0)		
Yes	1 (14.3)	6 (85.7)	2.15	0.282
Correct knowledge of HIV at baseline				
No	1 (50.0)	1 (50.0)	0.28	0.571
Yes	4 (30.8)	9 (69.2)		

Factors associated with the receipt of HIV test results of pregnant women

In the logistic regression analysis, low education (primary) had an odds ratio of 0.21 (95%[CI]: [0.08, 0.5]), indicating a decreased likelihood of the receipt of HIV test results and this was statistically significant ($p < 0.05$). None of the other TBA characteristics demonstrated statistical significance ($p > 0.05$) in predicting the likelihood of receiving the HIV test results of the pregnant women in their care (Table 6).

Factors associated with repeat testing at term for HIV-negative pregnant women

The likelihood of HIV-negative pregnant women at term repeating an HIV test was approximately 4.1 times higher when referred by TBAs in cluster 1 (AOR=4.14; 95% CI [2.82–5.99]) compared to those in the control group and 1.9 times in cluster 2 (AOR=1.93; 95% CI [1.3–2.89]) compared to the control group. Additionally, older TBAs (OR=1.62; 95% CI [1.26–2.1]) and TBAs with more years of experience in their practice (OR=1.45; 95% CI

Table 6 Logistic regression of factors associated with the receipt of HIV test results of pregnant women

Variables	Unadjusted OR (95% CI)	ρ value	Adjusted OR (95% CI)	ρ value
Arms				
Control	1.00		1.00	
Cluster 1 (Training)	1.80 (0.9–3.63)	0.102	1.73 (0.84–3.6)	0.137
Cluster 2 (Training + CM)	1.3 (0.66–2.56)	0.450	1.28 (0.62–2.66)	0.495
Age group (years)				
20–39	1.00		1.00	
40–59	5.99 (0.61–1.97)	0.764	1.30 (0.64–2.66)	0.463
Above 60	1.68 (0.22–12.93)	0.616	11.2 (1.2–105.6)	0.033*
Level of Education				
None	1.00		1.00	
Primary	0.21 (0.08–0.5)	0.001*	0.11 (0.04–0.29)	< 0.001*
Secondary	1.68 (0.39–1.4)	0.394	0.77 (0.4–2.12)	0.444
Years of practice				
1–10	1.00		1.00	
11–20	0.57 (0.57–1.99)	0.859	1.01 (0.5–2.03)	0.979
Above 20	1.06 (0.52–2.18)	0.864	0.35 (0.38–2.12)	0.810
Correct knowledge of HIV at baseline				
No	1.00		1.00	
Yes	0.58 (0.31–2.69)	0.098	0.43 (0.17–1.13)	0.085

*Statistically significant

Table 7 Logistic regression of factors associated with repeat testing at term for HIV-negative pregnant women

Variables	Unadjusted OR (95% CI)	ρ value	Adjusted OR (95% CI)	ρ value
Arms				
Control	1.00		1.00	
Cluster 1 (Training)	4.1 (2.83–5.93)	< 0.001*	4.14 (2.82–5.99)	< 0.001*
Cluster 2 (Training + CM)	1.73 (1.16–2.56)	0.006	1.93 (1.3–2.89)	0.001*
Age group (years)				
20–39	1.00		1.00	
40–59	1.62 (1.26–2.1)	< 0.001*	1.12 (1.22–1.52)	0.479
Level of Education				
None	1.00		1.00	
Primary	2.05 (0.25–0.94)	0.032*	0.86 (0.56–2.41)	0.692
Secondary	0.81 (0.64–1.02)	0.07	1.04 (0.40–1.49)	0.729
Years of practice				
1–10	1.00		1.00	
11–20	1.25 (0.96–1.6)	0.101	0.17 (0.27–1.55)	0.288
Above 20	1.45 (1.09–1.93)	0.01*	1.4 (1.01–1.95)	0.049*
Correct knowledge of HIV at baseline				
No	1.00		1.00	
Yes	1.08 (0.13–1.43)	0.59	1.16 (0.85–1.57)	0.342

*Statistically significant

[1.09–1.93]) were more likely to encourage retesting among HIV-negative women at term (Table 7).

Factors associated with linkage to care in HIV-positive pregnant women

In the logistic regression analysis using Firth logistic regression, the likelihood for HIV-positive pregnant women in cluster 2 being linked to care was approximately 40.0 times higher when compared with the control group, (AOR=40.0; 95% CI [0.8–820.6]), however, the result did not achieve statistical significance ($p > 0.05$). Similarly, other factors indicated no significant association between TBA characteristics and linkage to care (Table 8).

Discussion

This 3-arm study assessed and compared the effectiveness of PMTCT training-only and training of TBAs along with the utilization of case managers in the prevention of mother-to-child transmission of HIV. The study aimed to evaluate interventions for identifying HIV-positive pregnant women and their linkage to PMTCT centres for care. There were 240 TBAs who rendered antenatal care services to 2022 pregnant women over a period of 6 months.

At baseline, there were no significant differences in HIV-related knowledge and PMTCT practices among the 3 groups. However, TBAs in cluster 1 (training-only)

and cluster 2 (training and case manager support) demonstrated higher levels of awareness regarding the HIV status of their pregnant clients and better record-keeping practices, with these differences being statistically significant ($p < 0.05$). Previous studies have highlighted the advantages of involving trained and supervised TBAs in preventing mother-to-child transmission of HIV [10, 32, 33]. Nevertheless, by the end of this study, there were no significant improvements in the TBAs' knowledge about how HIV can be transmitted from a mother to her child during pregnancy and breastfeeding across the 3 groups. Training TBAs in low- and middle-income countries to enhance their knowledge and practices related to PMTCT of HIV has yielded mixed results. These variations can be attributed to several challenges, including the TBAs' lower levels of education, difficulties in reporting practices and the inadequacy of supervision quality [34]. It was observed that the effectiveness of this training was more pronounced in regions where essential obstetric care services were readily available and could be utilized as referral options by TBAs [35]. In such contexts, the indirect impact of training, which facilitated referrals to higher-level healthcare facilities when needed, appeared to be more beneficial than solely focusing on direct training for the TBAs themselves.

Our study revealed that TBAs who underwent training and had access to case managers demonstrated a remarkable rate of referring nearly all of their pregnant clients

Table 8 Firth logistic regression of factors associated with linkage to care among HIV-positive pregnant women

Variables	Unadjusted OR (95% CI)	p value	Adjusted OR (95% CI)	p value
Arms				
Control	1.00		1.00	
Cluster 1 (Training)	4.22 (0.36–48.9)	0.253	1.1 (0.05–149.9)	0.627
Cluster 2 (Training + CM)	25.7 (0.80–820.6)	0.067	40.0 (0.74–1652.4)	0.052
Age group (years)				
20–39	1.00		1.00	
40–59	1.1 (0.21–35.5)	0.447	0.24 (0.002–26.8)	0.555
Above 60	0.33 (0.01–16.7)	0.583	4.09 (0.004–4817.4)	0.694
Level of Education				
None	1.00		1.00	
Primary	10.2(0.31–337.0)	0.193	9.68 (0.08–1141.4)	0.351
Secondary	3.0 (0.08–16.8)	0.555	–	
Years of practice				
1–10	1.00		1.00	
11–20	4.57 (0.1–9.87)	0.998	0.20 (0.006–66.7)	0.590
Above 20	3.0 (0.08–323.8)	0.165	3.28 (0.05–212.7)	0.572
Correct knowledge of HIV at baseline				
No	1.00		1.00	
Yes	2.11 (0.17–26.3)	0.562	1.28 (0.004–365.0)	0.93

for HIV tests with 99.4% compliance. This rate was significantly higher than the proportion of HIV testing seen in the other clusters ($p < 0.001$). This aligns with findings from previous studies conducted in Nigeria, rural Zambia and Malawi [9, 10, 36], which also indicated that TBAs who received PMTCT training were more likely to refer for HIV tests, thus contributing to increased awareness of HIV status. Despite the relatively high proportion of HIV test referrals observed across all clusters, the practice of HTS referral during the initial visit was less common. The control group had the highest improvement of HTS referrals between baseline and endline assessments.

The HIV positivity rate in this study was 0.7%, which is lower than the 2019 national average of 1.4% [37]. The recent drop in estimates has been attributed to enhanced surveillance [38]. However, Nigeria has not met the UNAID's 2015 target of the countdown to zero with the Global Plan towards the elimination of new HIV infections among children [39]. Achieving this is hinged on identifying pregnant women living with HIV and giving access to antiretroviral drugs through their linkage to care.

In our study, we observed that less than a third of the pregnant women were referred for an HIV test at term or during the process of labour. This finding is notably lower than 52.1% of pregnant women in Vietnam who received repeat HIV testing [40]. The latter study comprised women who had their babies in health facilities with well-established PMTCT programs, which likely contributed to the higher proportion of repeat testing in that context.

Furthermore, our study revealed variations in the rates of repeat HIV testing among different clusters. The training-only cluster had the highest rate at 30.9%, while the control group had the lowest rate at 9.7%. This difference was statistically significant ($p < 0.001$). Research has emphasized the importance of conducting provider-initiated counselling and testing (PICT) not only during the initial antenatal care (ANC) visit but also at term/delivery. This is because some pregnant women may seroconvert to HIV later in their pregnancy, underscoring the necessity of repeat tests [41]. HIV incidence proportions among pregnant women who initially tested negative but later seroconverted were observed at 0.41% in Kenya [41], 0.12% in India [42], 0.5% in Zambia [43], and 3.3% in South Africa [44]. These statistics highlight the ongoing risk of HIV infection during pregnancy and the importance of repeat testing to ensure timely diagnosis and appropriate interventions.

In cluster 2, which involved training and utilization of case managers, all pregnant women who tested positive for HIV were linked to care at the designated PMTCT centres. This rate was higher compared to the training-only cluster and control groups, where 66.7 and 25.0%

of HIV-positive pregnant women, respectively, demonstrated evidence of being linked to care. This suggests that the implemented strategies, especially in the cluster involving training and utilization of case managers, have contributed to a higher rate of successful linkage to PMTCT services. However, these differences were not statistically significant ($p > 0.05$). Additionally, factors such as the TBA's age, level of education, years of practice and knowledge of HIV did not show significant associations with the linkage to care for HIV-positive pregnant women ($p > 0.05$). This aligns with findings of other studies, which have highlighted the role of HIV case managers with appropriate training and resource support in promoting treatment adherence and improving cluster of differentiation 4 (CD4) counts among HIV patients [45, 46].

From our study, the training and use of case manager interventions did not affect receiving HIV test results from the pregnant women in the TBAs care, as almost all the pregnant women who had been requested to undertake the HIV test did so. It is acknowledged that TBAs are powerful actors in maternal health issues due to cultural beliefs, norms and practices [47]. TBAs who belonged to the intervention groups, who were older, and who had spent more years in practice were more likely to refer for a HIV retest at term to pregnant women who were initially negative. In view of the significant proportion of pregnant women in Nigeria who do not deliver at health centres, innovative ways to identify and link HIV-positive pregnant women to HIV care and treatment are critical to eliminating MTCT of HIV [48–51].

Study limitations

There are several strengths in this study, including a large sample size of TBAs and pregnant women in their care. However, some limitations exist. One potential limitation is the close proximity of the study sites from which the TBA groups were recruited. This geographical proximity may have resulted in some contamination among the groups. Second, the end-of-study assessment of TBAs' knowledge of HIV and PMTCT was performed via phone calls due to the COVID-19 lockdown, unlike the face-to-face interviews at baseline. Although we used the same interviewers and retrained them for the purpose, the mode of interview may have impacted the findings.

Conclusions

In conclusion, the combination of case managers and PMTCT training was more effective than training alone for TBAs in facilitating the linkage to care of HIV-positive pregnant women, although this effect did not reach statistical significance. Neither training nor the utilization of case managers had any statistically significant

improvement in the knowledge of the TBAs at the end of the study. Larger-scale studies to further investigate the benefits of case manager support in facilitating the linkage to care for the prevention of mother-to-child transmission (PMTCT) of HIV are recommended.

Abbreviations

ANOVA	Analysis of variance
ARV	Antiretroviral
cART	Combined antiretroviral therapy
CD4	Cluster of differentiation 4
CI	Confidence interval
CM	Case manager
COVID-19	Coronavirus disease
HIV	Human immunodeficiency virus
HTS	HIV testing services
LGA	Local government area
MOH	Medical officer of health
MTCT	Mother to child transmission
OR	Odds ratio
PMTCT	Prevention of mother to child transmission
SDG	Sustainable development goals
TBA	Traditional birth attendant
WHO	World health organization

Supplementary Information

The online version contains supplementary material available at <https://doi.org/10.1186/s12884-024-06332-2>.

Supplementary file 1.

Supplementary file 2.

Acknowledgements

The authors acknowledge the traditional birth attendants, medical officers of health and the ape nurses of the LGAs for their support in undertaking this research.

Protocol

This protocol is available as supplementary material.

Authors' contributions

OAO, OKA, and OBO conceptualized and designed the study; OAO, BMR, and AAS contributed to the protocol and tool development; and OAO and OG conducted the data analysis and primary manuscript writing. OAO, OKA, OBO, SM, BMR, and AAS all contributed to the interpretation of data and final manuscript draft and approved the final version.

Funding

This research was supported by the Fogarty International Center of the National Institutes of Health under Award Number D43TW010134.

Availability of data and materials

The datasets used during the current study are available from the corresponding author upon reasonable request.

Declarations

Ethics approval and consent to participate

The participants provided informed consent after a thorough explanation of the procedures, risks and benefits of the study. The participants were informed that they could withdraw from the study at any time without any penalty. The use of identification codes ensured confidentiality. Ethical approval was obtained from the health, research and ethics committee, College of Medicine, University of Lagos with approval ID CMUL/HREC/03/19/504 before the

commencement of the study. All steps/methods were performed in accordance with the relevant guidelines and regulations.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

Author details

¹Department of Community Health and Primary Care, College of Medicine, University of Lagos, Lagos, Nigeria. ²Department of Obstetrics and Gynaecology, College of Medicine, University of Lagos, Lagos, Nigeria. ³Division of Epidemiology and Biostatistics, Faculty of Health Sciences, University of Witwatersrand, Johannesburg, South Africa. ⁴Department of Obstetrics and Gynaecology, Robert H. Lurie Comprehensive Cancer Center, Northwestern University Feinberg School of Medicine, Chicago, USA. ⁵Department of Haematology and Blood Transfusion, College of Medicine, University of Lagos, Lagos State, Lagos, Nigeria.

Received: 11 November 2022 Accepted: 7 February 2024

Published online: 21 February 2024

References

1. Nigeria Demographic and Health Survey 2018. National Population Commission Federal Republic of Nigeria Abuja, Nigeria. Rockville, Maryland, USA: ICF International; 2014. p. 104–10. Available from: <https://www.dhsprogram.com/pubs/pdf/fr293/fr293.pdf> Accessed 26 Sep 2023.
2. Ebuehi OM, Akintujoye IA. Perception and utilization of traditional birth attendants by pregnant women attending primary health care clinics in a rural local government area in Ogun state, Nigeria. *Int J Women Health*. 2012;4:25–34.
3. World Health Organization. Traditional birth attendants: a joint WHO/UNFPA/UNICEF statement. Geneva: World Health Organization; 1992. p. 18.
4. Ofili AN, Okojie OH. Assessment of the role of traditional birth attendants in maternal health care in Oredo local government area, Edo state, Nigeria. *J Community Med Primary Health Care*. 2005;17:55–60.
5. National Agency for the Control of AIDS. FACT SHEET: Prevention of Mother to Child Transmission (PMTCT). 2016. Available at <https://naca.gov.ng/fact-sheet-prevention-mother-child-transmission-pmtct-2016/>. Accessed Sep 30 2019 .
6. World Health Organization. Towards universal access: scaling up priority HIV/AIDS interventions in the health sector. Geneva: WHO; 2010.
7. Newell ML. Current issues in the prevention of mother-to-child transmission of HIV-1 infection. *Trans R Soc Trop Med Hyg*. 2006;100:1–5.
8. National Agency for the Control of AIDS. Nigeria global AIDS response country Progress report. Abuja: NACA; 2012.
9. Chizoba AE, Pharr JR, Odo G, Ezeobi E, Ilozumba J, Egharevba J, Ezeanolue EE, Nwatu A. Increasing HIV testing among pregnant women in Nigeria. Evaluating traditional birth attendants and primary health care (tap-in) model. *AIDS Care*. 2017;29(9):1094–8.
10. Hamela G, Kabondo C, Tembo T, Zimba C, Kamanga E, Mofolo I, Bulla B, Sellers C, Nakanga RC, Lee C, Martinson F, Hoffman I, van der Horst C, Hosseinipour MC. Evaluating the benefits of incorporating traditional birth attendants in HIV prevention of mother to child transmission service delivery in Lilongwe, Malawi. *Afr J Reprod Health*. 2014;18(1):27–34.
11. Muzyamba C, Groot W, Tomini SM, Pavlava M. The usefulness of traditional birth attendants to women living with HIV in resource-poor settings: the case of Mfuwe, Zambia. *Trop Med Health*. 2017;45:37.
12. Che Chi P, Urdal H. The evolving role of traditional birth attendants in maternal health in post-conflict Africa: a qualitative study of Burundi and northern Uganda. *SAGE Open Med*. 2018;6:1–9.
13. Gorman DA, Nyirenda LJ, Theobald SJ. Prevention of mother-to-child transmission of HIV infection: views and perceptions about swallowing nevirapine in rural Lilongwe, Malawi. *BMC Public Health*. 2010;10:354.
14. Anígilájé EA, Ageda BR, Nweke NO. Barriers to uptake of prevention of mother-to-child transmission of HIV services among mothers of vertically infected HIV-seropositive infants in Makurdi, Nigeria. *Patient Prefer Adher*. 2016;10:57–72.

15. Okoli JC, Lansdown GE. Barriers to successful implementation of prevention-of-mother-to-child-transmission (PMTCT) of HIV programmes in Malawi and Nigeria: a critical literature review study. *Pan Afr Med J*. 2014;19:154.
16. FHI 360. Improving access to HIV testing, care and treatment for key populations through an existing national health system: Lessons from Ghana. Available at <https://www.fhi360.org/sites/default/files/media/documents/linkages-success-stories-ghana-lessons-june-2016.pdf>. Accessed 1 Oct 2019.
17. UNAIDS. Promising practices in community engagement for elimination of new HIV infections among children by 2015 and keeping their mothers alive. 2012. http://www.unaids.org/sites/default/files/media_asset/20120628_JC2281_PromisingPracticesCommunityEngagements_en_0.pdf. Accessed 1 Oct 2019.
18. Rural health information hub. Case Management and patient navigation <https://www.ruralhealthinfo.org/toolkits/hiv-aids/2/manage/case-management>. Accessed 1 Oct 2019.
19. World Health Organization. SDG3: Ensure healthy lives and promote wellbeing for all at all ages. Available at <http://www.who.int/sdg/targets/en/>. Accessed Sep 30 2019.
20. World Health Organization. Continuity and coordination of care: a practice brief to support implementation of the WHO Framework on integrated people-centred health services. Geneva. Geneva: WHO; 2018.
21. Gardner EM, McLees MP, Steiner JF, Del Rio C, Burman WJ. The spectrum of engagement in HIV care and its relevance to test-and-treat strategies for prevention of HIV infection. *Clin Infect Dis*. 2011;52:793–800.
22. Simoni JM, Pearson CR, Pantalone DW, Marks G, Crepaz N. Efficacy of interventions in improving highly active antiretroviral therapy adherence and HIV-1 RNA load: a meta-analytic review of randomized controlled trials. *J Acquir Immune Defic Syndr*. 2006;43(Suppl 1):S23–35.
23. Ado-Odo Ota Local Government Area. About the Local Government. Available at <https://adoodootalg.org.ng/about/>. Accessed 10 Oct 2021.
24. Wikipedia. Ifo. Available at <https://en.wikipedia.org/wiki/Ifo>. Accessed 10th October 2021.
25. Balogun M, Odeyemi K. Knowledge and practice of prevention-of-mother-to-child-transmission (PMTCT) of HIV among TBA in Lagos state, Nigeria. *Pan Afr Med J*. 2010;5:12.
26. World Health Organization. Antiretroviral Drugs for Treating Pregnant Women and Preventing HIV Infection in Infants: Recommendations for a Public Health Approach. Ver. Geneva, Switzerland: World Health Organization; 2010. p. 2010.
27. World Health Organization. WHO recommendations on the diagnosis of HIV infection in infants and children. Geneva, Switzerland: World Health Organization; 2010.
28. World Health Organization. Consolidated guidelines on the use of antiretroviral drugs for treating and preventing HIV infection. Recommendations for a public health approach. Geneva, Switzerland: World Health Organization; 2013.
29. World Health Organization. Guideline on when to start antiretroviral therapy and on pre-exposure prophylaxis for HIV. Geneva, Switzerland: World Health Organization; 2015.
30. World Health Organization. WHO Safe Childbirth Checklist Implementation Guide Improving the quality of facility-based delivery for mothers and newborns. Available at http://apps.who.int/iris/bitstream/handle/10665/199177/9789241549455_eng.pdf;jsessionid=C5C7643EF375B6447370D53FC1E5EF76?sequence=1. Accessed 10 Sep 2019.
31. Moher D, Hopewell S, Schulz KF, Montori V, Gøtzsche PC, et al. CONSORT 2010 explanation and elaboration: updated guidelines for reporting parallel group randomised trials. *Int J Surg*. 2012;10(1):28–55. <https://doi.org/10.1016/j.ijsu.2011.10.001>.
32. Abiodun O, Sotunsa J, Olu-Abiodun O, Ani F, Taiwo A, Taiwo O. The effect of training on traditional birth attendants' PMTCT related knowledge and care practices in Nigeria. *J AIDS Clin Res*. 2015;6:498. <https://doi.org/10.4172/2155-6113.1000498>.
33. Nsirim RO, et al. Integration of Traditional Birth Attendants into Prevention of Mother-to-Child Transmission at Primary Health Facilities in Kaduna, North-West Nigeria. *J Public Health Afr*. 2015;6(1):455.
34. Chizoba AF, Chineke HN, Adogu POU. Roles and challenges of traditional birth attendants in prevention of mother to child transmission of HIV in Nigeria - a brief review. *J Adv Med Med Res*. 2020;32(20):58–67.
35. Oshonwoh F, Nwankuo GK, Ekiyor CP. Traditional birth attendants and women health practices: a case study of Pantani in southern Nigeria. *J Public Health Epidemiol*. 2014;6:252–61.
36. Brennan AT, Thea DM, Semrau K, Goggin C, Scott N, Pilingana P, Seidenberg P. In-home HIV testing and nevirapine dosing by traditional birth attendants in rural Zambia: a feasibility study. *J Midwifery Women's Health*. 2014;59(2):198–204.
37. UNAIDS. Press Release. New survey results indicate that Nigeria has an HIV prevalence of 1.4%. Available at https://www.unaids.org/en/resources/press-centre/pressreleaseandstatementarchive/2019/march/20190314_nigeria. Accessed 11 Oct 2021.
38. PEPFAR. 'Large National Survey Shows Smaller HIV Epidemic in Nigeria Than Once Thought and Highlights Key Gaps Toward Reaching HIV Epidemic Control' Available at <https://www.state.gov/pepfar/>. Accessed 10 Oct 2021.
39. UNAIDS. Countdown to zero. Global plan towards the elimination of new HIV infections among children by 2015 and keeping their mothers alive. 2011–2015. Available at https://www.unaids.org/sites/default/files/media_asset/20110609_JC2137_Global-Plan-Elimination-HIV-Children_en_1.pdf. Accessed 10 Oct 2021.
40. Hãnh NT, Gammeltoft TM, Rasch V. Number and timing of antenatal HIV testing: evidence from a community-based study in northern Vietnam. *BMC Public Health*. 2011;11:183. <https://doi.org/10.1186/1471-2458-11-183>.
41. Mushamiri I, Adudans M, Apat D, Ben AY. Optimizing PMTCT efforts by repeat HIV testing during antenatal and perinatal care in resource-limited settings: a longitudinal assessment of HIV seroconversion. *PLoS One*. 2020;15(5):e0233396. <https://doi.org/10.1371/journal.pone.0233396>.
42. Joshi S, Kulkarni V, Gangakhedkar R. Cost-effectiveness of a repeat HIV test in pregnancy in India. *BMJ Open*. 2015;5:e006718.
43. Mandala J, Kasonde P, Badru T, Dirks R, Torpey K. HIV retesting of HIV-negative pregnant women in the context of prevention of mother-to-child transmission of HIV in primary health centers in rural Zambia: what did we learn? *J Int Assoc Providers AIDS Care (JIAPAC)*. 2019;18:2325958218823530. <https://doi.org/10.1177/2325958218823530>.
44. Dinh T-H, Delaney KP, Goga A, Jackson D, Lombard C, Woldeesenbet S, et al. Impact of maternal HIV seroconversion during pregnancy on early mother to child transmission of HIV (MTCT) measured at 4-8 weeks postpartum in South Africa 2011–2012: a National Population-Based Evaluation. *PLoS One*. 2015;10(5):e0125525. <https://doi.org/10.1371/journal.pone.0125525>.
45. Shelton RC, Golin CE, Smith SR, Eng E, Kaplan A. Role of the HIV/AIDS case manager: analysis of a case management adherence training and coordination program in North Carolina. *AIDS Patient Care STDs*. 2006;20(3):193–204.
46. Sarfo B, Vanderpuye NA, Addison A, Nyasulu P. HIV case management support service is associated with improved CD4 counts of patients receiving Care at the Antiretroviral Clinic of Pantang hospital, Ghana. *AIDS Res Treat*. 2017;2017:4697473.
47. Kululanga L, Sundby J, Malata A, Chirwa E. Striving to promote male involvement in maternal health care in rural and urban settings in Malawi—a qualitative study. *Reprod Health*. 2011;8(36)
48. Olakunde BO, Adeyinka DA, Olawepo JO, Pharr JR, Ozigbu CE, Wakdok S, Oladele T, Ezeanolue EE. Towards the elimination of mother-to-child transmission of HIV in Nigeria: a health system perspective of the achievements and challenges. *Int Health*. 2019;11:240–9.
49. Johnson OE, Obidike PC, Eroh MU, Okpon AA, Bassey EI, Patrick PC, Ebong PE, Ojumah E. Choices and determinants of delivery location among mothers attending a primary health facility in southern Nigeria. *Niger Postgrad Med J*. 2020;27:42–8.
50. Abubakar S, Adamu D, Hamza R, Galadima JB. Determinants of home delivery among women attending antenatal Care in Bagwai Town, Kano Nigeria. *Afr J Reprod Health*. 2017;21(4):73–9.
51. Moore BM, Alex-Hart BA, George IO. Utilization of health care services by pregnant mothers during delivery: a community-based study in Nigeria. *East Afr J Public Health*. 2011;8(1):49–51.

Publisher's Note

Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.