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## Translating new evidence into clinical practice: the effect of a novel outreach mentoring approach on the knowledge, attitudes and confidence of health workers providing HIV and infant feeding counselling in South Africa

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## Translating new evidence into clinical practice: the effect of a novel outreach mentoring approach on the knowledge, attitudes and confidence of health workers providing HIV and infant feeding counselling in South Africa

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## Abstract

**Objectives:** We report the effectiveness of a theory-driven, facility-based mentoring approach to disseminate updated HIV and infant feeding guidelines.

**Design:** A quasi-experimental controlled before-after study.

**Setting:** Primary health care clinics were randomly selected (n=24 intervention, n=12 comparison) from two districts, South Africa.

**Participants:** All health workers (HW) providing infant feeding counselling in each intervention clinic were invited to participate.

**Interventions:** three 1-2 hour, on-site workshops were conducted over 3-6 weeks.

**Primary outcome measures:** a) knowledge scores: 22 statements each scored 1 if correct or 0; b) attitude scores: 21 statements with 5 possible responses: completely disagree (1), disagree (2), neutral (3), agree (4) and completely agree (5); c) confidence scores: 19 statements with 4 possible responses: not at all confident (1), not confident (2), confident (3) and very confident (4). Analysis was at the HW level, with clinic as a random effect to adjust for clustering. Data were analysed using STATA/SE version 15.

**Results:** In intervention and comparison sites, respectively: 289 and 131 baseline and 253 and 114 follow-up interviews were conducted. At baseline, the proportion of participants previously trained in HIV and infant feeding was significantly higher in comparison clinics. At follow-up, the mean score for the 22 knowledge questions was 15.2 (69%) in comparison and 17.2 (78.2%) in intervention sites ( $p<0.001$ ). Knowledge scores among HW who attended 3 workshops was significantly better ( $p<0.0001$ ) compared with HW who attended  $<3$  workshops. At follow-up, the mean attitude and confidence scores towards breastfeeding were significantly better in intervention sites versus comparison sites ( $p<0.001$  and  $p=0.05$ , respectively).

**Conclusion:** A participatory, low intensity on-site mentoring programme improved HW's knowledge, attitudes and confidence more than standard training to provide infant feeding counselling. Further research is required to evaluate the effectiveness, feasibility and sustainability of implementing such a mentoring approach at scale.

### Strengths and limitations of the study:

1. Fieldwork was conducted in two geographically and historically different provinces, facilitating generalisability of results.
2. The intervention was participatory, low intensity, on-site and integrated into routine facilities.
3. Several types of analyses were conducted which all yielded congruent results.
4. However, limitations were that we purposively selected districts for inclusion; we could not control for previous breastfeeding experience as we did not gather these data; the follow-up evaluation was done 3 months after the intervention; thus, we were only able to measure short term benefits, and we did not measure the effect of improved knowledge, attitudes and confidence on actual infant feeding practices.
5. The finding that knowledge scores at follow-up of participants who attended 3 workshops compared with knowledge scores at follow-up of participants who attended less than 3 workshops was significantly better, may simply reflect better motivation amongst attendees of more workshops, rather than the effect of the workshops themselves. We could not tease out these effects.

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## Competing interests statement

No author has declared any competing interests.

## Introduction

Policies and clinical practice guidelines are updated regularly to ensure that health care is guided by the most recent evidence. In the area of HIV and infant feeding, guidelines have been updated frequently as evidence emerged, but effective dissemination of these guidelines has lagged behind. Multi-component dissemination strategies, which aim to increase the reach, ability and motivation of health workers, are more effective than one strategy alone.[1] However, the standard of evidence to guide dissemination strategies is low as studies are few; additionally, most studies have been conducted in high income countries, and results may not apply to low-middle income countries, which have different needs and challenges.[1] We examined how HIV and infant feeding guidelines, which have been updated over the past two decades to align with new evidence, can be effectively disseminated in a middle income setting with high HIV prevalence.

The benefits of breastfeeding in all settings, and particularly in low-middle income settings with high HIV prevalence, are undisputed.[2 3] In 2010, the World Health Organisation (WHO) issued HIV and infant feeding recommendations, in support of six to 12 months of breastfeeding under antiretroviral cover.[4] This followed a period when, in the absence of evidence for interventions such as triple antiretroviral therapy (ART) to prevent postnatal transmission, the avoidance of breastfeeding was recommended if specific conditions conducive to the safe use of replacement feeds could be met. In 2009, evidence was published that both maternal triple ART and infant antiretroviral prophylaxis greatly reduce breast milk HIV transmission risk.[5 6] In July 2016, the WHO guidelines on HIV and infant feeding were updated to recommend exclusive breastfeeding (EBF) for the first six months of life, with the introduction of appropriate complementary foods thereafter and continued breastfeeding for at least 12 to 24 months amongst HIV-negative mothers and mothers living with (MLHIV) while being fully supported for ART adherence, on the assumption that they will be virally suppressed.[7] In June 2017, these recommendations were adopted in South Africa, thus necessitating updates for health workers. Many studies on the uptake of breastfeeding recommendations have focused on mothers, assessing the effect of counselling versus standard education on breastfeeding practices.[8] A few studies have investigated the impact of staff training on HIV and infant feeding guideline implementation.[9] These demonstrated that interventions and training that aim to develop HW's capacity of can significantly improve their skills, self-efficacy and confidence to counsel, support and promote breastfeeding among MLHIV.[8] Consequently, a key question was: What learning approach could best develop health care worker capacity and confidence to implement the updated HIV and

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3 infant feeding guideline, using a methodology that was sustainable and feasible to implement at  
4 scale. Pedagogical research highlights the advantage of participatory training compared with  
5 standard didactic teaching for improving health worker skills.[10 11] Thus, we sought to  
6 determine whether a participatory outreach mentorship approach to disseminate the updated HIV  
7 and infant feeding guidelines, using simple low-technology activities, improves the knowledge,  
8 attitude, and confidence of health workers.  
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## 11 **Methods**

### 12 **Study design**

13 A quasi-experimental before-after design with intervention and comparison sites was used. Two  
14 purposively-selected districts (Ugu and Tshwane District) in South Africa in each of two  
15 geographically disparate provinces, KwaZulu-Natal (KZN) and Gauteng (Figure 1), were included  
16 for their differing infant feeding historical contexts: KZN has a history of strong political will to  
17 support breastfeeding, whilst Gauteng has historically supported formula feeding amongst  
18 MLHIV. Both provinces experienced a policy change when infant feeding guidelines were  
19 updated in 2017.  
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### 22 **Sampling**

23 In Ugu District all four sub-districts were selected; within Tshwane District two of the seven  
24 service delivery regions were randomly selected.  
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27 Twelve intervention and six comparison primary health care clinics were randomly sampled in  
28 Ugu District and Tshwane District (separately). Only clinics with above the median number of  
29 annual clinic visits for children under-5 years in the district were eligible for inclusion in the  
30 sampling frame. The comparison clinics served to capture any temporal changes in health worker  
31 knowledge, confidence and attitudes due to other interventions or training provided by the health  
32 system and hence a smaller sample was required than for the intervention sites for which we  
33 required more precise estimates of the intervention effect. A two-stage process was used to recruit  
34 participants. Firstly, research staff explained the study and participant inclusion and exclusion  
35 criteria to each facility manager during face-to-face on-site introductory meetings. Then the  
36 facility manager compiled a list of all eligible health workers involved in the care of pregnant  
37 women and children, including nurses, midwives, visiting doctors, lay counsellors, dieticians,  
38 nutritionists, facility managers and community health workers (CHWs). In the second stage,  
39 research staff approached eligible health workers and invited them to participate in the research.  
40 We aimed to recruit 8-10 health workers per clinic to have a manageable group size to participate  
41 in the intervention, and in the evaluation. The same staff were approached for the baseline and  
42 follow-up evaluation.  
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### 47 **Sample size**

48 The sample size was determined based on 80% power and alpha 0.05 to measure a 15-percentage  
49 points difference in health worker confidence in HIV and infant feeding counselling between the  
50 intervention and comparison clinics comparing baseline and follow-up. The expected effect was  
51 based on the researchers' experience and data from recent studies in South Africa with the baseline  
52 level of high confidence to counsel HIV-positive women on breastfeeding duration set at 45%. [12]  
53 It was assumed that the confidence score would remain unchanged in the comparison clinics,  
54 implying a two-sample test in the post-intervention period. Clinic-level analyses were used for the  
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3 sample size calculations, assuming a sampling ratio of 2:1 for the intervention clinics and a  
4 standard deviation of 15% in the mean score between clinics. Based on these assumptions, and  
5 adjusting for clustering, the sample size was determined to be 24 intervention clinics and 12  
6 comparison clinics.  
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### 10 **Description of the intervention**

11 We designed a participatory intervention consisting of on-site mentoring through three workshops  
12 in each clinic, targeting all health workers who provide care for pregnant women, breastfeeding  
13 mothers and their infants. This was delivered by the same trained facilitator (nurse in Gauteng or  
14 nutritionist in KZN) in each intervention clinic. Each workshop lasted 1-2 hours over a 3-6-week  
15 period and had well-defined learning outcomes. The intervention has been described elsewhere  
16 (Horwood et.al, in press). In summary, our participatory intervention was guided by evidence that  
17 health workers' attitudes and practices are influenced by various factors, not just exposure to  
18 training and information.[13] We used Dee Fink's six part taxonomy as a guiding theory. This  
19 proposes that significant learning only occurs by developing foundational knowledge, applying  
20 skills, integrating ideas, developing new feelings/interests and values, and learning how to learn  
21 (encouraging the spirit of enquiry) (Figure 2).[14] Additionally, we applied the theory of planned  
22 behaviour to the intervention design (Figure 2).[15 16] This states that an individual's intention to  
23 perform a behaviour is influenced by the person's attitudes towards performing the behaviour,  
24 their beliefs about whether people who are important to them will approve of the behaviour  
25 (subjective norms), and their beliefs about how likely they are to be able to implement the  
26 behaviour successfully. According to this theory, if health workers are to provide infant feeding  
27 counselling and support in accordance with updated infant feeding guidelines to HIV-infected and  
28 uninfected mothers, they need to agree with the change, believe that their colleagues and other  
29 stakeholders will approve of the action, and believe in their ability to implement it successfully.  
30 The workshops were tailored to achieve these goals: Workshop 1 covered knowledge gaps reported  
31 by participants, controversial statements, and advantages of breastfeeding. Following workshop 1,  
32 a poster or cards with key messages were placed in a prominent place in the clinic. Workshop 2  
33 comprised a progressive case study discussed in small groups. Workshop 3 involved one-on-one  
34 mentorship: each participant was observed providing infant feeding counselling or a case study  
35 was discussed if no mothers were available for counselling. The same facilitator conducted all  
36 three workshops at each clinic. In addition, a WhatsApp cell phone messaging group was  
37 established to support participants in intervention sites to facilitate sharing of concerns, tips for  
38 counselling and dealing with difficult situations. Key messages were posted on the group  
39 approximately weekly. Comparison sub-districts were exposed to routine supervision and training  
40 activities that take place at district level. The study team documented whether and how the June  
41 2017 circular issued by the National Department of Health, informing health facilities about the  
42 change in the 2013 Infant and Young Child feeding policy, was disseminated to comparison  
43 clinics.  
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### 50 **Patient and Public Involvement**

51 Patients and the public were not involved in the design of this study, as the main population of  
52 interest were health workers; thus, the intervention targeted health workers who were consulted to  
53 assist with intervention design. These details are explained in our intervention paper (Horwood  
54 et.al.,) which is currently under review.  
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## Data collection

The primary outcome measure for the study was confidence level of health workers to counsel on infant feeding, evaluated using a Likert-scale tool, developed after reviewing existing tools and literature. Secondary outcomes included health worker knowledge and attitude about breastfeeding counselling. A baseline assessment amongst all participating health workers in intervention and comparison sites was undertaken prior to the start of the intervention (August 2017). Health workers self-completed the assessment on study-provided electronic tablets at their workplaces. Questions covered basic demographic information, types of activities undertaken at work, knowledge, attitudes and confidence around counselling on infant feeding. A mean of 12 weeks after the baseline assessment, a follow-up assessment using the same tool was conducted amongst the same group of health workers. The tool had been piloted amongst a separate group of health workers to determine length, complexity of questions and level of understanding. Health workers who were not in the clinic on the day of the follow-up assessments were included in a special catch-up assessment. Questionnaire software had built in range and skip logic and was transferred automatically to a database held at the University of KwaZulu-Natal.

## Data analysis

There were three outcomes in the study: a) 22 knowledge statements which were scored 1 if correctly answered and 0 otherwise (binary outcomes); b) 21 attitude questions whose responses were measured on a 5-point Likert scale - given as completely disagree (1); disagree (2); neutral (3); agree (4) and completely agree (5); positive attitudes received higher scores and in some items, the scores were inverted; and c) 19 statements on confidence item questions which were also measured on a Likert scale, scored as such: not at all confident (1), not confident (2), confident (3) and very confident (4). For both attitude and confidence domains, a participant outcome was measured by the sum of the responses to the respective items (we verified that there was not a missing response on the items). Thus, the ranges for the attitude and confidence scores were 5 to 105, and 4 to 75, respectively.

## Statistical Analysis

Participants baseline and follow-up characteristics and outcomes between the intervention and control areas were compared using Chi-squared tests for categorical variables and for continuous measures, two-sample t tests were used after confirmation of normality in the data. To assess the effect of the proposed intervention, several analysis methods for comparing treatment effect in pre-post quasi-experimental designs were considered. These include using post-measures and change from pre-treatment to post-treatment as the response variables. Approaches that use change and post measurements as response variables, adjusting for pre-treatment measures are preferred, and often give similar results.[17] In this paper, we used linear regression on change and post-measurements, adjusting for the level of the corresponding baseline measurement and characteristics. The analyses were adjusted for the possible clustering effect at the site level, using a variance-correction method. Data can be obtained by e-mailing the corresponding author.

## Ethics

Ethics approval was obtained from the South African Medical Research Council (EC028-9/2016), the University of KwaZulu-Natal (RECIP348/17) and the WHO Ethics Review Committee (ERC0002833). Permission for undertaking the study was obtained from Tshwane and KZN Districts. Informed consent was sought from all study participants and no personal identifying information was captured in the questionnaires, only a study identification number.

## Results

Tshwane and Ugu Districts differed significantly in three characteristics: Tshwane had significantly more participants who had worked for less than 2 years (14.4% versus 6.2%,  $p=0.007$ ), significantly more registered nurses, and fewer lay counsellors/CHWs (57% versus 26.2% and 7.3% versus 50%, respectively,  $p=0.02$  for the difference in participant's clinic roles in Tshwane versus Ugu districts); however, data from the two sites were combined for the analysis as the sites did not differ in the main outcomes measured (knowledge, attitude and confidence) at baseline. At baseline and follow-up, 23 intervention clinics (one large clinic was sampled twice with two rounds of data collection) and 12 comparison clinics were visited; 289 and 131 health care provider interviews were conducted at baseline, respectively (Figure 3). Loss to follow-up between baseline and follow-up did not differ between intervention and comparison sites: 17 (13%) in comparison sites versus 36 (12.5%) in intervention sites.

All staff approached agreed to participate. There were no significant differences between intervention and comparison sites at baseline, regarding district of origin, median age of respondent, gender, cadre of health worker, and working duration (Table 1). The proportion of participants who had received previous training (through the routine health system) on specific topics was similar in intervention versus comparison sites, except for three topics which had better coverage in comparison sites (Supplementary Figure 1). These were: ever trained on how to assess and support ART adherence for HIV-infected women (78.6% in intervention sites versus 89.2% in comparison sites,  $p=0.01$ ); ever trained about managing breastfeeding problems (76.5% in intervention sites and 86.2% in comparison sites,  $p=0.02$ ); and received any information or training about the revised infant feeding policy (55.1% in intervention sites versus 67.4% in comparison sites  $p=0.02$ ). At baseline, activities around breastfeeding counselling and management were similar between comparison and intervention sites in all respects except that comparison site participants reportedly spoke more frequently to HIV-infected pregnant women about feeding than intervention participants (67% versus 71.6% spoke more than 1-3 times per month,  $p=0.04$ , data not shown).

**Table 1: Characteristics of the participants in the intervention and comparison groups at baseline**

Characteristic	Intervention group (n=289) (N (%))	Comparison group (n=131) (N (%))	p-value
<b>District:</b>			
- Tshwane	152 (52.6)	56 (42.8)	0.06
- Ugu	137 (47.4)	75 (57.3)	
<b>Age categories:</b>			
- 23 to 35 years	56 (19.4)	38 (29.7)	0.11
- 36 to 41 years	61 (21.2)	25 (19.5)	
- 42 to 46 years	53 (18.4)	26 (20.3)	
- 47 to 54 years	64 (22.2)	18 (14.1)	
- Over 54 years	54 (18.8)	21 (16.4)	
<b>Gender</b>			
- Female	267 (92.7)	118 (91.5)	0.66
- Male	21 (7.3)	11 (8.5)	
<b>Cadre of health worker</b>			
- Community level worker	84 (29.5)	52 (40)	0.05
- Trained health professional*	151 (53.0)	64 (49.2)	
- Enrolled nurse	50 (17.4)	14 (10.8)	
<b>Work experience in yrs</b>			
- Less than 1 yr	4 (1.4)	3 (2.3)	0.2
- 1 to <2 yrs	23 (8.0)	12 (9.3)	
- 2 to less than 5 yrs	36 (12.5)	18 (14.0)	
- 5 to less than 10 yrs	71 (24.7)	43 (33.3)	
- 10 yrs or more	154 (53.5)	53 (41.1)	

Abbreviations:; \*includes 68% nurses in the intervention arm and 58% nurses in comparison arm. This group also includes operation managers, dieticians, doctors and nutritionists.

In intervention sites, workshops were attended by 84-88% of participants interviewed at follow-up (Table 2).

**Table 2: Attendance at workshops 1-3 measured at follow-up in intervention sites**

	Attended workshop n	Attended catch-up n	Total attended n/N (%)
<b>Number of staff attending each workshop:</b>			
Group workshop 1	202	63	265/303 (87.5)
Group workshop 2	223	34	257/303 (84.8)
Workshop 3 (Clinical mentoring)	216	40	256/303 (84.5)
<b>Number of workshops attended:</b>			
	number	%	
No workshop	18	7.2	
1-2 workshops	10	4.0	
All 3 workshops	221	88.8	
<b>Total</b>	<b>249</b>	<b>100</b>	

### Effect of the intervention on health worker knowledge

At baseline, knowledge about key infant feeding statements or facts was similar between intervention and comparison sites, except for knowledge about soft porridge (Table 3). Although at baseline, more than 90% of intervention and comparison site participants knew that a baby under 4 months should not be given soft porridge if hungry, significantly more intervention site participants knew this recommendation (Table 3). The percentage of participants at baseline correctly answering the more difficult questions (on bottle sterilisation, storing expressed breastmilk, feeding HIV exposed infants) was low (Table 3). At follow-up significantly more intervention site participants correctly answered knowledge questions, regarding the leading cause of death in children under 5, the risk of formula feeding, duration of breastfeeding for HIV-negative mothers and MLHIV, how to stop breastfeeding, complementary feeding, storing expressed breastmilk, feeding whilst at work, breastfeeding and viral suppression, mixed feeding in MLHIV, adherence to ART and breastfeeding, breastfeeding difficulties in MLHIV and managing MLHIV who are breastfeeding, than comparison site participants (Table 3). The significant differences between intervention and comparison sites regarding soft porridge were not present at follow-up. Although improvements were seen in knowledge related to the risks of mixed feeding for MLHIV, most health workers still provided incorrect responses at follow-up. At baseline, the mean knowledge score was 15.0 (68%) in comparison sites versus 15.2 (69%) in intervention sites,  $p=0.89$  (Table 3). At follow-up the mean knowledge score was 15.2 (69%) in comparison sites and 17.2 (78.2%) in intervention sites,  $p<0.001$  (Table 3). The difference in difference in the mean knowledge scores at baseline and follow-up between intervention and control sites was significant ( $p=0.0000$ , data not shown). At follow-up, knowledge scores of participants who attended 3 workshops compared with knowledge scores of participants who attended less than 3 workshops was significantly better ( $p=0.0000$ ).

**Table 3: Knowledge of health care workers about breastfeeding in the intervention and comparison sites at baseline and follow-up**

Knowledge statements	Number (%) with correct answers at BASELINE			Number (%) with correct answers at FOLLOW-UP		
	Intervention (n=289)	Comparison (n=128)	P-value *	Intervention (n=250)	Comparison (n=112)	P-value *
<b>General breastfeeding</b>						
Exclusive breastfeeding is the recommended infant feeding method for ALL infants aged 0-6 months in SA, regardless of mother's HIV status (True)	271 (93.8)	118 (90.1)	0.18	234 (93.6)	102 (91.1)	0.39
Giving any formula milk during the first six months of life increases the risk of death from diarrhoea and/or pneumonia (True)	246 (85.1)	104 (79.4)	0.14	232 (92.8)	95 (84.8)	0.02
A mother who is working and giving formula milk should mix the milk herself and leave for the carer to give during the day (False)	218 (75.4)	94 (71.8)	0.42	189 (75.6)	68 (60.7)	<0.01
When sterilising feeding bottles cover the bottles with water in a saucepan and place on the heat. As soon as the water boils remove from heat and do not leave the bottles in the water until completely cool (False)	64 (22.2)	27 (20.6)	0.72	53 (21.2)	25 (22.3)	0.81
In South Africa, the leading cause of death amongst children under 5 is pneumonia (True)	189 (65.4)	82 (62.6)	0.58	230 (92.0)	75 (67.0)	<0.01
Continued breastfeeding for 2 years is the recommended infant method in SA for ALL children, regardless of mother's HIV status (True)	190 (65.7)	91 (69.5)	0.45	224 (89.6)	88 (78.6)	<0.01
A baby under 4 months should be given soft porridge once he/she seems hungry (False)	284 (98.3)	124 (94.7)	0.04	247 (98.8)	108 (96.4)	0.13
Giving a baby expressed breastmilk is not as good as breastfeeding (False)	234 (81.0)	106 (80.9)	0.99	218 (87.2)	96 (85.7)	0.70
It is safe to give the baby expressed breastmilk that has been kept outside the fridge for 8 hours (True)	106 (36.7)	43 (32.8)	0.44	120 (48.0)	38 (33.9)	<0.05
There are long term health benefits of breastfeeding for mother and child that last beyond the breastfeeding period (True)	264 (91.4)	116 (88.6)	0.37	232 (92.8)	100 (89.3)	0.26
<b>Breastfeeding and HIV</b>						
Mothers living with HIV who are receiving antiretroviral treatment and are virally suppressed should be advised not to breastfeed their infants (False)	252 (87.2)	115 (87.8)	0.87	230 (92.0)	99 (88.4)	0.27
When an HIV-infected mother is ready to add complementary feeds she should stop breastfeeding rapidly over a 24-hour period (False)	214 (74.1)	103 (78.6)	0.31	217 (86.8)	86 (76.8)	<0.05

If an HIV exposed baby is receiving both breastmilk and formula milk, the mother should choose either breastfeeding or formula feeding if she is adherent to ART (False)	69 (23.9)	29 (22.1)	0.70	75 (30.0)	28 (25.0)	0.33
An HIV-positive mother who is virally suppressed on antiretroviral treatment should breastfeed her child rather than not breastfeed to improve the child's survival (True)	237 (82.0)	108 (82.4)	0.91	236 (94.4)	96 (85.7)	<0.01
In South Africa, HIV-infected women who are breastfeeding should be supported to adhere to antiretroviral treatment and should be counselled and supported to exclusively breastfeed their infants for the first six months of life whilst maintaining an undetectable viral load (True)	281 (97.2)	123 (93.9)	0.10	242 (96.8)	109 (97.3)	0.79
A mother living with HIV and adherent to antiretroviral treatment cannot exclusively breastfeed her 4-month old infant because she is working. It is better for this mother to give formula during the day and breastfeed at night rather than giving no breast milk at all (True)	22 (7.6)	14 (10.7)	0.30	40 (16.0)	14 (12.5)	0.38
⊖ If a mother misses 2 doses of her ART in one month, she should be classified as a treatment failure (False)	185 (64.0)	82 (62.6)	0.78	191 (76.4)	73 (65.2)	<0.05
An HIV-positive mother who has cracked nipples should continue to breastfeed unless they are bleeding (True)	143 (49.5)	64 (48.9)	0.91	187 (74.8)	59 (52.7)	<0.01
⊖ An HIV-exposed baby who is exclusively breastfeeding should be given some water when the weather is very hot (False)	270 (93.4)	122 (93.13)	0.91	239 (95.6)	105 (93.8)	0.45
⊖ If a baby has a positive PCR (HIV test) at birth the mother should stop breastfeeding if this is affordable and feasible in her situation (False)	224 (81.0)	106 (80.9)	0.99	214 (85.6)	82 (73.2)	<0.01
⊖ A mother who has missed 6 tablets of FDC in one month is considered to be poorly adherent and should stop breastfeeding immediately (False)	181 (62.6)	89 (67.9)	0.29	201 (80.4)	72 (64.3)	<0.01
In South Africa, HIV-infected women who are breastfeeding should be supported to adhere to antiretroviral treatment and should introduce complementary foods around 6 months and be supported to continue breastfeeding for at least two years. (True)	245 (84.8)	116 (88.6)	0.30	244 (97.6)	91 (81.3)	<0.01
<b>Mean knowledge score (standard deviation) out of 22</b>	15.2 (2.6)	15.0 (3.1)	0.89*	17.2 (2.1)	15.2 (2.8)	<0.001

⊖ The Statement is false; thus, the scales were inverted during data analysis.

\*Mann-Whitney U test comparing intervention and comparison sites at the relevant time point.

Note: the tables displays numbers with correct knowledge

### Effect of the intervention on attitudes

Comparing baseline and follow-up there were few significant differences between intervention and comparison sites in individual attitude statements towards breastfeeding (Supplementary Table 1). However, at follow-up, the mean attitude score towards breastfeeding was significantly higher (better) in intervention sites ( $p < 0.001$ ), (Supplementary Table 1). All three approaches to analysis demonstrated that, after controlling for other variables, final attitude (measured as attitude at follow-up, change in attitude between intervention and comparison sites or change in attitude between baseline and follow-up between intervention and comparison sites) was significantly better in intervention compared with comparison sites (Table 4). In these analyses, attitude at follow-up and change in attitude at follow-up was 5.36 points higher in the intervention group than the comparison group; the difference in attitudes using a diff-in-diff analysis showed a significant 4.40-point higher score in the intervention compared with the comparison group (Table 4). The first two analytical approaches demonstrated that being an enrolled nurse, and being in the youngest (36-41 years) or oldest ( $>54$  years) age group was associated with a significantly lower attitude score; the diff-in-diff analysis demonstrated that, controlling for other factors, trained health professionals had a significantly higher attitude score at follow-up (Table 4). We did not detect a dose-association in intervention sites when comparing 0-1 or 1-2 versus 3 workshops ( $p = 0.4$ ); but numbers in each group may have been too small to reliably assess any dose effect.

**Table 4: Adjusted effect of the intervention on health worker attitude score using different methods (Effect estimate and 95% confidence interval (CI))**

Variable	Modelling attitude score at follow-up		Modelling diff-in-diff attitude score	
	Effect estimate	95% CI	Effect estimate	95% CI
Attitude score at baseline	0.52	0.35; 0.69*	N/A	N/A
Intervention	5.36	3.95; 6.76*	4.40	2.56; 6.23*
Follow-up Period	N/A	N/A	1.35	-0.15; 2.84
<b>Professional role: vs community level</b>				
- Trained health professional	1.62	-0.04; 3.28	5.24	3.37; 7.11*
- Enrolled nurse	-2.56	-5.10; -0.01*	-0.06	-2.33; 2.21
<b>Ugu District vs Tshwane District</b>	-0.82	-2.23; 0.59	-1.09	-3.00; 0.83
<b>Age category: vs 23-35 yrs</b>				
- 36 to 41 yrs	-2.78	-5.29; -0.26*	-1.40	-3.86; 1.05
- 42 to 46 yrs	-0.91	-3.32; 1.50	-0.06	-2.45; 2.34
- 47 to 54 yrs	0.48	-1.96; 2.91	-0.89	-2.84; 1.05
- over 54 yrs	-3.30	-5.57; -1.02*	-1.95	-4.32; 0.42
<b>Work experience &lt;5 yrs vs ≥5yrs</b>	-0.36	-2.49; 1.77	-1.63	-3.88; 0.63

\* $p < 0.005$  N/A: not applicable. NB: All analyses are adjusted for clustering

## Effect of the intervention on confidence

There was no difference in the percentage of participants in the intervention and control sites who were confident or very confident at baseline and at follow-up (Supplementary Table 2). However, the mean confidence score at follow-up was significantly higher in the intervention compared with the comparison sites at follow-up ( $p=0.05$ ) (Table 5). All three approaches to analysis demonstrated that final confidence (measured as confidence at follow-up, change in confidence between intervention and comparison sites and change in confidence between baseline and follow-up between intervention and comparison sites) was significantly better in intervention compared with comparison sites (Table 5). Confidence at follow-up and change in confidence at follow-up was 2.42 points higher in the intervention arm than the comparison arm; the difference in confidence using a diff-in-diff analysis showed a significant 3.00-point higher score in the intervention compared with the comparison group (Table 5). Our analysis demonstrated that, controlling for other factors, being a trained health professional significantly increased confidence scores by 3.11 (ANCOVA or linear regression analysis) or 4.25 (diff-in-diff analysis). Additionally, the diff-in-diff analysis demonstrated that, controlling for other factors, working for less than 5 years significantly reduced the confidence score. We did not measure a dose-effect (one or two versus three workshops ( $p=0.4$ )); but numbers in each group may have been too small to assess this.

**Table 5: Adjusted effect of the intervention on health worker confidence scores, using different multivariable analysis methods (Effect estimate and 95% confidence interval (CI))**

Variable	Modelling confidence score at follow-up		Modelling diff-in-diff confidence score	
	Effect estimate	95% CI	Effect estimate	95% CI
<b>Confidence score at baseline</b>	<b>0.42</b>	<b>0.28; 0.56*</b>	N/A	N/A
<b>Intervention</b>	<b>2.42</b>	<b>0.39; 4.45*</b>	3.00	0.56; 5.43*
<b>Follow-up time</b>	N/A	N/A	0.01	-2.03; 2.05
<b>Cadre of health professional: vs community level</b>				
- Trained health professional	<b>3.11</b>	<b>0.34; 5.87*</b>	<b>4.25</b>	<b>2.14; 6.36*</b>
- Enrolled nurse	-0.85	-4.17; 2.48	-1.82	-3.84; 0.20
<b>Ugu District vs Tshwane District</b>	0.00	-2.08; 2.08	-0.48	-2.71; 1.75
<b>Age category vs 23-35 yrs</b>				
- 36 to 41 yrs	-1.03	-3.77; 1.70	0.46	-2.21; 3.12
- 42 to 46 yrs	0.25	-2.85; 3.35	0.45	-2.19; 3.09
- 47 to 54 yrs	1.42	-0.73; 3.56	-0.89	-3.30; 1.51
- over 54 yrs	-2.28	-5.53; 0.97	-0.38	-3.62; 2.86
<b>Work experience &lt;5 yrs vs ≥5 yrs</b>	-0.44	-3.31; 2.43	<b>-2.24</b>	<b>-4.06; -0.41*</b>

\* $p<0.005$  N/A= not applicable yrs= years. NB: All analyses are adjusted for clustering



## Discussion

We implemented a participatory, team-based mentoring approach to disseminating updated HIV and infant feeding guidelines that had four distinct features: 1) it was on-site so that learning occurred in context and all cadres of health workers could attend (as lower cadres are frequently left out in off-site training); 2) it was team-based; all participants learned together; 3) content was led by the gaps in knowledge identified by participants themselves, and 4) activities were piloted and rooted in a theoretical framework. This mentorship approach was significantly associated with increased knowledge, especially around HIV and infant feeding, better attitudes and more confidence compared with a standard approach to disseminating infant feeding guidelines. Although some knowledge items did not change, we noted key improvements in the important knowledge items relating to HIV and infant feeding, however further reinforcement is needed regarding the issue of mixed feeding for MLHIV which is possibly the biggest practice change in the 2016 guidelines. Although some individual attitude and confidence items did not change at all, or only changed marginally, all our analyses indicated an improvement in follow-up attitude and confidence, controlling for clustering. Although the intervention group still performed poorly on some of the more difficult questions, we hypothesise that this could be attributed to the short duration of the intervention – three one-hour workshops over a period of three to six weeks. Notwithstanding this, we demonstrated shifts in key HIV-related parameters, and hypothesise that the overall change in knowledge, attitudes and confidence could positively influence infant feeding counselling and infant feeding practices.

There is ample evidence that in-service training and supervision improves the knowledge, skills and practices of health workers managing childhood undernutrition, and can improve health worker job satisfaction and motivation.[18 19] Post-training supervision and follow-up are included as key components of important child health programmes, such as the Integrated management of childhood illness strategy (IMCI)[20]; however, implementation challenges have been described, including inadequately trained or shortages of supervisors or inadequate job aids for follow-up, and if community views/ practise are not aligned to the programme then implementation and uptake is suboptimal.[21] Our approach provides a low technology, sustainable model for skills development at clinic level that could be used by existing personnel including supervisors and adapted to different settings and other areas of care quality or to dissemination of guidelines and improve confidence.

We used a mentorship approach to dissemination because mentorship is a holistic process that aims to empower the participant.[22] Using a team-based approach allows different cadres of health workers to learn together and could improve belief among health workers that their peers are supportive of the change in practice. Our findings demonstrate the advantages of a participatory, mentorship approach: In accordance with Dee Fink's theory, such an approach allows participants to develop foundational knowledge, apply skills, integrate ideas, develop new feelings/ interests and values and learn how to learn.[13] Our experience suggests that such an approach allowed discussion of the participant's attitudes towards performing the behaviour, their beliefs about whether people who are important to them will approve of the behaviour (subjective norms), and their beliefs about how likely they are to be able to implement the behaviour successfully.[15 16] Our findings corroborate a scoping review which demonstrated that

mentorship improves certain quality of care outcomes [22]; in our case it improved knowledge, attitudes and confidence. However, only four studies were included in this scoping review, and the nature of the mentorship varied from video-conferencing to monthly, six-weekly or annual visits interspersed with other contact forums, conducted over 1 day to an entire week. A list of desirable features of mentorship interventions, using insights gained from the scoping review, include at least one dedicated mentor per facility, ensuring an adequate mentor:mentee ratio so that all staff can be supported, forming meaningful relationships between mentors and mentees, ensuring cultural congruency between mentee and mentor, and using mentors for protocol-driven programmes, such as IMCI or HIV.[22] Our intervention related to HIV and infant feeding guidelines, was low cost and low technology (one mentor working with pen, flip chart and paper in the health facility), and was implemented by a dedicated mentor from the same cultural background as the mentees. She provided onsite support during the workshops, which lasted approximately one hour, and additional support through a WhatsApp messaging group.

Given the ongoing health worker crisis in resource limited settings, including maldistribution of staff, an imbalance in skills mix, increasingly complicated health programmes and complicated socio-cultural-political-economic environments, some may question whether an on-site mentorship approach to guidelines dissemination is feasible to include within routine systems and services. We argue that strengthening investment in on-site mentorship rather than off-site training, improves health care management and likely to be a worthwhile and cost-effective health system investment (though not measured in this study). In our setting, all clinics receive regular visits from district primary health care (PHC) supervisors, who often focus on administrative aspects of clinic management. These supervisors, as well as existing district PHC trainers, could be capacitated to provide clinical mentoring for health workers in the clinics they oversee. In this way our model of team-based learning and mentoring is an example of how mentorship can be used for any clinical guideline update within the health system.

Our study had several limitations: We purposively selected districts for inclusion; we could not control for previous breastfeeding experience as we did not gather these data; the follow-up evaluation was done 3 months after the intervention; thus, we were only able to measure short term benefits and we did not measure the effect of improved knowledge, attitudes and confidence on actual infant feeding practices. The finding that knowledge scores at follow-up of participants who attended 3 workshops compared with knowledge scores at follow-up of participants who attended less than 3 workshops was significantly better may simply reflect better motivation amongst attendees of more workshops, rather than the effect of the workshops themselves. We could not tease out these effects, However, we were able to conduct several types of analyses and they all yielded congruent results.

**Conclusion:** We demonstrated improved knowledge, attitudes and confidence of health workers following a participatory mentorship approach to HIV and infant feeding guideline dissemination compared with a standard approach. More research is needed to better understand how to bring about changes in actual practice which may then improve breastfeeding practices.

### What is already known?

Policies and clinical practice guidelines are updated regularly to ensure that health care is guided by the most recent evidence. In the area of HIV and infant feeding, guidelines have been updated frequently as evidence emerged, but effective dissemination of these guidelines has lagged behind. Multi-component dissemination strategies, which aim to increase the reach, ability and motivation of health workers, are more effective than one strategy alone. However, the standard of evidence to guide dissemination strategies in low-middle income settings where HIV prevalence is high, is low as studies are few and most studies have been conducted in high income countries. Thus, results may not apply to low-middle income countries, which have unique needs and challenges.

### What are the new findings?

In primary health care clinics within South Africa (a high HIV prevalence setting), a quasi-experimental controlled before-after design comparing three 1-2 hour, on-site mentoring workshops over 3-6 weeks to disseminate updated guidelines on HIV and infant feeding with standard dissemination, showed positive results: At follow-up, mean knowledge, attitude and confidence scores of health workers (HW) participating in mentoring workshops were significantly higher than HW receiving standard dissemination ( $p<0.001$ ,  $p<0.01$  and  $p=0.05$  respectively). Knowledge scores among HW who attended 3 workshops were significantly better ( $p<0.001$ ), compared with HW who attended <3 workshops.

### What do the new findings imply?

In low-middle income settings, a low-technology, on-site mentoring approach to guideline dissemination significantly benefits HW knowledge attitudes and confidence, compared with dissemination through circulars. Low-middle income settings that have existing cadres of HW in supervisory roles should recommend that these cadres adopt a mentoring approach. Furthermore, they should test the effectiveness of mentoring-based supervision on HW knowledge, attitude, confidence, job satisfaction and morale when implemented at scale.

**Authors contributions:**

AG: Study conceptualization and tool development, protocol writing including intervention development, oversight of sampling and field work, writing of the first draft of this manuscript, receiving and incorporating co-author comments, finalization of the paper

TD: Study conceptualization and tool development, protocol writing including intervention development, set up the sample frame and sampling, contributed to the manuscript, reviewed and approved the final version of the manuscript

SM: Led the statistical components of the protocol; provided overall oversight on the statistical analysis, contributed to the manuscript, reviewed and approved the final version of the manuscript

TN: Performed the work on the statistical components of the protocol, under SM's guidance; provided data analysis under SM's guidance, contributed to the manuscript, reviewed and approved the final version of the manuscript

LH: Contributed to study conceptualization and tool development, protocol writing including intervention development; was overall Project Manager; established, managed and cleaned the database; contributed to the manuscript, reviewed and approved the final version of the manuscript

VJ: Provided guidance on intervention development. Contributed to the manuscript, reviewed and approved the final version of the manuscript

IMSE: Contributed to study conceptualization and tool development, protocol writing including intervention development; contributed to the manuscript, reviewed and approved the final version of the manuscript

UF: Contributed to study conceptualization, assisted with district level buy-in in Tshwane District, provided information on how routine dissemination of updated infant feeding guidelines; contributed to the manuscript, reviewed and approved the final version of the manuscript

MAD: Contributed to study conceptualization and tool development; contributed to the manuscript, reviewed and approved the final version of the manuscript

NR: Contributed to study conceptualization; contributed to the manuscript, reviewed and approved the final version of the manuscript

MK: Contributed to study conceptualization and tool development; contributed to the manuscript, reviewed and approved the final version of the manuscript

DS: Contributed to study conceptualization and tool development; contributed to the manuscript, reviewed and approved the final version of the manuscript

SK: Contributed to study conceptualization, assisted with national level buy-in, provided information on how routine dissemination of updated infant feeding guidelines; contributed to the manuscript, reviewed and approved the final version of the manuscript

TT: Contributed to study conceptualization and tool development; contributed to the manuscript, reviewed and approved the final version of the manuscript

CH: Study conceptualization, protocol writing including intervention development, high level oversight of study implementation, contributed to the manuscript, reviewed and approved the final version of the manuscript

**Data sharing statement:** Data can be obtained by e-mailing the corresponding author, and upon reasonable request

**Figure legends:**

Figure 1: Study districts: Tshwane District in Gauteng Province and Ugu District in KwaZulu-Natal Province of South Africa

Figure 2: Theoretical frameworks which informed the development of the intervention

Figure 3: Study population at baseline and follow-up for intervention and comparison sites

Supplementary Figure 1: Prior training reported by participants at baseline (intervention versus comparison groups)

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**Figure 1: Study districts: Tshwane Metropolitan Municipality in Gauteng Province and Ugu District in KwaZulu-Natal Province of South Africa**

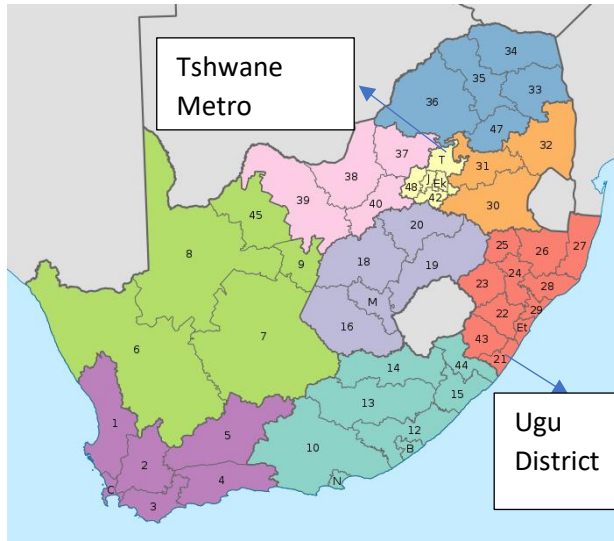
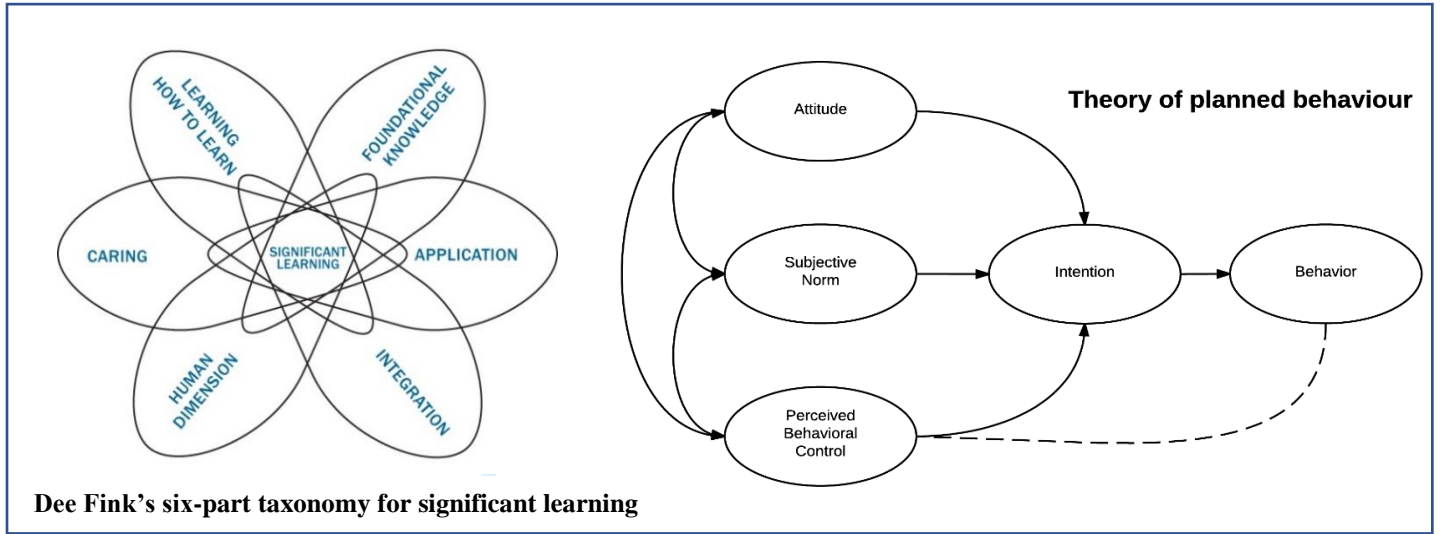


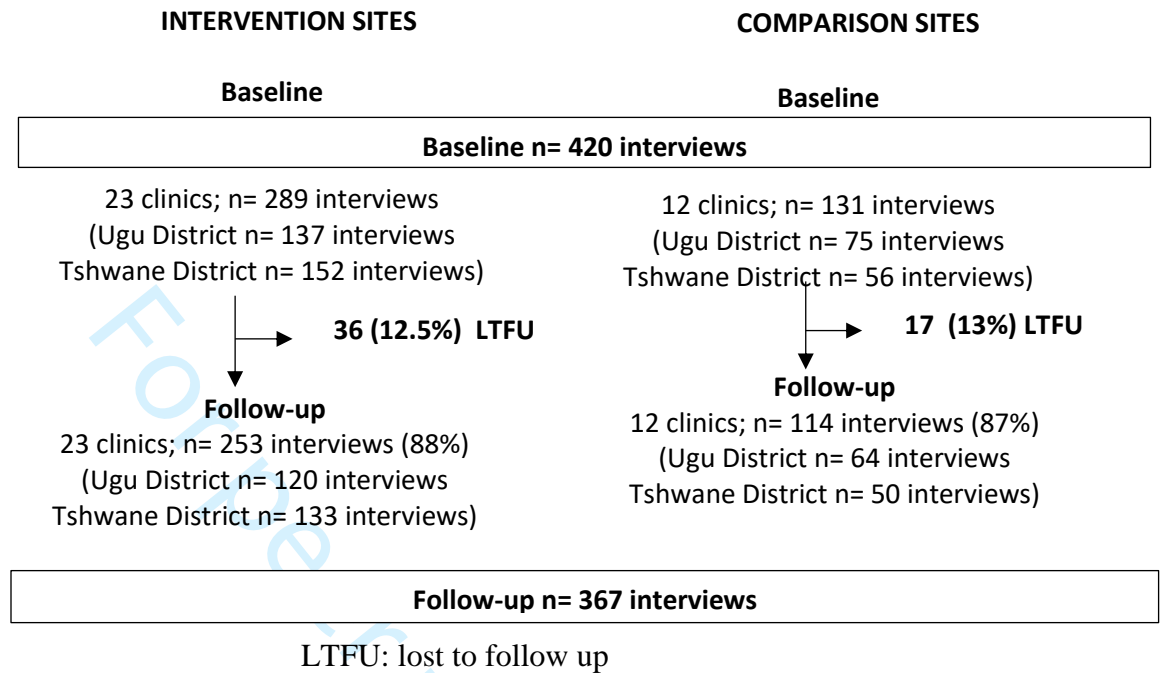


Figure 2: Theoretical frameworks which informed the development of the intervention

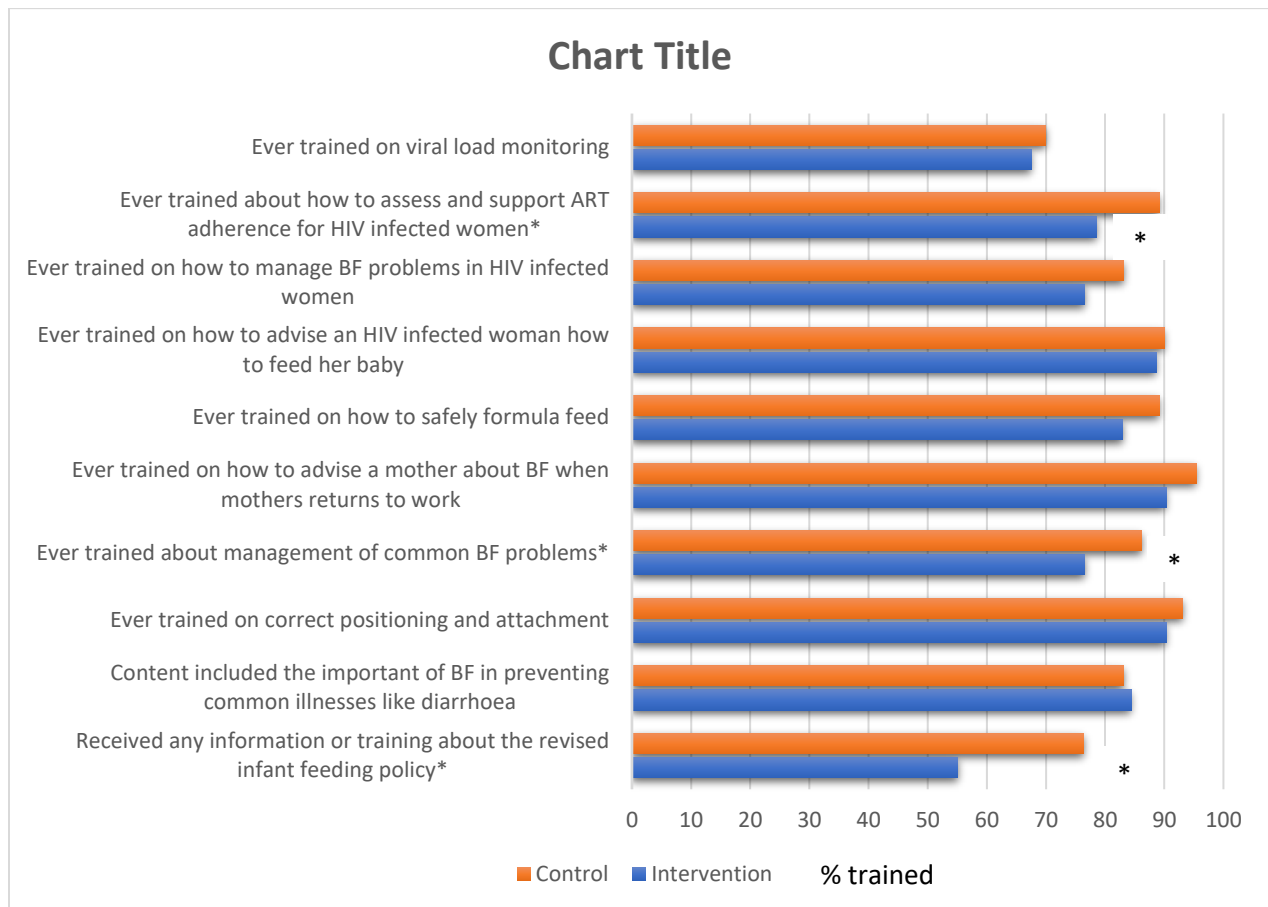


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**Figure 3: Study population at baseline and follow-up for intervention and comparison sites**

**Supplementary Figure 1: Prior training reported by participants at baseline (intervention versus comparison groups)**



\* $p < 0.05$

Abbreviations: ART= antiretroviral therapy; BF= breastfeeding

**Supplementary Table 1: Attitude scores of health workers at baseline and follow-up**

Attitude statements	Number (%) who agreed or strongly agreed with the statement at baseline			Number (%) who agreed or strongly agreed with the statement at follow-up		
	Intervention (n=289)	Comparison (n=128)	P-value *	Intervention (n=250)	Comparison (n=112)	p-value*
There have been so many changes to the infant feeding guidelines and breastfeeding guidelines however I am NOT confused about what to tell mothers who are HIV-infected about breastfeeding	155 (53.6)	74 (56.9)	0.09	174 (69.6)	63 (56.3)	0.14
When a baby cries all the time it is NOT usually because the baby is hungry and needs more food than just breastmilk	260 (90.0)	107 (83.0)	0.14	229 (91.6)	90 (80.4)	0.18
Exclusive breastfeeding in the first 6 months of life is the best choice for all mothers and babies in South Africa	256 (88.6)	114 (88.4)	0.06	238 (95.2)	69 (85.7)	0.22
For an HIV-exposed infant any breastfeeding is better than no breastfeeding at all, as long as the mother is virally suppressed and on antiretroviral therapy	189 (65.4)	79 (61.2)	0.06	195 (78.0)	73 (65.2)	0.18
The benefits of breastfeeding for protecting children from illness such as diarrhoea and pneumonia outweighs the risk of acquiring HIV if the mother is on antiretroviral treatment	224 (77.5)	93 (72.1)	0.12	216 (86.4)	86 (76.8)	0.17
I feel that an HIV-infected mother who has not disclosed to her partner is NOT at high risk of non-adherence to ART and should NOT stop breastfeeding as soon as possible	128 (44.3)	51 (39.5)	0.09	136 (54.4)	44 (39.3)	0.17
I should support all mothers, regardless of HIV status, to continue breastfeeding until 2 years, as long as HIV-infected women are virally suppressed	137 (82.0)	101 (78.3)	0.08	236 (94.4)	86 (76.8)	0.30
I should NOT advise an HIV-positive virally suppressed mother who has cracked and bleeding nipples to temporarily stop breastfeeding	80 (27.7)	40 (31.3)	0.07	96 (38.4)	24 (21.4)	0.18
HIV-exposed babies who are PCR negative must NOT stop breastfeeding as soon as possible	238 (82.4)	104 (81.3)	0.11	220 (88.0)	93 (83.0)	0.14
Formula feeding is NOT the best choice for mothers living in good socio-economic circumstances who are going back to work	202 (70.0)	95 (74.2)	0.07	197 (78.8)	72 (64.3)	0.17
For an HIV-positive mother on antiretroviral treatment and virally suppressed mixed feeding is better than not breastfeeding at all	39 (13.5)	15 (11.7)	0.08	57 (22.8)	15 (13.5)	0.12
Exclusive breastfeeding for six months is an achievable goal for the majority of mothers	249 (86.2)	105 (82.0)	0.10	225 (90.0)	94 (83.9)	0.13
It is safer for HIV-positive mothers to breastfeed than to formula feed	231 (79.9)	89 (69.5)	0.06	225 (90.0)	83 (74.1)	0.27

In our community working mothers can successfully maintain exclusive breast feeding while going to work	219 (75.8)	89 (69.5)	0.08	207 (82.8)	90 (80.4)	0.11
An HIV-positive mother who is on ART and not virally suppressed and is mixed feeding is putting her child at risk of acquiring HIV	256 (88.6)	109 (85.2)	0.11	219 (87.6)	95 (84.8)	0.07
It is NOT very difficult for mothers to express breastmilk while they are at work or school	164 (53.0)	57 (44.5)	0.12	168 (67.2)	50 (44.7)	0.23
If an HIV-positive mother can afford to buy formula it is NOT better for her to formula feed her baby	170 (58.8)	83 (64.9)	0.06	184 (73.6)	66 (58.9)	0.19
Promoting breastfeeding for two years for HIV-exposed infants is NOT a risk because mothers will be able to maintain good ART adherence for that long	197 (68.2)	85 (66.4)	0.11	209 (83.6)	78 (69.6)	0.18
In South Africa it is possible to improve exclusive breastfeeding rates	244 (84.7)	108 (84.4)	0.08	229 (91.6)	95 (84.8)	0.15
There are exceptional circumstances where an HIV-positive mother would be advised not to breastfeed, such as failure of 2 <sup>nd</sup> or 3 <sup>rd</sup> line ART treatment, but these are not common	225 (77.9)	93 (72.7)	0.08	200 (80.0)	86 (76.8)	0.12
Formula feeding is NOT more convenient for a mother than breastfeeding	253 (87.5)	109 (85.2)	0.09	211 (84.4)	98 (87.5)	0.11
<b>Number (%) participants whose attitude was to at least agree (Attitude score <math>\geq</math>84)*</b>	<b>71 (24.6)</b>	<b>23 (17.9)</b>	<b>0.12</b>	<b>123 (49.2)</b>	<b>27 (24.1)</b>	<b>&lt;0.01</b>
<b>Mean attitude score out of 105 (95% CI)</b>	<b>76.9 (75.9 – 77.9)</b>	<b>75.0 (73.0 – 77.0)</b>	<b>0.07</b>	<b>82.7 (81.6 – 83.8)</b>	<b>76.8 (75.0 – 78.5)</b>	<b>&lt;0.01</b>

\*84 was the minimum score obtainable if a participant at least agreed with all statements

**Supplementary Table 2: Confidence statements of health workers at baseline and follow-up**

Confidence statements	Number (%) who felt confident or very confident at baseline			Number (%) who felt confident or very confident at follow-up		
	Intervention (n=289)	Comparison (n=128)	p-value	Intervention (n=250)	Comparison (n=112)	p-value
How confident do you feel about counselling an HIV-positive pregnant woman about how she will feed her baby	265 (91.7)	116 (90.6)	0.03	239 (95.6)	98 (87.5)	0.19
How confident do you feel about giving information about the risks and benefits of breastfeeding to an HIV-infected mother	268 (92.7)	120 (93.6)	0.07	236 (94.4)	100 (89.3)	0.11
How confident do you feel about assessing whether there is good positioning and attachment during breastfeeding	263 (91.0)	125 (97.7)	0.13	241 (96.8)	105 (93.8)	0.07
How confident do you feel about advising an HIV-positive mother about how to continue to breastfeed her baby when she returns to work or school	258 (89.3)	117 (91.4)	0.08	240 (96.0)	99 (88.4)	0.18
How confident do you feel about advising an HIV-infected mother who is virally suppressed who is mixed feeding her infant	243 (84.1)	113 (88.3)	0.06	224 (89.6)	97 (86.6)	0.05
How confident do you feel about advising an HIV-infected mother to continue breastfeeding for two years	216 (74.7)	105 (82.0)	0.09	234 (93.6)	91 (81.3)	0.21
How confident do you feel about advising an HIV-infected mother about how to stop breastfeeding	214 (74.1)	89 (69.5)	0.09	188 (75.2)	84 (75.0)	0.05
How confident do you feel about advising an HIV-positive mother about starting complementary feeds	251 (86.9)	115 (89.9)	0.05	227 (90.8)	101 (90.2)	0.12
How confident do you feel about assessing ART compliance in an HIV-positive mother	240 (83.1)	111 (86.7)	0.08	229 (91.6)	92 (82.1)	0.16
How confident do you feel about identifying when an HIV-positive mother is not adhering to her ART treatment	224 (77.5)	104 (81.3)	0.09	216 (86.4)	88 (78.6)	0.18
How confident do you feel about reassuring a mother living with HIV who is virally suppressed that a shorter duration of breastfeeding is better than never initiating breastfeeding	227 (78.5)	103 (80.5)	0.08	214 (85.6)	94 (83.9)	0.06
How confident do you feel about explaining the risks of HIV transmission through breastmilk to an HIV-infected mother with high viral load	247 (85.5)	114 (89.1)	0.06	218 (87.2)	103 (92.0)	0.09
How confident do you feel about assisting a mother with HIV to safely formula feed her baby	212 (73.4)	102 (79.7)	0.12	190 (76.0)	93 (83.0)	0.11

How confident do you feel about advising an HIV-infected mother who is exclusively breastfeeding and has cracked nipples with bloody milk about how to feed her baby	196 (67.8)	84 (65.6)	0.11	200 (80.0)	78 (69.6)	0.13
How confident do you feel about using the guidelines for safe replacement feeding when you counsel a mother who is not adherent to ART and has a viral load above 1000 copies/ml	191 (66.1)	99 (77.4)	0.17	184 (73.6)	74 (66.1)	0.13
How confident do you feel about advising an HIV-infected mother who is exclusively breastfeeding and has defaulted from her ART about how to feed her baby	205 (70.9)	97 (75.8)	0.11	187 (74.8)	79 (70.5)	0.08
How confident do you feel about explaining to a mother about expressing and storing milk	269 (93.1)	124 (96.9)	0.10	235 (94.0)	107 (95.5)	0.06
How confident do you feel about managing poor ART compliance in an HIV-infected breastfeeding mother	215 (74.4)	104 (81.3)	0.15	207 (82.8)	87 (77.7)	0.11
A mother is not adherent to ART and her last viral load is 1000 copies per ml. How confident do you feel about counselling her about feeding her infant?	199 (68.9)	98 (76.6)	0.10	196 (78.4)	78 (69.9)	0.12
<b>Number (%) participants who were confident or very confident (Sum Score <math>\geq</math> 57)</b>	<b>164 (56.8)</b>	<b>86 (67.2)</b>	<b>0.09</b>	<b>175 (70.0)</b>	<b>72 (64.3)</b>	<b>0.28</b>
<b>Mean confidence score out of 76 (95% CI)</b>	<b>59.1 (58.0-60.2)</b>	<b>59.1 (57.0-61.3)</b>	<b>1.0</b>	<b>61.2 (60.8-63.1)</b>	<b>59.9 (58.1-61.7)</b>	<b>0.05</b>

# BMJ Open

## Translating new evidence into clinical practice: the effect of a novel outreach mentoring approach on the knowledge, attitudes and confidence of health workers providing HIV and infant feeding counselling in South Africa

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## Translating new evidence into clinical practice: the effect of a novel outreach mentoring approach on the knowledge, attitudes and confidence of health workers providing HIV and infant feeding counselling in South Africa

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## Abstract

**Objectives:** We report the effectiveness of a facility-based mentoring approach to improve health workers' knowledge, attitudes and confidence with counselling on HIV and infant feeding.

**Design:** A quasi-experimental controlled before-after study.

**Setting:** Primary health care clinics were randomly selected (n=24 intervention, n=12 comparison) from two districts, South Africa.

**Participants:** Health workers (HW) providing infant feeding counselling.

**Intervention:** three 1-2 hour, on-site workshops over 3-6 weeks.

**Primary outcome measures:** a) knowledge scores: 22 statements each scored 1 if correct or 0; b) attitude scores: 21 statements with 5 possible responses: completely disagree (1), disagree (2), neutral (3), agree (4) and completely agree (5); c) confidence scores: 19 statements with 4 possible responses: not at all confident (1), not confident (2), confident (3) and very confident (4). Analysis was at the HW level, with clinic as a random effect to adjust for clustering. Data were analyzed using STATA/SE version 15.

**Results:** In intervention and comparison sites, respectively: 289 and 131 baseline and 253 and 114 follow-up interviews were conducted (August-December 2017). At follow-up, the mean score for the 22 knowledge questions was 15.2 (69%) in comparison and 17.2 (78.2%) in intervention sites ( $p<0.001$ ). Knowledge scores among HW who attended 3 (versus <3) workshops was significantly better ( $p<0.0001$ ). At follow-up, the mean attitude and confidence scores were significantly better in intervention versus comparison sites ( $p<0.001$  and  $p=0.05$ , respectively). Controlling for other factors there was a significant 5.1-point higher attitude score, and a non-significant 1.5 point increase in confidence score in the intervention group compared with the comparison group.

**Conclusion:** A participatory, low intensity on-site mentoring approach to disseminating updated infant feeding guidelines improved HWs' knowledge, attitudes and confidence more than standard dissemination. Further research is required to evaluate the effectiveness, feasibility and sustainability of implementing such a mentoring approach at scale.

### Strengths and limitations of the study:

1. Fieldwork was conducted in two geographically and historically different provinces, facilitating generalisability of results.
2. The intervention was participatory, low intensity, on-site and integrated into routine facilities.
3. Several types of analyses were conducted which all yielded congruent results.
4. However, limitations were that (i) we purposively selected districts for inclusion (ii) we could not control for HWs' personal breastfeeding experience as we did not gather these data (iii) the follow-up evaluation was undertaken 3 months after the intervention - thus, we measured short term benefits, and did not measure the direct effect of improved HWs' knowledge, attitudes and confidence on mothers' infant feeding practices.
5. The finding that knowledge scores amongst participants who attended 3 workshops were significantly better than knowledge scores amongst participants who attended less than 3 workshops, may simply reflect better motivation amongst attendees of more workshops, rather than the effect of the workshops themselves. We could not tease out these effects.

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### Competing interests statement

No author has declared any competing interests.

### Introduction

Policies and clinical practice guidelines are updated regularly following the accumulation of recent evidence. In the area of HIV and infant feeding, strategies to facilitate the effective dissemination of these updated guidelines have lagged behind. Research demonstrates that multi-component dissemination strategies, which aim to increase the reach, ability and motivation of health workers, are more effective than one strategy alone.[1] However, the reality is that there are few published studies to inform strategies for guideline dissemination, and most of these studies have been conducted in high income countries. Their results may therefore not be relevant to low-middle income settings, which have unique challenges.[1] We studied the effectiveness of a mentorship approach to disseminate updated HIV and infant feeding guidelines amongst health workers in a middle income setting with high HIV prevalence.

The benefits of breastfeeding in all settings, and particularly in low-middle income settings with high HIV prevalence, are undisputed.[2 3] In 2010, the World Health Organization (WHO) issued HIV and infant feeding recommendations, in support of six to 12 months of breastfeeding under antiretroviral cover.[4] This followed a difficult period during which effective triple antiretroviral therapy (ART) was not available and breastfeeding avoidance was recommended if specific conditions conducive to the safe use of replacement feeds were met. In 2009, data emerged that maternal ART and infant antiretroviral prophylaxis greatly reduce breast milk HIV transmission risk.[5 6] In 2011 the Tshwane Declaration of support for breastfeeding was adopted in South Africa and the provision of free commercial infant formula to prevent vertical HIV transmission (MTCT) was phased out.[7] These recommendations were followed by the implementation of PMTCT Option B+ in 2015, including lifelong ART for all pregnant and lactating women living with HIV, and support for continued breastfeeding for one year.[8] In July 2016, the WHO guidelines on HIV and infant feeding were updated to recommend exclusive breastfeeding (EBF) for the first six months, appropriate complementary foods from about 6 month and continued breastfeeding for at least 12 to 24 months amongst HIV-negative mothers and mothers living with HIV who were fully supported for ART adherence.[9] In June 2017, these feeding recommendations were adopted in South Africa, and revisions were communicated through a circular issued by the National Department of Health, necessitating health worker re-training.

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3 Research has demonstrated that improving HWs' capacity can significantly improve their skills,  
4 self-efficacy and confidence to counsel, support and promote breastfeeding among mothers living  
5 with HIV.[10] .[11] Consequently, a key question was: What learning approach could best develop  
6 health worker capacity and confidence to implement the updated HIV and infant feeding guideline,  
7 using a methodology that is sustainable and feasible to implement at scale. Pedagogical research  
8 highlights the advantage of participatory training compared with standard didactic teaching for  
9 improving health worker skills.[12 13] Thus, we sought to determine whether a participatory  
10 outreach mentorship approach to disseminate the updated HIV and infant feeding guidelines, using  
11 simple low-technology activities, improves health workers' knowledge of, attitudes towards and  
12 confidence with counselling on HIV and infant feeding..  
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## 15 **Methods**

### 16 **Study design**

17  
18 A quasi-experimental before-after design with intervention and comparison sites was used. Two  
19 purposively-selected districts (Ugu and Tshwane District) in South Africa in each of two  
20 geographically disparate provinces, KwaZulu-Natal (KZN) and Gauteng (Figure 1), were included  
21 for their differing infant feeding historical contexts: KZN has a history of strong political will to  
22 support breastfeeding, whilst Gauteng has historically supported formula feeding amongst mothers  
23 living with HIV. Both provinces experienced a policy change when infant feeding guidelines were  
24 updated in 2017.  
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### 27 **Sampling**

28 In Ugu District all four sub-districts were selected; within Tshwane District two of the seven  
29 service delivery regions were randomly selected.  
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32 Twelve intervention and six comparison primary health care clinics were randomly sampled in  
33 Ugu District and Tshwane District (separately). Only clinics with above the median number of  
34 annual clinic visits for children under-5 years in the district were eligible for inclusion in the  
35 sampling frame. The comparison clinics served to capture any temporal changes in health worker  
36 knowledge, confidence and attitudes due to other interventions or trainings; hence a smaller sample  
37 was required in comparison versus intervention sites as the latter required more precise estimates  
38 of the intervention effect. A two-stage process was used to recruit participants. Firstly, research  
39 staff explained the study and participant inclusion and exclusion criteria to each facility manager  
40 during face-to-face on-site introductory meetings. The facility manager compiled a list of all  
41 eligible health workers involved in the care of pregnant women and children, including nurses,  
42 midwives, visiting doctors, lay counsellors, dieticians, nutritionists, facility managers and  
43 community health workers (CHWs). In the second stage, research staff approached eligible health  
44 workers and invited them to participate in the research. We aimed to recruit a manageable size of  
45 8-10 health workers per clinic for participation in the intervention, and in the evaluation. The same  
46 staff were approached for the baseline and follow-up evaluations.  
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### 50 **Sample size**

51 The sample size was determined based on 80% power and alpha 0.05 to measure a 15-percentage  
52 points difference in health worker confidence in HIV and infant feeding counselling between the  
53 intervention and comparison clinics comparing baseline and follow-up. The expected effect was  
54 based on the researchers' experience and data from recent studies in South Africa with the baseline  
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3 level of high confidence to counsel HIV-positive women on breastfeeding duration set at 45%. [14]  
4 It was assumed that the confidence score would remain unchanged in the comparison clinics,  
5 implying a two-sample test in the post-intervention period. Clinic-level analyses were used for the  
6 sample size calculations, assuming a sampling ratio of 2:1 for the intervention clinics and a  
7 standard deviation of 15% in the mean score between clinics. Based on these assumptions, and  
8 adjusting for clustering, the sample size was determined to be 24 intervention clinics and 12  
9 comparison clinics. [15]  
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### 14 **Description of the intervention**

15 We designed a participatory intervention comprising on-site mentoring through three workshops  
16 in each clinic, involving selected health workers who provide care for pregnant women,  
17 breastfeeding mothers and their infants. The intervention was delivered by the same trained  
18 facilitator (a nurse in Gauteng and nutritionist in KZN) in each intervention clinic. Each workshop  
19 lasted 1-2 hours over a 3-6-week period and had well-defined learning outcomes. The intervention  
20 has been described elsewhere. [16] In summary, our participatory intervention was guided by  
21 evidence that health workers' attitudes and practices are influenced by various factors, not just  
22 exposure to training and information. [17] We used Dee Fink's six part taxonomy as a guiding  
23 theory. This proposes that significant learning only occurs by developing foundational knowledge,  
24 applying skills, integrating ideas, developing new feelings/interests and values, and learning how  
25 to learn (encouraging the spirit of enquiry) (Figure 2). [18] Additionally, we applied the theory of  
26 planned behaviour to the intervention design (Figure 2). [19 20] This states that an individual's  
27 intention to perform a behaviour is influenced by the person's attitudes towards performing the  
28 behaviour, their beliefs about whether people who are important to them will approve of the  
29 behaviour (subjective norms), and their beliefs about how likely they are to be able to implement  
30 the behaviour successfully. According to this theory, if health workers are to provide infant  
31 feeding counselling and support in accordance with updated infant feeding guidelines to HIV-  
32 positive or negative mothers, they need to agree with the change, believe that their colleagues and  
33 other stakeholders will approve of the action, and believe in their ability to implement it  
34 successfully. The workshops were tailored to achieve these goals: Workshop 1 covered knowledge  
35 gaps reported by participants, controversial statements, and advantages of breastfeeding.  
36 Following workshop 1, a poster or cards with key messages were placed in a prominent place in  
37 the clinic. Workshop 2 comprised a progressive case study discussed in small groups. Workshop  
38 3 involved one-to-one mentorship: each participant was observed providing infant feeding  
39 counselling or a case study was discussed if no mothers were available for counselling. The same  
40 facilitator conducted all three workshops at each clinic. In addition, a WhatsApp cell phone  
41 messaging group was established to support participants in intervention sites to facilitate sharing  
42 of concerns, tips for counselling and dealing with difficult situations. Key messages were posted  
43 on the group approximately weekly. Comparison sub-districts were exposed to routine supervision  
44 and training activities that took place at district level. The study team documented that the June  
45 2017 circular issued by the National Department of Health, informing health facilities of the  
46 change in Infant and Young Child feeding policy, was disseminated to comparison clinics as an  
47 announcement via e-mail and other electronic communication as well as during meetings or  
48 trainings. We documented that in Tshwane, 15 of the 18 clinics had received the circular; 11 via  
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3 e-mail and three at a meeting. In Ugu nine of 17 clinics had received the circular; 8 received it via  
4 hand delivery and one via e-mail.  
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### 10 **Patient and Public Involvement**

11 Patients and the public were not involved in the design of this study, as the main population of  
12 interest were health workers.. The intervention and tool were piloted amongst a separate group of  
13 health workers to determine length, complexity of questions and level of understanding. These  
14 details are explained in our intervention paper..[16]  
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### 16 **Data collection**

17 Data were collected between August and December 2017 by dedicated trained non-nurse data  
18 collectors who were independent of the intervention staff. As per study design, data collection staff  
19 were not part of any intervention activities and had never been exposed to the intervention. The  
20 primary outcome measure for the study was confidence level of health workers to counsel on infant  
21 feeding, evaluated using a Likert-scale tool, developed after reviewing the WHO Breastfeeding  
22 Counselling Course, and the WHO HIV and Infant feeding counselling courses.[9 21-  
23 24].Secondary outcomes included health worker knowledge and attitude about breastfeeding  
24 counselling. A baseline assessment amongst all participating health workers in intervention and  
25 comparison sites was undertaken prior to the start of the intervention (August 2017). Health  
26 workers self-completed the assessment on study-provided electronic tablets at their workplaces.  
27 Questions covered basic demographic information, types of activities undertaken at work,  
28 knowledge, attitudes and confidence around counselling on infant feeding. A mean of 12 weeks  
29 after the baseline assessment, a follow-up assessment using the same tool was conducted amongst  
30 the same group of health workers. Health workers who were not in the clinic on the day of the  
31 follow-up assessments were included in a special catch-up assessment. Questionnaire software had  
32 built in range and skip logic and data were transferred automatically to a database held at the  
33 University of KwaZulu-Natal.  
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### 38 **Data analysis**

39 There were three outcomes in the study: a) 22 knowledge statements which were scored 1 if  
40 correctly answered and 0 if not; answers were based on existing literature and guidelines (binary  
41 outcomes); b) 21 attitude questions whose responses were measured on a 5-point Likert scale -  
42 given as completely disagree (1); disagree (2); neutral (3); agree (4) and completely agree (5);  
43 positive attitudes received higher scores; and c) 19 statements on confidence item questions which  
44 were also measured on a Likert scale, scored as such: not at all confident (1), not confident (2),  
45 confident (3) and very confident (4). For both attitude and confidence domains, a participant  
46 outcome was measured by the sum of the responses to the respective items (we verified that there  
47 was not a missing response on the items). Thus, the ranges for the attitude and confidence scores  
48 were 5 to 105, and 4 to 75, respectively.  
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52 Participants baseline and follow-up characteristics and outcomes between the intervention and  
53 control areas were compared using Chi-squared tests for categorical variables and two-sample t  
54 tests for continuous measures, after confirming that data were normally distributed. To assess the  
55 effect of the proposed intervention, several analysis methods for comparing treatment effect in pre-  
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3 post quasi-experimental designs were considered. These include using post-measures and change  
4 from pre-treatment to post-treatment as the response variables. Approaches that use change and  
5 post measurements as the outcome, adjusting for pre-treatment measurements are recommended,  
6 and often give similar results.[25] In this paper, we considered three methods for estimating and  
7 testing the intervention effect using the sum of individual attitude or confidence scores as an  
8 outcome variable in a linear regression. Model 1 used the post-treatment  
9 measurements as the outcome variable, but adjusts for the pre-treatment values; Model 2 analyses  
10 the change score as an outcome variable with an adjustment for the pre-treatment values; and  
11 Model 3 analysed all the pre-and post-measurements as the outcome variable, and uses time (coded  
12 : 1 at follow-up and 0 at baseline) as a covariate with an interaction term for time and treatment,  
13 in addition to an adjustment for the pre-treatment values). Using Models 1 and 2, the coefficient  
14 for the intervention (coded:1 intervention group and 0: comparison group) estimates the  
15 differences in the post intervention means and differences in the mean of change of sum scores  
16 mean between of the treatment groups, controlling for the pre-treatment measurement. Using  
17 Model 3, the sum of coefficients of intervention and the interaction terms is taken as the mean  
18 difference between treatment groups post-treatment, allowing for pre-treatment mean differences  
19 between the groups. All analyses also controlled for baseline participant characteristics and prior  
20 training. The analyses were adjusted for the possible clustering effect at the site level, using a  
21 variance-correction method.[15] Data can be obtained by e-mailing the corresponding author.  
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## 27 Ethics

28 Ethics approval was obtained from the South African Medical Research Council (EC028-9/2016),  
29 the University of KwaZulu-Natal (RECIP348/17) and the WHO Ethics Review Committee  
30 (ERC0002833). Permission for undertaking the study was obtained from Tshwane and KZN  
31 Districts. Informed consent was sought from all study participants and no personal identifying  
32 information was captured in the questionnaires, only a study identification number.  
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## 36 Results

37 At baseline and follow-up, 23 intervention clinics (one large clinic was sampled twice with two  
38 rounds of data collection per time point) and 12 comparison clinics were visited; 289 and 131  
39 health worker interviews were conducted at baseline in intervention and comparison clinics,  
40 respectively (Figure 3). Loss to follow-up between baseline and follow-up did not differ between  
41 intervention and comparison sites: 17 (13%) in comparison sites versus 36 (12.5%) in intervention  
42 sites.  
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44 Tshwane and Ugu Districts did not differ in the main outcome measures at baseline (knowledge,  
45 attitude and confidence). Additionally, they were similar in all health worker characteristics except  
46 three: Tshwane had significantly more participants with less than 2 years employment (14.4%  
47 versus 6.2%,  $p=0.007$ ), more registered nurses (57% versus 26.2%,  $p=0.02$ ), and fewer lay  
48 counsellors/CHWs (7.3% versus 50.0%, respectively,  $p=0.02$ ). Given the lack of significant  
49 difference in the main outcome variables at baseline, data from the two sites were combined for  
50 the analysis.  
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54 All staff approached agreed to participate. There were no significant differences between  
55 intervention and comparison sites at baseline, regarding district of origin, median age of  
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3 respondent, gender, cadre of health worker, and working duration (Table 1). The proportion of  
4 participants who had received previous training (through the routine health system) on specific  
5 topics was similar in intervention versus comparison sites, except for three topics which had better  
6 coverage in comparison sites (Supplementary Figure 1). These were: ever trained on how to assess  
7 and support ART adherence for HIV positive women (78.6% in intervention sites versus 89.2% in  
8 comparison sites,  $p=0.01$ ); ever trained about managing breastfeeding problems (76.5% in  
9 intervention sites and 86.2% in comparison sites,  $p=0.02$ ); and received any information or training  
10 about the revised infant feeding policy (55.1% in intervention sites versus 67.4% in comparison  
11 sites  $p=0.02$ ). At baseline, activities around breastfeeding counselling and management were  
12 similar between comparison and intervention sites in all respects except that comparison site  
13 participants reportedly spoke more frequently to HIV positive pregnant women about feeding than  
14 intervention participants (67% versus 71.6% spoke more than 1-3 times per month,  $p=0.04$ , data  
15 not shown).  
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**Table 1: Characteristics of the participants in the intervention and comparison groups at baseline**

Characteristic	Intervention group (n=289) (N (%))	Comparison group (n=131) (N (%))	p-value
<b>District:</b>			
- Tshwane	152 (52.6)	56 (42.8)	0.06
- Ugu	137 (47.4)	75 (57.3)	
<b>Age categories:</b>			
- 23 to 35 years	56 (19.4)	38 (29.7)	0.11
- 36 to 41 years	61 (21.2)	25 (19.5)	
- 42 to 46 years	53 (18.4)	26 (20.3)	
- 47 to 54 years	64 (22.2)	18 (14.1)	
- Over 54 years	54 (18.8)	21 (16.4)	
<b>Gender</b>			
- Female	267 (92.7)	118 (91.5)	0.66
- Male	21 (7.3)	11 (8.5)	
<b>Cadre of health worker</b>			
- Community level worker	84 (29.5)	52 (40.0)	0.05
- Trained health professional*	151 (53.0)	64 (49.2)	
- Enrolled nurse	50 (17.4)	14 (10.8)	
<b>Work experience in yrs</b>			
- Less than 1 yr	4 (1.4)	3 (2.3)	0.20
- 1 to <2 yrs	23 (8.0)	12 (9.3)	
- 2 to less than 5 yrs	36 (12.5)	18 (14.0)	
- 5 to less than 10 yrs	71 (24.7)	43 (33.3)	
- 10 yrs or more	154 (53.5)	53 (41.1)	

Abbreviations:; \*includes 68% nurses in the intervention arm and 58% nurses in comparison arm. This group also includes operation managers, dieticians, doctors and nutritionists.

In intervention sites, workshops were attended by 84-88% of participants interviewed at follow-up (Table 2).

**Table 2: Attendance at workshops 1-3 measured at follow-up in intervention sites**

	Attended workshop n	Attended catch-up n	Total attended n/N (%)
<b>Number of staff attending each workshop:</b>			
Group workshop 1	202	63	265/303 (87.5)
Group workshop 2	223	34	257/303 (84.8)
Workshop 3 (Clinical mentoring)	216	40	256/303 (84.5)
<b>Number of workshops attended:</b>			
	number	%	
No workshop	18	7.2	
1-2 workshops	10	4.0	
All 3 workshops	221	88.8	
<b>Total</b>	<b>249</b>	<b>100</b>	

### Effect of the intervention on health worker knowledge

At baseline, knowledge about key infant feeding statements or facts was similar between intervention and comparison sites, except for knowledge about soft porridge (Table 3). Although at baseline, more than 90% of intervention and comparison site participants knew that a baby under 4 months should not be given soft porridge if hungry, significantly more intervention site participants knew this recommendation (Table 3). The percentage of participants at baseline correctly answering the more difficult questions (on bottle sterilisation, storing expressed breastmilk, feeding HIV exposed infants) was low (Table 3). At follow-up significantly more intervention site participants correctly answered knowledge questions, regarding the leading cause of death in children under 5, the risk of formula feeding, duration of breastfeeding for HIV-negative mothers and mothers living with HIV, how to stop breastfeeding, complementary feeding, storing expressed breastmilk, feeding whilst at work, breastfeeding and viral suppression, mixed feeding in mothers living with HIV, adherence to ART and breastfeeding, breastfeeding difficulties in mothers living with HIV and managing mothers living with HIV who are breastfeeding, than comparison site participants (Table 3). The significant differences between intervention and comparison sites regarding soft porridge were not present at follow-up. Although improvements were seen in knowledge related to the risks of mixed feeding for mothers living with HIV, most health workers still provided incorrect responses at follow-up. At baseline, the mean knowledge score was 15.0 (68%) in comparison sites versus 15.2 (69%) in intervention sites,  $p=0.89$  (Table 3). At follow-up the mean knowledge score was 15.2 (69%) in comparison sites and 17.2 (78.2%) in intervention sites,  $p<0.001$  (Table 3). For the two questions measuring knowledge about the 2017 change in infant feeding guidelines, namely, “Continued breastfeeding for 2 years is the recommended infant method in SA for ALL children, regardless of mother’s HIV status” and “In South Africa, HIV-infected women who are breastfeeding should be supported to adhere to antiretroviral treatment and should introduce complementary foods around 6 months and be supported to continue breastfeeding for at least two years. (True)”, there was a 36% improvement in knowledge in the intervention group at follow-up compared with a 13% increase in knowledge in the control group. For the second question there was a 15% increase in correct knowledge in the intervention group at follow-up while for the comparison group knowledge decreased from 89-81%. The difference in difference in the mean

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3 knowledge scores at baseline and follow-up between intervention and control sites was significant  
4 (p<0.001, data not shown). At follow-up, knowledge scores of participants who attended 3  
5 workshops compared with knowledge scores of participants who attended less than 3 workshops  
6 was significantly better (p<0.001).  
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For peer review only

**Table 3: Knowledge of health workers about breastfeeding in the intervention and comparison sites at baseline and follow-up**

Knowledge statements	Number (%) with correct answers at BASELINE			Number (%) with correct answers at FOLLOW-UP		
	Intervention (n=289)	Comparison (n=128)	P-value *	Intervention (n=250)	Comparison (n=112)	P-value *
<b>General breastfeeding</b>						
Exclusive breastfeeding is the recommended infant feeding method for ALL infants aged 0-6 months in SA, regardless of mother's HIV status (True)	271 (93.8)	118 (90.1)	0.18	234 (93.6)	102 (91.1)	0.39
Giving any formula milk during the first six months of life increases the risk of death from diarrhoea and/or pneumonia (True)	246 (85.1)	104 (79.4)	0.14	232 (92.8)	95 (84.8)	0.02
A mother who is working and giving formula milk should mix the milk herself and leave for the carer to give during the day (False)	218 (75.4)	94 (71.8)	0.42	189 (75.6)	68 (60.7)	<0.01
When sterilising feeding bottles cover the bottles with water in a saucepan and place on the heat. As soon as the water boils remove from heat and do not leave the bottles in the water until completely cool (False)	64 (22.2)	27 (20.6)	0.72	53 (21.2)	25 (22.3)	0.81
In South Africa, the leading cause of death amongst children under 5 is pneumonia (True)	189 (65.4)	82 (62.6)	0.58	230 (92.0)	75 (67.0)	<0.01
Continued breastfeeding for 2 years is the recommended infant method in SA for ALL children, regardless of mother's HIV status (True) <sup>†</sup>	190 (65.7)	91 (69.5)	0.45	224 (89.6)	88 (78.6)	<0.01
A baby under 4 months should be given soft porridge once he/she seems hungry (False)	284 (98.3)	124 (94.7)	0.04	247 (98.8)	108 (96.4)	0.13
Giving a baby expressed breastmilk is not as good as breastfeeding (False)	234 (81.0)	106 (80.9)	0.99	218 (87.2)	96 (85.7)	0.70
It is safe to give the baby expressed breastmilk that has been kept outside the fridge for 8 hours (True)	106 (36.7)	43 (32.8)	0.44	120 (48.0)	38 (33.9)	<0.05
There are long term health benefits of breastfeeding for mother and child that last beyond the breastfeeding period (True)	264 (91.4)	116 (88.6)	0.37	232 (92.8)	100 (89.3)	0.26
<b>Breastfeeding and HIV</b>						
Mothers living with HIV who are receiving antiretroviral treatment and are virally suppressed should be advised not to breastfeed their infants (False)	252 (87.2)	115 (87.8)	0.87	230 (92.0)	99 (88.4)	0.27
When an HIV-infected mother is ready to add complementary feeds she should stop breastfeeding rapidly over a 24-hour period (False)	214 (74.1)	103 (78.6)	0.31	217 (86.8)	86 (76.8)	<0.05

If an HIV exposed baby is receiving both breastmilk and formula milk, the mother should choose either breastfeeding or formula feeding if she is adherent to ART (False)	69 (23.9)	29 (22.1)	0.70	75 (30.0)	28 (25.0)	0.33
An HIV-positive mother who is virally suppressed on antiretroviral treatment should breastfeed her child rather than not breastfeed to improve the child's survival (True)	237 (82.0)	108 (82.4)	0.91	236 (94.4)	96 (85.7)	<0.01
In South Africa, HIV-infected women who are breastfeeding should be supported to adhere to antiretroviral treatment and should be counselled and supported to exclusively breastfeed their infants for the first six months of life whilst maintaining an undetectable viral load (True) <sup>‡</sup>	281 (97.2)	123 (93.9)	0.10	242 (96.8)	109 (97.3)	0.79
A mother living with HIV and adherent to antiretroviral treatment cannot exclusively breastfeed her 4-month old infant because she is working. It is better for this mother to give formula during the day and breastfeed at night rather than giving no breast milk at all (True)	22 (7.6)	14 (10.7)	0.30	40 (16.0)	14 (12.5)	0.38
If a mother misses 2 doses of her ART in one month, she should be classified as a treatment failure (False)**	185 (64.0)	82 (62.6)	0.78	191 (76.4)	73 (65.2)	<0.05
An HIV-positive mother who has cracked nipples should continue to breastfeed unless they are bleeding (True)	143 (49.5)	64 (48.9)	0.91	187 (74.8)	59 (52.7)	<0.01
An HIV-exposed baby who is exclusively breastfeeding should be given some water when the weather is very hot (False)**	270 (93.4)	122 (93.13)	0.91	239 (95.6)	105 (93.8)	0.45
If a baby has a positive PCR (HIV test) at birth the mother should stop breastfeeding if this is affordable and feasible in her situation (False)**	224 (81.0)	106 (80.9)	0.99	214 (85.6)	82 (73.2)	<0.01
A mother who has missed 6 tablets of FDC in one month is considered to be poorly adherent and should stop breastfeeding immediately (False)**	181 (62.6)	89 (67.9)	0.29	201 (80.4)	72 (64.3)	<0.01
In South Africa, HIV-infected women who are breastfeeding should be supported to adhere to antiretroviral treatment and should introduce complementary foods around 6 months and be supported to continue breastfeeding for at least two years. (True)	245 (84.8)	116 (88.6)	0.30	244 (97.6)	91 (81.3)	<0.01
<b>Mean knowledge score (standard deviation) out of 22</b>	15.2 (2.6)	15.0 (3.1)	0.89*	17.2 (2.1)	15.2 (2.8)	<0.001

\*\*The Statement is false; thus, the scales were inverted during data analysis. <sup>‡</sup> - these questions measure the change in knowledge relating to the 2017 circular and updated HIV and Infant feeding guidelines

\*Mann-Whitney U test comparing intervention and comparison sites at the relevant time point.

Note: the tables displays numbers with correct knowledge

## Effect of the intervention on attitudes

At baseline, intervention and comparison sites were similar in HW attitudes except for attitudes towards feeding a crying baby and expressing breastmilk, which were significantly better in intervention sites (Supplementary Table 1). At follow-up attitudes to breastfeeding and HIV were significantly better in the intervention group for 13 of the 21 questions, and the mean attitude score towards breastfeeding was significantly better in intervention sites ( $p < 0.001$ ) (Supplementary Table 1). All three approaches to analysis demonstrated that, after controlling for other variables, final attitude (measured as attitude at follow-up, change in attitude between intervention and comparison sites or change in attitude between baseline and follow-up between intervention and comparison sites) was significantly better in intervention compared with comparison sites (Table 4). In Model 1 analysis, attitude at follow-up was 5.4 points higher in the intervention group than the comparison group; using Model 3, analysis showed a significant 5.1-point higher score in the intervention compared with the comparison group (Table 4). Model 1 demonstrated that being an enrolled nurse, and being in the youngest (36-41 years) or oldest ( $> 54$  years) age group was associated with a significantly lower attitude score; Model 3 analysis demonstrated that, controlling for other factors, trained health professionals had a significantly higher attitude score at follow-up (Table 4,  $p < 0.05$ ). We did not detect a dose-association in intervention sites when comparing 0-1 or 1-2 versus 3 workshops ( $p = 0.4$ ); but numbers in each group may have been too small to reliably assess any dose effect.

**Table 4: Adjusted effect of the intervention on health worker attitude score using different methods (Effect estimate and 95% confidence interval (CI))**

Variable	Model 1		Model 3	
	Effect estimate	95% CI	Effect estimate	95% CI
<b>Attitude score at baseline</b>	<b>0.5</b>	<b>0.3; 0.7*</b>	N/A	N/A
<b>Intervention</b>	<b>5.4</b>	<b>3.9; 6.9*</b>	<b>5.1</b>	<b>2.1; 8.1*</b>
<b>Follow-up Period</b>	N/A	N/A	1.8	0.2-3.4*
<b>Professional role: vs community level</b>				
- Trained health professional	1.6	-0.05; 3.2	<b>4.8</b>	<b>2.8; 6.7*</b>
- Enrolled nurse	<b>-2.4</b>	<b>-5.0; -0.2*</b>	0.9	-1.4; 3.2
<b>Ugu District vs Tshwane District</b>	-0.83	-2.2; 0.5	-1.4	-3.1; 0.2
<b>Age category: vs 23-35 yrs</b>				
- 36 to 41 yrs	<b>-2.8</b>	<b>-5.4; -0.2*</b>	-1.8	-4.1; 0.6
- 42 to 46 yrs	-0.9	-3.3; 1.5	-0.2	-2.5; 2.2
- 47 to 54 yrs	0.5	-2.0; 2.9	-1.2	-3.1; 0.8
- over 54 yrs	<b>-3.3</b>	<b>-5.7; -1.0*</b>	-2.2	-4.8; 0.3
<b>Work experience &lt;5 yrs vs ≥5yrs</b>	-0.3	-2.5; 1.9	-1.3	-3.4; 0.8
<b>Received training or information at work about the revised policy</b>	0.5	-1.4; 2.3	1.7	0.1-3.24
<b>Received any training about managing common breastfeeding problems?</b>	0.3	-2.5; 3.0	3.2	0.9-5.5
<b>Ever received any training about how to assess and</b>	-0.1	-2.2; 2.0	1.6	-0.5-3.8



<b>support ART adherence for HIV positive women?</b>				
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\*p<0.05 N/A: not applicable. NB: All analyses are adjusted for clustering

### Effect of the intervention on confidence

At baseline there was no difference in the percentage of participants in the intervention and control sites who were confident or very confident in counselling mothers on HIV / infant feeding (Supplementary Table 2). However, at follow-up HWs from intervention sites were significantly more confident in counselling an HIV positive women, advising HIV positive women about breastfeeding and return to school/work, advising HIV positive mothers to continue breastfeeding for two years, assessing ART adherence in HIV positive mothers, and advising HIV positive mothers about breastfeeding with cracked nipples (Supplementary table 2). The mean confidence score at follow-up was significantly higher in the intervention compared with the comparison sites at follow-up (p=0.05) (Supplementary Table 2). All three approaches to analysis demonstrated that confidence was significantly better in intervention compared with comparison sites (Table 5). Using Model 1, confidence at follow-up was 2.4 points higher in the intervention arm than the comparison arm. Using Model 3, the results showed a significant 1.5 point higher score in the intervention compared with the comparison group, although this was not significant (Table 5). Our analysis demonstrated that, controlling for other factors, being a trained health professional significantly increased confidence score by 3.1 (Model 1) or 3.7 (Model 3). Additionally, Model 3 demonstrated that, controlling for other factors, working for less than 5 years significantly reduced the confidence score. We did not measure a dose-effect (one or two versus three workshops (p=0.4)); but numbers in each group may have been too small to assess this.

**Table 5: Adjusted effect of the intervention on health worker confidence scores, using different multivariable analysis methods (Effect estimate and 95% confidence interval (CI))**

Variable	Model 1		Model 3	
	Effect estimate	95% CI	Effect estimate	95% CI
<b>Confidence score at baseline</b>	<b>0.4</b>	<b>0.3; 0.6*</b>	N/A	N/A
<b>Intervention</b>	<b>2.4</b>	<b>0.3; 4.5*</b>	1.5	-2.2; 5.1
<b>Follow-up time</b>	N/A	N/A	0.5	-1.5; 2.5
<b>Cadre of health professional: vs community level</b>				
- Trained health professional	<b>3.1</b>	<b>0.3; 5.9*</b>	<b>3.7</b>	<b>1.5; 5.9*</b>
- Enrolled nurse	-0.8	-4.3; 2.7	-0.7	-3.1; 1.6
<b>Ugu District vs Tshwane District</b>	0.00	-2.1; 2.1	-1.	-3.2; 1.2
<b>Age category vs 23-35 yrs</b>				

- 36 to 41 yrs	-1.0	-3.7; 1.6	-0.1	-2.7; 2.5
- 42 to 46 yrs	0.3	-2.9; 3.4	0.4	-1.2; 2.9
- 47 to 54 yrs	1.4	-0.7; 3.5	-1.3	-3.4; 0.8
- over 54 yrs	-2.5	-5.7; 0.7	-0.9	-4.0; 2.2
<b>Work experience &lt;5 yrs vs ≥5 yrs</b>	-0.5	-3.4; 2.4	<b>-1.9</b>	<b>-3.7; -0.2*</b>
<b>Received training or information at work about the revised policy</b>	0.05	-1.5; 1.6	1.7	-0.3; 3.6
<b>Received any training about managing common breastfeeding problems?</b>	-0.6	-3.2; 2.1	1.8	-0.5; 4.1
<b>Ever received any training about how to assess and support ART adherence for HIV positive women?</b>	0.8	-2.1; 3.7	5.7	3.5; 7.9

\*p<0.005 N/A= not applicable yrs= years. NB: All analyses are adjusted for clustering

## Discussion

We demonstrate that a participatory, team-based mentoring approach to disseminating updated HIV and infant feeding guidelines was associated with an improvement in health workers' attitudes, controlling for other factors, an improvement in confidence scores, and a non-significant improvement in confidence when controlling for other factors. There was also a significant improvement in mean knowledge score between intervention and control sites at follow-up: In particular, there was a 36% improvement in knowledge of breastfeeding duration in the intervention group compared with 13% in the control group, and a 15% increase in knowledge about ART adherence and complementary feeding in the intervention group, compared with a decline in knowledge in the control group. These two questions speak specifically to the changes in the 2017 guidelines.

The mentoring approach had five distinct features: 1) it was on-site so that learning occurred in context 2) it was open to all cadres of health workers; 3) it was team-based; all participants learned together; 4) content was led by the gaps in knowledge identified by participants themselves, and 5) activities were piloted and rooted in a theoretical framework.

This mentorship approach was significantly associated with increased knowledge, especially around HIV and infant feeding, better attitudes and more confidence compared with the standard approach to disseminating infant feeding guidelines. Although some knowledge items did not change, we noted key improvements in the important knowledge items relating to HIV and infant feeding, however further reinforcement is needed regarding the issue of mixed feeding for mothers living with HIV which is possibly the biggest practice change in the 2016 guidelines. Although a few individual attitude and confidence items did not change, or only changed marginally, all our analyses indicated an improvement in follow-up attitude and confidence scores. Although the intervention group still performed poorly on some of the more difficult confidence questions such as confidence with counselling when a mother is not ART adherent, managing high viral loads during breastfeeding, explaining HIV transmission risks to a mother with a high viral load,

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3 assisting mothers with HIV to safely formula feed and advising that some breastfeeding is better  
4 than no breastfeeding, we hypothesise that this could be attributed to the short duration of the  
5 intervention – three one-hour workshops over a period of three to six weeks.  
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8 There is evidence that in-service training, supervision and follow-up improves the knowledge,  
9 skills and practices of health workers managing childhood undernutrition, and can improve health  
10 worker job satisfaction and motivation, but no data exist on how to improve health worker  
11 knowledge, skills and confidence in the tricky area of HIV and infant feeding.[26-28]; however,  
12 implementation challenges have been described, including inadequately trained or shortages of  
13 supervisors, inappropriate job aids for follow-up, and poor alignment between community views/  
14 practice and health programmes.[29] Our approach used a low technology, model for skills  
15 development at clinic level. We worked with health workers by acknowledging that they are  
16 members of their community: we discussed their fears and beliefs, and then introduced facts and  
17 evidence to extend their knowledge, change their attitudes and increase their confidence to  
18 implement updated guidelines on HIV and infant feeding. This approach can be used by routinely  
19 employed primary health care supervisors and adapted to different settings to conduct in-service  
20 training on HIV and infant feeding or other topics.  
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25 We used a team-based mentorship approach as we aimed to empower health workers.[30] A team-  
26 based approach allowed collaborative learning between different cadres of health workers,  
27 facilitating any future change in practice. In accordance with Dee Fink's theory, a participatory  
28 mentorship approach allows participants to develop foundational knowledge, apply skills,  
29 integrate ideas, develop new feelings/ interests and values and learn how to learn.[17] Our  
30 experience suggests that such an approach allowed discussion of participant's attitudes towards  
31 performing the behaviour, beliefs about whether critical, important people will approve of the  
32 behaviour (subjective norms), and about their likelihood of successfully implementing the  
33 behaviour.[19 20] Our findings corroborate a scoping review which demonstrated that mentorship  
34 improves certain quality of care outcomes [30]; in our study it improved knowledge, attitudes and  
35 confidence. However, only four studies were included in this scoping review, and the nature of the  
36 mentorship varied from video-conferencing to monthly, six-weekly or annual visits interspersed  
37 with other contact forums, conducted over one day to an entire week. A list of desirable features  
38 of mentorship interventions, include at least one dedicated mentor per facility, ensuring an  
39 adequate mentor:mentee ratio so that all staff can be supported, forming meaningful relationships  
40 between mentors and mentees, ensuring cultural congruency between mentee and mentor, and  
41 using mentors for protocol-driven programmes, such as IMCI or HIV.[30] Our intervention related  
42 to HIV and infant feeding guidelines, was low cost and low technology (one mentor working with  
43 pen, flip chart and paper in the health facility), and was implemented by a dedicated mentor from  
44 the same cultural background as the mentees. She provided onsite support during the workshops,  
45 which lasted approximately one hour, and additional support through a WhatsApp messaging  
46 group.  
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53 Given the ongoing health worker crisis in resource limited settings, including maldistribution of  
54 staff, an imbalance in skills mix, increasingly complicated health programmes and complicated  
55 socio-cultural-political-economic environments, questions about the feasibility of an on-site  
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3 mentorship approach to guidelines dissemination arise. We argue that strengthening investment in  
4 on-site mentorship rather than off-site training, may be a cost-saving approach. In our setting, all  
5 clinics receive regular visits from district primary health care (PHC) supervisors, but they mostly  
6 focus on administration and clinic management matters. These supervisors, as well as existing  
7 district PHC trainers, could be capacitated to provide clinical mentoring for health workers in the  
8 clinics they oversee. Our model of team-based learning and mentoring can be used for on-site  
9 mentoring, and avoids accommodation and travel costs, and absence from work that off-site  
10 training requires.  
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14 Our study had several limitations: We purposively selected districts for inclusion. We could not  
15 control for previous breastfeeding experience of health workers as we did not gather these data.  
16 The study tools were piloted before finalisation, but no factor analyses or validation exercises  
17 were conducted. The follow-up evaluation was conducted 3 months after the intervention; thus,  
18 we were only able to measure short term benefits and did not measure the effect of improved  
19 knowledge, attitudes and confidence on actual infant feeding practices. We could not tease out  
20 whether the relationship between number of workshops and outcomes was due to staff motivation  
21 (more motivated staff attended more workshops) or the workshops themselves. Our study's  
22 strength is that we conducted several types of analyses and all yielded congruent results.  
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25  
26 **Conclusion:** We demonstrated improved knowledge, attitudes and confidence of health workers  
27 following a participatory mentorship approach to HIV and infant feeding guideline dissemination  
28 compared with a standard approach. More research is needed to better understand how to change  
29 health worker practices, which may then improve breastfeeding practices.  
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### Authors contributions:

AG: Study conceptualization and tool development, protocol writing including intervention development, oversight of sampling and field work, writing of the first draft of this manuscript, receiving and incorporating co-author comments, finalization of the paper

TD: Study conceptualization and tool development, protocol writing including intervention development, set up the sample frame and sampling, contributed to the manuscript, reviewed and approved the final version of the manuscript

SM: Led the statistical components of the protocol; provided overall oversight on the statistical analysis, contributed to the manuscript, reviewed and approved the final version of the manuscript

TN: Performed the work on the statistical components of the protocol, under SM's guidance; provided data analysis under SM's guidance, contributed to the manuscript, reviewed and approved the final version of the manuscript

LH: Contributed to study conceptualization and tool development, protocol writing including intervention development; was overall Project Manager; established, managed and cleaned the database; contributed to the manuscript, reviewed and approved the final version of the manuscript

VJ: Provided guidance on intervention development. Contributed to the manuscript, reviewed and approved the final version of the manuscript

IMSE: Contributed to study conceptualization and tool development, protocol writing including intervention development; contributed to the manuscript, reviewed and approved the final version of the manuscript

UF: Contributed to study conceptualization, assisted with district level buy-in in Tshwane District, provided information on how routine dissemination of updated infant feeding guidelines; contributed to the manuscript, reviewed and approved the final version of the manuscript

MAD: Contributed to study conceptualization and tool development; contributed to the manuscript, reviewed and approved the final version of the manuscript

NR: Contributed to study conceptualization; contributed to the manuscript, reviewed and approved the final version of the manuscript

MK: Contributed to study conceptualization and tool development; contributed to the manuscript, reviewed and approved the final version of the manuscript

DS: Contributed to study conceptualization and tool development; contributed to the manuscript, reviewed and approved the final version of the manuscript

SK: Contributed to study conceptualization, assisted with national level buy-in, provided information on how routine dissemination of updated infant feeding guidelines; contributed to the manuscript, reviewed and approved the final version of the manuscript

TT: Contributed to study conceptualization and tool development; contributed to the manuscript, reviewed and approved the final version of the manuscript

CH: Study conceptualization, protocol writing including intervention development, high level oversight of study implementation, contributed to the manuscript, reviewed and approved the final version of the manuscript

**Data sharing statement:** Data can be obtained by e-mailing the corresponding author, and upon reasonable request

**Figure legends:**

Figure 1: Study districts: Tshwane District in Gauteng Province and Ugu District in KwaZulu-Natal Province of South Africa

Figure 2: Theoretical frameworks which informed the development of the intervention

Figure 3: Study population at baseline and follow-up for intervention and comparison sites

Supplementary Figure 1: Prior training reported by participants at baseline (intervention versus comparison groups)

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**Figure 1: Study districts: Tshwane Metropolitan Municipality in Gauteng Province and Ugu District in KwaZulu-Natal Province of South Africa**

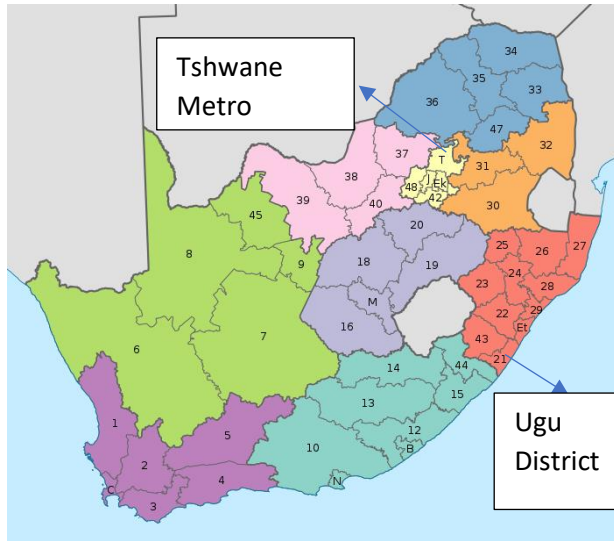
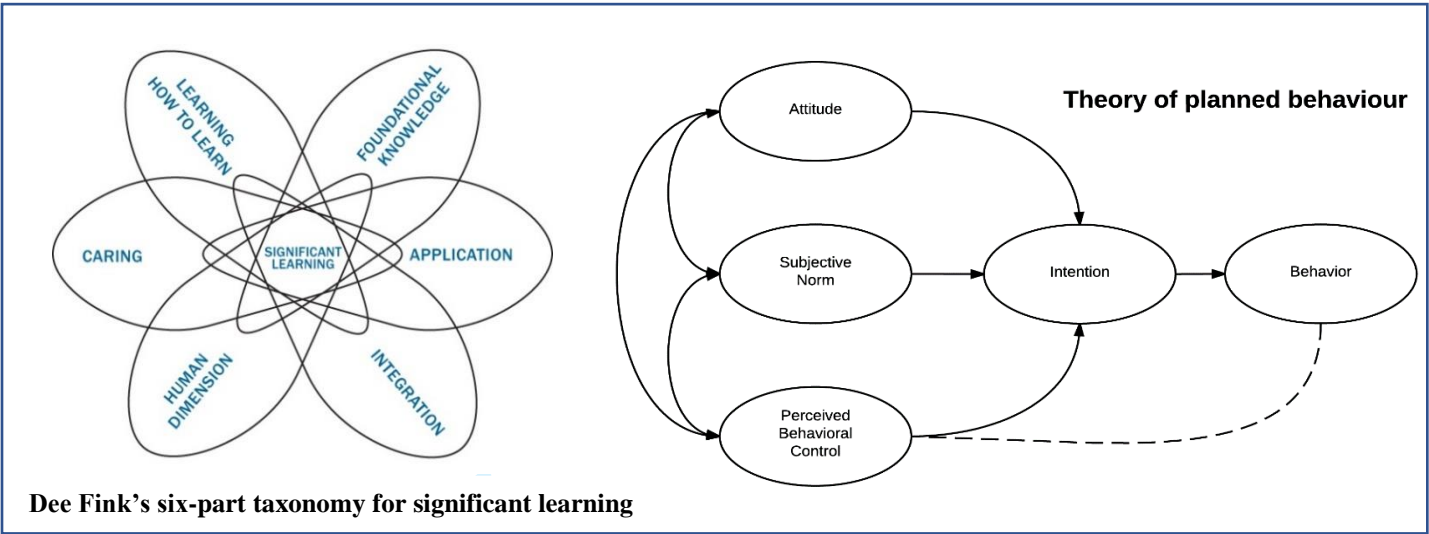


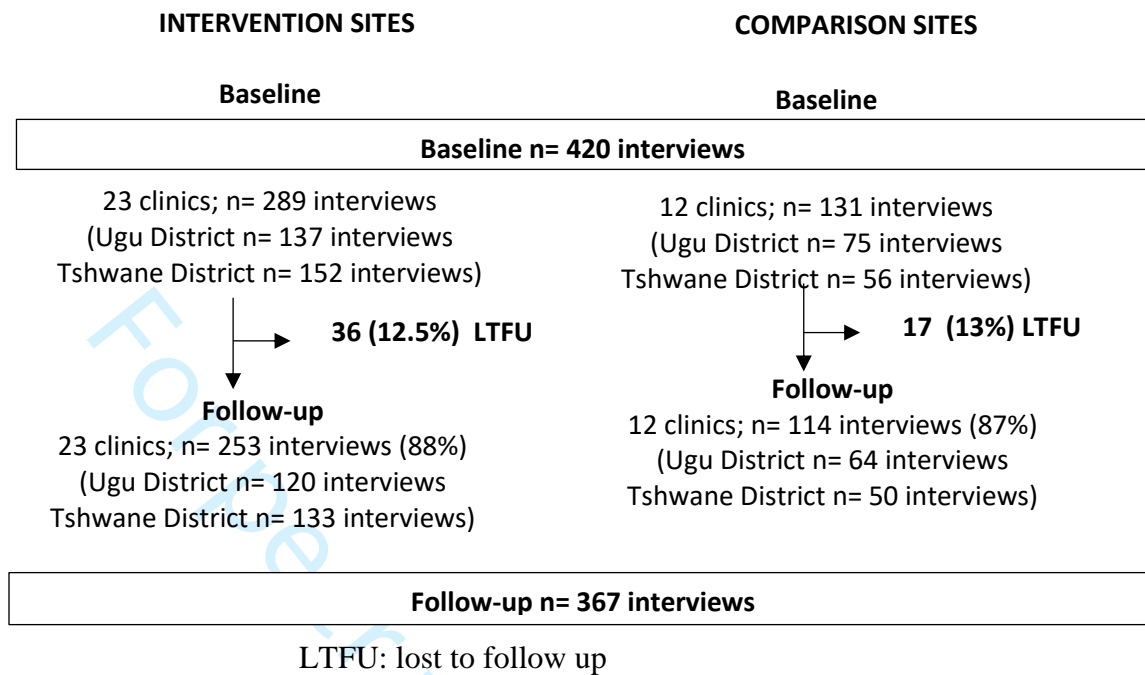
Figure 2: Theoretical frameworks which informed the development of the intervention



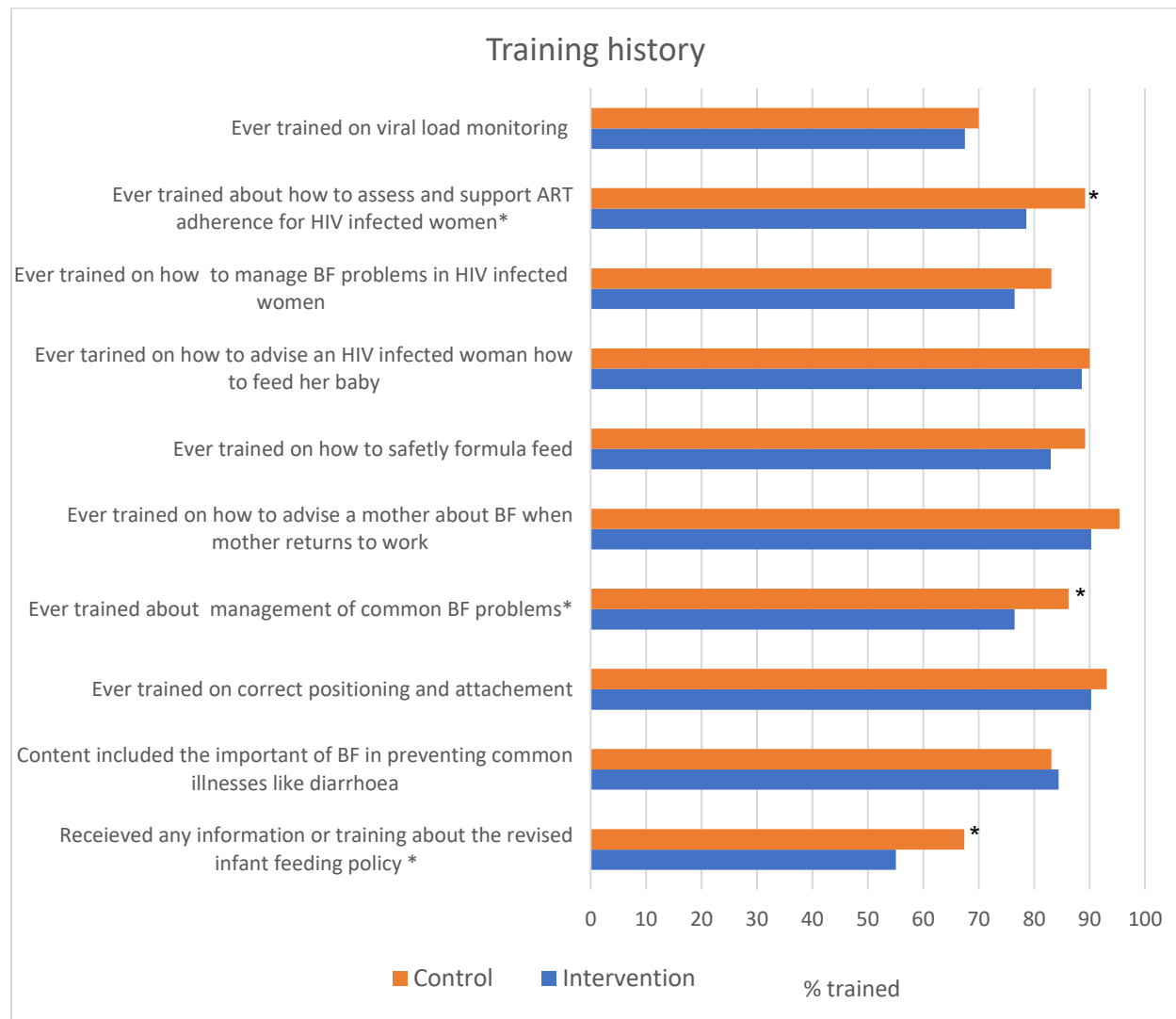
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**Figure 3: Study population at baseline and follow-up for intervention and comparison sites**



**Supplementary Figure 1: Prior training reported by participants at baseline (intervention versus comparison groups)**



\* $p < 0.05$

Abbreviations: ART= antiretroviral therapy; BF= breastfeeding

**Supplementary Table 1: Attitude scores of health workers at baseline and follow-up**

Attitude statements	Number (%) who agreed or strongly agreed with the statement at baseline			Number (%) who agreed or strongly agreed with the statement at follow-up		
	Intervention (n=289)	Comparison (n=131)	P-value *	Intervention (n=252)	Comparison (n=114)	p-value*
There have been so many changes to the infant feeding guidelines and breastfeeding guidelines however I am NOT confused about what to tell mothers who are HIV-infected about breastfeeding	155 (53.6)	74 (56.9)	0.59	175 (69.4)	65 (57.0)	0.02
When a baby cries all the time it is NOT usually because the baby is hungry and needs more food than just breastmilk	260 (90.0)	107 (83.0)	0.02	230 (91.3)	91(79.8)	<0.01
Exclusive breastfeeding in the first 6 months of life is the best choice for all mothers and babies in South Africa	256 (88.6)	114 (88.4)	0.65	239 (94.8)	98 (86.0)	<0.01
For an HIV-exposed infant any breastfeeding is better than no breastfeeding at all, as long as the mother is virally suppressed and on antiretroviral therapy	189 (65.4)	79 (61.2)	0.31	196 (77.8)	74 (64.9)	0.01
The benefits of breastfeeding for protecting children from illness such as diarrhoea and pneumonia outweighs the risk of acquiring HIV if the mother is on antiretroviral treatment	224 (77.5)	93 (72.1)	0.15	218 (86.5)	87 (76.3)	0.02
I feel that an HIV-infected mother who has not disclosed to her partner is NOT at high risk of non-adherence to ART and should NOT stop breastfeeding as soon as possible	128 (44.3)	51 (39.5)	0.30	137 (54.4)	46 (40.4)	0.01
I should support all mothers, regardless of HIV status, to continue breastfeeding until 2 years, as long as HIV-infected women are virally suppressed	237 (82.0)	101 (78.3)	0.24	237 (94.1)	87 (76.3)	<0.01
I should NOT advise an HIV-positive virally suppressed mother who has cracked and bleeding nipples to temporarily stop breastfeeding	80 (27.7)	40 (31.3)	0.55	97 (38.5)	24 (21.1)	<0.01
HIV-exposed babies who are PCR negative must NOT stop breastfeeding as soon as possible	238 (82.4)	104 (81.3)	0.47	221 (87.7)	95 (83.3)	0.26
Formula feeding is NOT the best choice for mothers living in good socio-economic circumstances who are going back to work	202 (70.0)	95 (74.2)	0.58	198 (78.6)	74 (64.9)	<0.01
For an HIV-positive mother on antiretroviral treatment and virally suppressed mixed feeding is better than not breastfeeding at all	39 (13.5)	15 (11.7)	0.56	57 (22.6)	16 (14.0)	0.06
Exclusive breastfeeding for six months is an achievable goal for the majority of mothers	249 (86.2)	105 (82.0)	0.11	227 (90.1)	96 (84.1)	0.11
It is safer for HIV-positive mothers to breastfeed than to formula feed	231 (79.9)	89 (69.5)	0.63	226 (89.7)	85 (74.6)	<0.01

In our community working mothers can successfully maintain exclusive breast feeding while going to work	219 (75.8)	89 (69.5)	0.09	208 (82.5)	92 (80.7)	0.67
An HIV-positive mother who is on ART and not virally suppressed and is mixed feeding is putting her child at risk of acquiring HIV	256 (88.6)	109 (85.2)	0.13	219 (86.9)	97 (85.1)	0.64
It is NOT very difficult for mothers to express breastmilk while they are at work or school	164 (53.0)	57 (44.5)	0.01	1689(67.1)	51 (44.7)	<0.01
If an HIV-positive mother can afford to buy formula it is NOT better for her to formula feed her baby	170 (58.8)	83 (64.9)	0.38	185 (73.4)	68 (59.7)	<0.01
Promoting breastfeeding for two years for HIV-exposed infants is NOT a risk because mothers will be able to maintain good ART adherence for that long	197 (68.2)	85 (66.4)	0.51	210 (83.3)	79 (69.3)	<0.01
In South Africa it is possible to improve exclusive breastfeeding rates	244 (84.7)	108 (84.4)	0.61	230 (91.3)	97 (85.1)	0.08
There are exceptional circumstances where an HIV-positive mother would be advised not to breastfeed, such as failure of 2 <sup>nd</sup> or 3 <sup>rd</sup> line ART treatment, but these are not common	225 (77.9)	93 (72.7)	0.13	201 (79.7)	87 (76.3)	0.46
Formula feeding is NOT more convenient for a mother than breastfeeding	253 (87.5)	109 (85.2)	0.23	211 (83.7)	100(87.7)	0.32
<b>Number (%) participants whose attitude was to at least agree (Attitude score <math>\geq</math>84)*</b>	<b>71 (24.6)</b>	<b>23 (17.9)</b>	<b>0.12</b>	<b>123 (49.2)</b>	<b>27 (24.1)</b>	<b>&lt;0.01</b>
<b>Mean attitude score out of 105 (95% CI)</b>	<b>76.9 (75.9 – 77.9)</b>	<b>75.0 (73.0 – 77.0)</b>	<b>0.07</b>	<b>82.7 (81.6 – 83.8)</b>	<b>76.8 (75.0 – 78.5)</b>	<b>&lt;0.01</b>

\*84 was the minimum score obtainable if a participant at least agreed with all statements

**Supplementary Table 2: Confidence statements of health workers at baseline and follow-up**

Confidence statements	Number (%) who felt confident or very confident at baseline			Number (%) who felt confident or very confident at follow-up		
	Intervention (n=289)	Comparison (n=131)	p-value	Intervention (n=252)	Comparison (n=114)	p-value
How confident do you feel about counselling an HIV-positive pregnant woman about how she will feed her baby	265 (91.7)	116 (88.6)	0.30	240 (95.2)	100 (87.7)	0.01
How confident do you feel about giving information about the risks and benefits of breastfeeding to an HIV-infected mother	268 (92.7)	120 (91.6)	0.67	238 (94.4)	102 (89.5)	0.09
How confident do you feel about assessing whether there is good positioning and attachment during breastfeeding	263 (91.0)	125 (95.4)	0.11	243(96.4)	107 (93.9)	0.27
How confident do you feel about advising an HIV-positive mother about how to continue to breastfeed her baby when she returns to work or school	258 (89.3)	117 (89.3)	0.99	242 (96.0)	101 (88.6)	<0.01
How confident do you feel about advising an HIV-infected mother who is virally suppressed who is mixed feeding her infant	243 (84.1)	113 (86.3)	0.57	226 (89.7)	99 (86.8)	0.43
How confident do you feel about advising an HIV-infected mother to continue breastfeeding for two years	216 (74.7)	105 (80.2)	0.23	236 (93.6)	93 (81.6)	<0.01
How confident do you feel about advising an HIV-infected mother about how to stop breastfeeding	214 (74.1)	89 (67.9)	0.20	188 (74.6)	86 (75.4)	0.87
How confident do you feel about advising an HIV-positive mother about starting complementary feeds	251 (86.9)	115 (87.8)	0.79	229 (90.9)	103 (90.4)	0.87
How confident do you feel about assessing ART compliance in an HIV-positive mother	240 (83.1)	111 (84.7)	0.67	230 (91.3)	94 (82.5)	0.02
How confident do you feel about identifying when an HIV-positive mother is not adhering to her ART treatment	224 (77.5)	104 (79.4)	0.67	218 (86.5)	90 (79.0)	0.07
How confident do you feel about reassuring a mother living with HIV who is virally suppressed that a shorter duration of breastfeeding is better than never initiating breastfeeding	227 (78.5)	103 (78.6)	0.99	215 (85.3)	96 (84.2)	0.78
How confident do you feel about explaining the risks of HIV transmission through breastmilk to an HIV-infected mother with high viral load	247 (85.5)	114 (87.0)	0.67	220 (87.3)	105 (92.1)	0.17
How confident do you feel about assisting a mother with HIV to safely formula feed her baby	212 (73.4)	102 (77.9)	0.33	191 (75.8)	95 (83.3)	0.11



How confident do you feel about advising an HIV-infected mother who is exclusively breastfeeding and has cracked nipples with bloody milk about how to feed her baby	196 (67.8)	84 (64.1)	0.45	201 (79.8)	80 (70.2)	0.04
How confident do you feel about using the guidelines for safe replacement feeding when you counsel a mother who is not adherent to ART and has a viral load above 1000 copies/ml	191 (66.1)	99 (75.6)	0.05	185 (73.4)	75 (65.8)	0.14
How confident do you feel about advising an HIV-infected mother who is exclusively breastfeeding and has defaulted from her ART about how to feed her baby	205 (70.9)	97 (74.1)	0.51	189 (75.0)	80 (70.2)	0.33
How confident do you feel about explaining to a mother about expressing and storing milk	269 (93.1)	124 (94.7)	0.54	237 (94.1)	109 (95.6)	0.54
How confident do you feel about managing poor ART compliance in an HIV-infected breastfeeding mother	215 (74.4)	104 (79.4)	0.27	209 (82.9)	89 (78.1)	0.27
A mother is not adherent to ART and her last viral load is 1000 copies per ml. How confident do you feel about counselling her about feeding her infant?	199 (68.9)	98 (74.8)	0.21	198 (78.6)	80 (70.2)	0.08
<b>Number (%) participants who were confident or very confident (Sum Score <math>\geq</math> 57)</b>	<b>164 (56.8)</b>	<b>86 (67.2)</b>	<b>0.09</b>	<b>175 (70.0)</b>	<b>72 (64.3)</b>	<b>0.28</b>
<b>Mean confidence score out of 76 (95% CI)</b>	<b>59.1 (58.0-60.2)</b>	<b>59.1 (57.0-61.3)</b>	<b>1.0</b>	<b>61.2 (60.8-63.1)</b>	<b>59.9 (58.1-61.7)</b>	<b>0.05</b>

# BMJ Open

## Translating new evidence into clinical practice: A quasi-experimental controlled before-after study evaluating the effect of a novel outreach mentoring approach on knowledge, attitudes and confidence of health workers providing HIV and infant feeding counselling in South Africa

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## Translating new evidence into clinical practice: A quasi-experimental controlled before-after study evaluating the effect of a novel outreach mentoring approach on knowledge, attitudes and confidence of health workers providing HIV and infant feeding counselling in South Africa

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### Key words:

## Abstract

**Objectives:** We report the effectiveness of a mentoring approach to improve health workers' knowledge, attitudes and confidence with counselling on HIV and infant feeding.

**Design:** A quasi-experimental controlled before-after study.

**Setting:** Primary health care clinics were randomly selected (n=24 intervention, n=12 comparison) from two districts, South Africa.

**Participants:** All health workers (HW) providing infant feeding counselling in selected facilities were invited to participate.

**Interventions:** three 1-2 hour, on-site workshops were conducted over 3-6 weeks.

**Primary outcome measures:** Knowledge, attitude and confidence scores (separately) scores. To estimate the effect of the intervention the sum of attitude or confidence scales were modeled using a linear regression. This allowed us to estimate the mean score difference between treatment groups post-intervention, adjusting for the mean score difference between groups at baseline. Analyses were adjusted for baseline characteristics of the participants and clustering at the health facility level.

**Results:** In intervention and comparison sites, respectively: 289 and 131 baseline and 253 and 114 follow-up interviews were conducted (August-December 2017). At baseline there was no difference in mean number of correctly answered knowledge questions (out of 22), but this differed significantly at follow-up (15.2 in comparison and 17.2 in intervention sites ( $p<0.001$ )). At follow-up, the mean attitude and confidence scores towards breastfeeding were significantly better in intervention sites versus comparison sites ( $p<0.001$  and  $p=0.05$ , respectively). Controlling for confounders, interactions between time and intervention status and pre-intervention values, attitude score was 5.1-points significantly higher for intervention compared with comparison groups.

**Conclusion:** A participatory, low intensity on-site mentoring approach to disseminating updated infant feeding guidelines improved HWs' knowledge, attitudes and confidence more than standard dissemination via a circular. Further research is required to evaluate the effectiveness, feasibility and sustainability of implementing such a mentoring approach at scale.

### Strengths and Limitations of this study:

1. Fieldwork was conducted in two geographically and historically different provinces, facilitating generalisability of results.
2. The intervention was participatory, low intensity, on-site and integrated into routine facilities.
3. Several types of analyses were conducted which all yielded congruent results.
4. However, limitations were that (i) we purposively selected districts for inclusion (ii) we could not control for HWs' personal breastfeeding experience as we did not gather these data (iii) the follow-up evaluation was undertaken 3 months after the intervention - thus, we measured short term benefits, and (iv) we did not measure the direct effect of improved HWs' knowledge, attitudes and confidence on health workers' counselling and mothers' infant feeding practices and (v) we did not co-design the intervention with women living with HIV.
5. The finding that knowledge scores amongst participants who attended 3 workshops were significantly better than knowledge scores amongst participants who attended less than 3

workshops, may simply reflect better motivation amongst attendees of more workshops, rather than the effect of the workshops themselves. We could not tease out these effects.

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### **Competing interests statement**

No author has declared any competing interests.

### **Introduction**

The benefits of breastfeeding in all settings, and particularly in low-middle income settings with high HIV prevalence, are undisputed.[1 2] Policies and clinical practice guidelines on preventing mother to child transmission of HIV (PMTCT) and infant feeding have undergone frequent evidence-based revisions. For example South African PMTCT policy and its accompanying infant feeding recommendations have been revised five times since 2001 (2008, 2010, 2013, 2015, 2019).[3-7]. Additionally, in 2011 a national infant feeding declaration withdrew free commercial infant formula as part of the PMTCT programme [8], and in 2017 the infant and young child feeding policy was updated to recommend that women living with HIV may continue breastfeeding for up to 24 months or longer (similar to the general population) while being fully supported for antiretroviral therapy (ART) adherence. This followed a 2016 World Health Organization (WHO) update which also stated that mixed feeding is not a reason to stop breastfeeding in the presence of ARV drugs.[9] However, a key gap is that these policies have not been effectively communicated to all health workers – a requirement of the Mother-Baby Friendly Initiative.[10 11] Health workers play a critical role in guiding infant feeding choices and sustaining infant feeding practices [11-13]; they wield power and authority [12 14] but their potentially positive influence on infant feeding is compromised by confusion over HIV and infant feeding, which has eroded their confidence.[11 13] Identifying and implementing optimal strategies to effectively disseminate updated guidelines have lagged behind. Multi-component dissemination strategies, which aim to increase the reach, ability and motivation of health workers, are more effective than one strategy alone.[15] However, in reality there are few published studies that inform guideline dissemination. Most of these are from high-income settings and may not be relevant to low-income settings which have unique challenges.[15]

Research has demonstrated that improving HWs' capacity can significantly improve their skills, self-efficacy and confidence to counsel, support and promote breastfeeding among women living with HIV.[16 17] Consequently, a key question was: What learning approach could best develop health worker capacity and confidence to implement the updated HIV and infant feeding guideline, using a methodology that is sustainable and feasible to implement at scale? Pedagogical research

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3 highlights the advantage of participatory training compared with standard didactic teaching for  
4 improving health worker skills.[18 19] Thus, we sought to determine whether a participatory  
5 outreach mentorship approach to disseminate the updated HIV and infant feeding guidelines, using  
6 simple low-technology activities, improves health workers' knowledge of, attitudes towards and  
7 confidence with counselling on HIV and infant feeding. We chose to focus on health workers  
8 knowledge, attitudes and confidence as health workers in South Africa consider themselves as  
9 advocates for babies. [20] Additionally, they are one of the key influential groups in the complex  
10 socio-ecology of infant feeding. [12 13 21 22]

## 13 **Methods**

### 14 **Study design**

15 A quasi-experimental before-after design with intervention and comparison sites was used. Two  
16 purposively-selected districts (Ugu and Tshwane District) in South Africa in each of two  
17 geographically disparate provinces, KwaZulu-Natal (KZN) and Gauteng (Figure 1), were  
18 included. Both provinces experienced a policy change in June 2017, when the 2013 South African  
19 Infant and Young Child Feeding Policy was amended to align with the 2016 WHO/UNICEF  
20 update on HIV and Infant feeding guideline.

### 23 **Sampling**

24 In Ugu District all four sub-districts were selected; within Tshwane District two of the seven  
25 service delivery regions were randomly selected.

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30 Twelve intervention and six comparison primary health care clinics were randomly sampled in  
31 Ugu District and Tshwane District (separately). Only clinics with above the median number of  
32 annual clinic visits for children under-5 years in the district were eligible for inclusion in the  
33 sampling frame. The comparison clinics served to capture any temporal changes in health worker  
34 knowledge, confidence and attitudes due to other interventions or trainings; hence a smaller sample  
35 was required in comparison versus intervention sites as the latter required more precise estimates  
36 of the intervention effect. A two-stage process was used to recruit participants. Firstly, research  
37 staff explained the study and participant inclusion and exclusion criteria to each facility manager  
38 during face-to-face on-site introductory meetings. The facility manager compiled a list of all  
39 eligible health workers involved in the care of pregnant women and children, including nurses,  
40 midwives, visiting doctors, lay counsellors, dieticians, nutritionists, facility managers and  
41 community health workers (CHWs). In the second stage, research staff approached eligible health  
42 workers and invited them to participate in the research. We aimed to recruit a manageable size of  
43 8-10 health workers per clinic for participation in the intervention, and in the evaluation. The same  
44 staff were approached for the baseline and follow-up evaluations.

### 46 **Sample size**

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48 The sample size was determined based on 80% power and alpha 0.05 to measure a 15-percentage  
49 points difference in health worker confidence in HIV and infant feeding counselling between the  
50 intervention and comparison clinics comparing baseline and follow-up. The expected effect was  
51 based on the researchers' experience and data from recent studies in South Africa with the baseline  
52 level of high confidence to counsel HIV-positive women on breastfeeding duration set at 45%.[23]  
53 It was assumed that the confidence score would remain unchanged in the comparison clinics,



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3 implying a two-sample test in the post-intervention period. Clinic-level analyses were used for the  
4 sample size calculations, assuming a sampling ratio of 2:1 for the intervention clinics and a  
5 standard deviation of 15% in the mean score between clinics. Based on these assumptions, and  
6 adjusting for clustering, the sample size was determined to be 24 intervention clinics and 12  
7 comparison clinics.[24] Within the intervention and comparison clinics, all health workers  
8 (nurses, midwives, visiting doctors, lay counsellors, dieticians, nutritionists, facility managers and  
9 community health workers (CHWs)), involved in caring for pregnant women and children were  
10 invited to participate in the study - we anticipated a mean number of health workers per  
11 participating facility to be 8-10.  
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### 17 **Description of the intervention**

18 We designed a participatory intervention comprising on-site mentoring through three workshops  
19 in each clinic, involving 303 selected health workers who provide care for pregnant women,  
20 breastfeeding mothers and their infants. This mentoring approach had five distinct features: 1) on-  
21 site: learning occurred in context 2) open to all cadres of health workers; 3) team-based;  
22 participants learned together; 4) content was led by self-identified gaps in knowledge and 5)  
23 activities were piloted and rooted in a theoretical framework. The intervention was delivered by  
24 the same trained facilitator (a nurse in Gauteng and nutritionist in KZN) in each intervention clinic.  
25 Each workshop lasted 1-2 hours over a 3-6-week period and had well-defined learning outcomes.  
26 The intervention has been described elsewhere.[25] In summary, our participatory intervention  
27 was guided by evidence that health workers' attitudes and practices are influenced by various  
28 factors, not just exposure to training and information.[26] We used Dee Fink's six part taxonomy  
29 as a guiding theory. This proposes that significant learning only occurs by developing foundational  
30 knowledge, applying skills, integrating ideas, developing new feelings/interests and values, and  
31 learning how to learn (encouraging the spirit of enquiry) (Figure 2).[27] Additionally, we applied  
32 the theory of planned behaviour to the intervention design (Figure 2).[28 29] This states that an  
33 individual's intention to perform a behaviour is influenced by the person's attitudes towards  
34 performing the behaviour, their beliefs about whether people who are important to them will  
35 approve of the behaviour (subjective norms), and their beliefs about how likely they are to be able  
36 to implement the behaviour successfully. According to this theory, if health workers are to provide  
37 infant feeding counselling and support in accordance with updated infant feeding guidelines to  
38 HIV-positive or negative mothers, they need to agree with the change, believe that their colleagues  
39 and other stakeholders will approve of the action, and believe in their ability to implement it  
40 successfully. The workshops were tailored to achieve these goals: Workshop 1 covered knowledge  
41 gaps reported by participants, controversial statements, and advantages of breastfeeding.  
42 Following workshop 1, a poster or cards with key messages were placed in a prominent place in  
43 the clinic. Workshop 2 comprised a progressive case study discussed in small groups. Workshop  
44 3 involved one-to-one mentorship: each participant was observed providing infant feeding  
45 counselling or a case study was discussed if no mothers were available for counselling. The same  
46 facilitator conducted all three workshops at each clinic. In addition, a WhatsApp cell phone  
47 messaging group was established to support participants in intervention sites to facilitate sharing  
48 of concerns, tips for counselling and dealing with difficult situations. Key messages were posted  
49 on the group approximately weekly. Comparison and intervention sub-districts were exposed to  
50 routine supervision and training activities that took place at district level. The study team  
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documented that the June 2017 circular issued by the National Department of Health, informing health facilities of the change in Infant and Young Child feeding policy, was disseminated to comparison clinics as an announcement via e-mail and other electronic communication as well as during meetings or trainings. We documented that in Tshwane, 15 of the 18 clinics had received the circular; 11 via e-mail and three at a meeting. In Ugu nine of 17 clinics had received the circular; 8 received it via hand delivery and one via e-mail.

### **Patient and Public Involvement**

Patients and the public were not involved in the design of this study, as the main population of interest were health workers.. The intervention and tool were piloted amongst a separate group of health workers to determine length, complexity of questions and level of understanding. These details are explained in our intervention paper.[25]

### **Data collection**

Data were collected between August and December 2017 by dedicated trained non-nurse data collectors who were independent of the intervention staff. As per study design, data collection staff were not part of any intervention activities and had never been exposed to the intervention. The primary outcome measure for the study was confidence level of health workers to counsel on infant feeding, evaluated using a Likert-scale tool, developed after reviewing the WHO Breastfeeding Counselling Course, and the WHO HIV and Infant feeding counselling courses.[9 30-33].Secondary outcomes included health worker knowledge and attitude about breastfeeding counselling. A baseline assessment amongst all participating health workers in intervention and comparison sites was undertaken prior to the start of the intervention (August 2017). Health workers self-completed the assessment on study-provided electronic tablets at their workplaces. Questions covered basic demographic information, types of activities undertaken at work, knowledge, attitudes and confidence around counselling on infant feeding. Approximately 12 weeks after the baseline assessment, a follow-up assessment using the same tool was conducted amongst the same group of health workers. Health workers who were not in the clinic on the day of the follow-up assessments were included in a special catch-up assessment. Questionnaire software had built in range and skip logic and data were transferred automatically to a database held at the University of KwaZulu-Natal.

### **Data analysis**

There were three outcomes in the study: a) 22 knowledge statements which were scored 1 if correctly answered and 0 if not; evaluation of answers were based on existing literature and guidelines (binary outcomes); b) 21 attitude questions whose responses were measured on a 5-point Likert scale - given as completely disagree (1); disagree (2); neutral (3); agree (4) and completely agree (5); positive attitudes received higher scores; and c) 19 statements on confidence item questions which were also measured on a Likert scale, scored as such: not at all confident (1), not confident (2), confident (3) and very confident (4). For both attitude and confidence domains, a participant outcome was measured by the sum of the responses to the respective items (we verified that there was not a missing response on the items). Thus, the ranges for the attitude and confidence scores were 21 to 105, and 19 to 75, respectively.

Participants baseline and follow-up characteristics and outcomes between the intervention and control areas were compared using Chi-squared tests for categorical variables and two-sample t

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3 tests for continuous measures, after confirming that data were normally distributed. To assess the  
4 effect of the proposed intervention, several analysis methods for comparing intervention effect in  
5 before (pre)-after (post) quasi-experimental designs were considered. These included using post-  
6 measures and change from pre-intervention to post-intervention as the response variables. These  
7 approaches that use change and post measurements as the outcome, adjusting for pre-intervention  
8 measurements are recommended, and often give similar results.[34] In this paper, we considered  
9 three methods for estimating and testing the intervention effect using the sum of individual attitude  
10 or confidence scores as an outcome variable in a linear regression. The first method used the post-  
11 intervention measurements as the outcome variable, but adjusted for the pre-intervention values;  
12 The second method analysed the change score as an outcome variable adjusting for pre-treatment  
13 values. The third method analysed the vectors of pre-and post-measurements as the outcome  
14 variable, and used time (coded : 1 at follow-up and 0 at baseline) and treatment (coded:1  
15 intervention group and 0: comparison group) as a covariates with an interaction term for time and  
16 treatment, in addition to an adjustment for pre-treatment values). Using methods 1 and 2 the  
17 coefficient for the intervention estimated the differences in the post intervention means and  
18 differences in the mean change of sum scores mean between the groups, controlling for the pre-  
19 intervention measurement. Using the third method, the sum of coefficients of intervention and the  
20 interaction terms was taken as the mean difference between groups post-treatment, allowing for  
21 pre-treatment mean differences between the groups. All analyses also controlled for baseline  
22 participant characteristics and prior training. Analyses adjusted for possible clustering effect at  
23 the site level, using a variance-correction method.[24] Data can be obtained by e-mailing the  
24 corresponding author.  
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### 31 **Ethics**

32 Ethics approval was obtained from the South African Medical Research Council (EC028-9/2016),  
33 the University of KwaZulu-Natal (RECIP348/17) and the WHO Ethics Review Committee  
34 (ERC0002833). Permission for undertaking the study was obtained from Tshwane and KZN  
35 Districts. Informed consent was sought from all study participants and no personal identifying  
36 information was captured in the questionnaires, only a study identification number.  
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### 40 **Results**

41 At baseline and follow-up, 23 intervention clinics (one large clinic was sampled twice with two  
42 rounds of data collection per time point) and 12 comparison clinics were visited; 289 and 131  
43 health worker interviews were conducted at baseline in intervention and comparison clinics,  
44 respectively (Figure 3). Loss to follow-up between baseline and follow-up did not differ between  
45 intervention and comparison sites: 17 (13%) in comparison sites versus 36 (12.5%) in intervention  
46 sites.  
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48 Tshwane and Ugu Districts did not differ in the main outcome measures at baseline (knowledge,  
49 attitude and confidence). Additionally, they were similar in all health worker characteristics except  
50 three: Tshwane had significantly more participants with less than 2 years employment (14.4%  
51 versus 6.2%,  $p=0.007$ ), more registered nurses (57% versus 26.2%,  $p=0.02$ ), and fewer lay  
52 counsellors/CHWs (7.3% versus 50.0%, respectively,  $p=0.02$ ). Given the lack of significant  
53 difference in the main outcome variables at baseline, data from the two sites were combined for  
54 the analysis.  
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4 All staff approached agreed to participate in the interviews. There were no significant differences  
5 between intervention and comparison sites at baseline, regarding district of origin, median age of  
6 respondent, gender, cadre of health worker, and working duration (Table 1). The proportion of  
7 participants who had received previous training (through the routine health system) on specific  
8 topics was similar in intervention versus comparison sites, except for three topics which had better  
9 coverage in comparison sites (Supplementary Figure 1). These were: ever trained on how to assess  
10 and support ART adherence for HIV positive women (78.6% in intervention sites versus 89.2% in  
11 comparison sites,  $p=0.01$ ); ever trained about managing breastfeeding problems (76.5% in  
12 intervention sites and 86.2% in comparison sites,  $p=0.02$ ); and received any information or training  
13 about the revised infant feeding policy (55.1% in intervention sites versus 67.4% in comparison  
14 sites  $p=0.02$ ). At baseline, activities around breastfeeding counselling and management were  
15 similar between comparison and intervention sites in all respects except that comparison site  
16 participants reportedly spoke more frequently to HIV positive pregnant women about feeding than  
17 intervention participants (67% versus 71.6% spoke more than 1-3 times per month,  $p=0.04$ , data  
18 not shown).  
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**Table 1: Characteristics of the participants in the intervention and comparison groups at baseline**

Characteristic	Intervention group (n=289) (N (%))	Comparison group (n=131) (N (%))	p-value
<b>District:</b>			
- Tshwane	152 (52.6)	56 (42.8)	0.06
- Ugu	137 (47.4)	75 (57.3)	
<b>Age categories:</b>			
- 23 to 35 years	56 (19.4)	38 (29.7)	0.11
- 36 to 41 years	61 (21.2)	25 (19.5)	
- 42 to 46 years	53 (18.4)	26 (20.3)	
- 47 to 54 years	64 (22.2)	18 (14.1)	
- Over 54 years	54 (18.8)	21 (16.4)	
<b>Gender</b>			
- Female	267 (92.7)	118 (91.5)	0.66
- Male	21 (7.3)	11 (8.5)	
<b>Cadre of health worker</b>			
- Community level worker	84 (29.5)	52 (40.0)	0.05
- Trained health professional*	151 (53.0)	64 (49.2)	
- Enrolled nurse	50 (17.4)	14 (10.8)	
<b>Work experience in year (yr)/ years (yrs)</b>			
- Less than 1 yr	4 (1.4)	3 (2.3)	0.20
- 1 to <2 yrs	23 (8.0)	12 (9.3)	
- 2 to less than 5 yrs	36 (12.5)	18 (14.0)	
- 5 to less than 10 yrs	71 (24.7)	43 (33.3)	
- 10 yrs or more	154 (53.5)	53 (41.1)	

Abbreviations: \*includes 68% nurses in the intervention arm and 58% nurses in comparison arm. This group also includes operation managers, dieticians, doctors and nutritionists.

In intervention sites, workshops were attended by 84-88% of participants interviewed at follow-up (Table 2).

**Table 2: Attendance at workshops 1-3 measured at follow-up in intervention sites**

	Attended workshop n	Attended catch-up n	Total attended n/N (%)
<b>Number of staff attending each workshop:</b>			
Group workshop 1	202	63	265/303 (87.5)
Group workshop 2	223	34	257/303 (84.8)
Workshop 3 (Clinical mentoring)	216	40	256/303 (84.5)
<b>Number of workshops attended:</b>			
	number	%	
No workshop	42	13.9	
1 workshop	8	2.6	
2 workshops	6	2.0	
All 3 workshops	247	81.5	
<b>Total</b>	<b>303</b>	<b>100</b>	

## Effect of the intervention on health worker knowledge

At baseline, knowledge about key infant feeding statements or facts was similar between intervention and comparison sites, except for knowledge about soft porridge (Table 3). Although at baseline, more than 90% of intervention and comparison site participants knew that a baby under 4 months should not be given soft porridge if hungry, significantly more intervention site participants knew this recommendation (Table 3). The percentage of participants at baseline correctly answering the more difficult questions (on bottle sterilisation, storing expressed breastmilk, feeding HIV exposed infants) was low (Table 3). At follow-up significantly more intervention site participants correctly answered knowledge questions, regarding the leading cause of death in children under 5, the risk of formula feeding, duration of breastfeeding for HIV-negative mothers and women living with HIV, how to stop breastfeeding, complementary feeding, storing expressed breastmilk, feeding whilst at work, breastfeeding and viral suppression, mixed feeding in women living with HIV, adherence to ART and breastfeeding, breastfeeding difficulties in women living with HIV and managing women living with HIV who are breastfeeding, than comparison site participants (Table 3). The significant differences between intervention and comparison sites regarding soft porridge were not present at follow-up. Although improvements were seen in knowledge related to the risks of mixed feeding for women living with HIV, most health workers still provided incorrect responses at follow-up. At baseline, the mean number of correctly answered knowledge questions was 15.0 (68%) in comparison sites versus 15.2 (69%) in intervention sites,  $p=0.89$  (Table 3). At follow-up the mean number was 15.2 (69%) in comparison sites and 17.2 (78.2%) in intervention sites,  $p<0.001$  (Table 3). For the two questions measuring knowledge about the 2017 change in infant feeding guidelines, namely, “Continued breastfeeding for 2 years is the recommended infant method in SA for ALL children, regardless of mother’s HIV status” and “In South Africa, HIV-infected women who are breastfeeding should be supported to adhere to antiretroviral treatment and should introduce complementary foods at 6 months and be supported to continue breastfeeding for at least two years. (True)”, there was a 36% improvement in knowledge in the intervention group at follow-up compared with a 13% increase in knowledge in the control group. For the second question there was a 15% increase in correct knowledge in the intervention group at follow-up while for the comparison group knowledge decreased from 89-81%. At follow-up, knowledge scores of participants who attended 3 workshops compared with knowledge scores of participants who attended less than 3 workshops was significantly better ( $p<0.001$ ).

**Table 3: Knowledge of health workers about breastfeeding in the intervention and comparison sites at baseline and follow-up**

Knowledge statements	Number (%) with correct answers at BASELINE			Number (%) with correct answers at FOLLOW-UP		
	Intervention (n=289)	Comparison (n=131)	P-value *	Intervention (n=250)	Comparison (n=112)	P-value *
<b>Knowledge relating to updates in the HIV and Infant feeding guidelines</b>						
<i>Significant improvements between intervention and comparison groups at follow-up</i>						
Continued breastfeeding for 2 years is the recommended infant method in SA for ALL children, regardless of mother's HIV status (True) <sup>†</sup>	190 (65.7)	91 (70.0)	0.39	224 (89.6)	88 (78.6)	<0.01
An HIV-positive mother who is virally suppressed on antiretroviral treatment should breastfeed her child rather than not breastfeed to improve the child's survival (True) <sup>†</sup>	237 (82.0)	108 (83.1)	0.79	236 (94.4)	96 (85.7)	<0.01
A mother who has missed 6 tablets of Fixed Dose Combination ART in one month is considered to be poorly adherent and should stop breastfeeding immediately (False)** <sup>†</sup>	181 (62.6)	89 (68.5)	0.25	201 (80.4)	72 (64.3)	<0.01
In South Africa, HIV-infected women who are breastfeeding should be supported to adhere to antiretroviral treatment and should introduce complementary foods at 6 months and be supported to continue breastfeeding for at least two years. (True) <sup>†</sup>	245 (84.8)	116 (89.2)	0.220	244 (97.6)	91 (81.3)	<0.01
When an HIV-infected mother is ready to add complementary feeds she should stop breastfeeding rapidly over a 24-hour period (False) <sup>†</sup>	214 (74.1)	103 (79.2)	0.25	217 (86.8)	86 (76.8)	<0.05
If a mother misses 2 doses of her ART in one month, she should be classified as a treatment failure (False)** <sup>†</sup>	185 (64.0)	82 (63.1)	0.85	191 (76.4)	73 (65.2)	<0.05
<i>Low levels of knowledge (&lt;80%) at baseline in both groups - – no significant differences between intervention and comparison groups at follow-up [concept that this relates to]</i>						
If an HIV exposed baby is receiving both breastmilk and formula milk, the mother should choose either breastfeeding or formula feeding if she is adherent to ART (False) <sup>†</sup> [mixed feeding with formula and breastmilk]	69 (23.9)	29 (22.3)	0.71	75 (30.0)	28 (25.0)	0.33
A mother living with HIV and adherent to antiretroviral treatment cannot exclusively breastfeed her 4-month old infant because she is working. It is better for this mother to give formula during the day and breastfeed at night rather than giving no breast milk at all (True) <sup>†</sup> [mixed feeding with formula and breastmilk]	22 (7.6)	14 (10.8)	0.29	40 (16.0)	14 (12.5)	0.38

<b>High levels of knowledge (<math>\geq 80\%</math>) at baseline in both groups – no significant differences between intervention and comparison groups at follow-up</b>						
In South Africa, HIV-infected women who are breastfeeding should be supported to adhere to antiretroviral treatment and should be counselled and supported to exclusively breastfeed their infants for the first six months of life whilst maintaining an undetectable viral load (True) <sup>†</sup>	281 (97.2)	123 (94.6)	0.18	242 (96.8)	109 (97.3)	0.79
Mothers living with HIV who are receiving antiretroviral treatment and are virally suppressed should be advised not to breastfeed their infants (False) <sup>†</sup>	252 (87.2)	115 (88.5)	0.85	230 (92.0)	99 (88.4)	0.27
<b>General breastfeeding</b>						
<b>Significant improvements between intervention and comparison groups at follow-up</b>						
In South Africa, the leading cause of death amongst children under 5 is pneumonia (True)	189 (65.4)	82 (63.1)	0.65	230 (92.0)	75 (67.0)	<0.01
Giving any formula milk during the first six months of life increases the risk of death from diarrhoea and/or pneumonia (True)	246 (85.1)	104 (80.0)	0.17	232 (92.8)	95 (84.8)	0.02
It is safe to give the baby expressed breastmilk that has been kept outside the fridge for 8 hours (True)	106 (36.7)	43 (33.1)	0.48	120 (48.0)	38 (33.9)	<0.05
A mother who is working and giving formula milk should mix the milk herself and leave for the carer to give during the day (False)	218 (75.4)	94 (72.3)	0.50	189 (75.6)	68 (60.7)	<0.01
<b>Low levels of knowledge (&lt;80%) at baseline in both groups - – no significant differences between intervention and comparison groups at follow-up</b>						
When sterilising feeding bottles cover the bottles with water in a saucepan and place on the heat. As soon as the water boils remove from heat and do not leave the bottles in the water until completely cool (False)	64 (22.2)	27 (20.8)	0.75	53 (21.2)	25 (22.3)	0.81
<b>High levels of knowledge (<math>\geq 80\%</math>) at baseline in both groups – no significant differences between intervention and comparison groups at follow-up</b>						
Exclusive breastfeeding is the recommended infant feeding method for ALL infants aged 0-6 months in SA, regardless of mother's HIV status (True)	271 (93.8)	118 (90.8)	0.27	234 (93.6)	102 (91.1)	0.32
A baby under 4 months should be given soft porridge once he/she seems hungry (False)	284 (98.3)	124 (95.4)	0.09	247 (98.8)	108 (96.4)	0.13
Giving a baby expressed breastmilk is not as good as breastfeeding (False)	234 (81.0)	106 (81.5)	0.89	218 (87.2)	96 (85.7)	0.70
There are long term health benefits of breastfeeding for mother and child that last beyond the breastfeeding period (True)	264 (91.4)	116 (89.2)	0.49	232 (92.8)	100 (89.3)	0.26



<b>Breastfeeding and HIV</b>						
<i>Significant improvements between intervention and comparison groups at follow-up</i>						
An HIV-positive mother who has cracked nipples should continue to breastfeed unless they are bleeding (True)	143 (49.5)	64 (49.2)	0.96	187 (74.8)	59 (52.7)	<0.01
If a baby has a positive PCR (HIV test) at birth the mother should stop breastfeeding if this is affordable and feasible in her situation (False)**	224 (81.0)	100 (76.9)	0.90	214 (85.6)	82 (73.2)	<0.01
<i>High levels of knowledge (&lt;80%) at baseline in both groups – no significant differences between intervention and comparison groups at follow-up</i>						
An HIV-exposed baby who is exclusively breastfeeding should be given some water when the weather is very hot (False)**	270 (93.4)	122 (93.9)	0.87	239 (95.6)	105 (93.8)	0.45
<b>Mean knowledge score (standard deviation) out of 22</b>	<u>15.2 (2.6)</u>	<u>15.0 (3.1)</u>	<u>0.61*</u>	<u>17.2 (2.1)</u>	<u>15.2 (2.8)</u>	<u>&lt;0.01</u>

\*\*The Statement is false; thus, the scales were inverted during data analysis. † these questions measure the change in knowledge relating to the South African Department of Health June 2017 circular and the WHO 2016 updated HIV and Infant feeding guidelines

\*independent t-test comparing intervention and comparison sites at the relevant time point.

Note: the tables displays numbers with correct knowledge

### Effect of the intervention on attitudes

At baseline, intervention and comparison sites were similar in HW attitudes except for attitudes towards feeding a crying baby and expressing breastmilk, which were significantly better in intervention sites (Supplementary Table 1). At follow-up attitudes to breastfeeding and HIV were significantly better in the intervention group for 13 of the 21 questions and the mean attitude score towards breastfeeding was significantly better in intervention sites ( $p < 0.001$ ) (Supplementary Table 1). At follow-up HW in the intervention group were significantly less confused about what to tell women living with HIV about infant feeding mothers about HIV and infant feeding. All three analysis methods demonstrated that, after controlling for other variables, final attitude (measured as attitude at follow-up, change in attitude between intervention and comparison sites or change in attitude between baseline and follow-up between intervention and comparison sites) was significantly better in intervention compared with comparison sites (Table 4). The first two methods yielded almost exactly the same results. In methods 1 and 2, attitude at follow-up was 5.4 points higher in the intervention group than the comparison group; Method 3 analysis showed a significant 5.1-point higher score in the intervention compared with the comparison group. Using method 1, being an enrolled nurse, and being in the youngest (36-41 years) or oldest (>54 years) age group was associated with a significantly lower attitude score. Results from application of methods 3 show that trained health professionals had a significantly higher attitude score at follow-up (Table 4,  $p < 0.05$ ). We did not detect a dose-association in intervention sites when comparing 0-1 or 1-2 versus 3 workshops ( $p = 0.4$ ); but numbers in each group may have been too small to reliably assess any dose effect.

**Table 4: Adjusted effect of the intervention on health worker attitude score using different methods (Effect estimate and 95% confidence interval (CI))**

Variable	Method 1		Method 3	
	Effect estimate	95% CI	Effect estimate	95% CI
Attitude score at baseline	0.5	0.3; 0.7*	N/A	N/A
Intervention	5.4	3.9; 6.9*	5.1	2.1; 8.1*
Follow-up Period	N/A	N/A	1.8	0.2-3.4*
<b>Professional role: vs community level</b>				
- Trained health professional	1.6	-0.05; 3.2	4.8	2.8; 6.7*
- Enrolled nurse	-2.4	-5.0; -0.2*	0.9	-1.4; 3.2
<b>Ugu District vs Tshwane District</b>	-0.83	-2.2; 0.5	-1.4	-3.1; 0.2
<b>Age category: vs 23-35 yrs</b>				
- 36 to 41 yrs	-2.8	-5.4; -0.2*	-1.8	-4.1; 0.6
- 42 to 46 yrs	-0.9	-3.3; 1.5	-0.2	-2.5; 2.2
- 47 to 54 yrs	0.5	-2.0; 2.9	-1.2	-3.1; 0.8
- over 54 yrs	-3.3	-5.7; -1.0*	-2.2	-4.8; 0.3
<b>Work experience &lt;5 yrs vs ≥5yrs</b>	-0.3	-2.5; 1.9	-1.3	-3.4; 0.8
<b>Received training or information at work about the revised policy</b>	0.5	-1.4; 2.3	1.7	0.1-3.24
<b>Received any training about managing common breastfeeding problems?</b>	0.3	-2.5; 3.0	3.2	0.9-5.5
<b>Ever received any training about how to assess and support ART adherence for HIV positive women?</b>	-0.1	-2.2; 2.0	1.6	-0.5-3.8

\*p<0.05 N/A: not applicable. Note: All analyses are adjusted for clustering

### Effect of the intervention on confidence

At baseline there was no difference in the percentage of participants in the intervention and control sites who were confident or very confident in counselling mothers on HIV / infant feeding (Supplementary Table 2). However, at follow-up HWs from intervention sites were significantly more confident in counselling an HIV positive women about HIV and infant feeding, advising HIV positive women about return to school/work, advising HIV positive mothers to continue breastfeeding for two years, assessing ART adherence in HIV positive mothers, and advising HIV positive mothers about breastfeeding with cracked nipples (Supplementary table 2). Confidence had not shifted about how to stop breastfeeding, identifying when a mother is not ART adherent and managing poor adherence, advising on formula feeding and counselling that a shorter breastfeeding duration is better than no breastfeeding. The mean confidence score at follow-up was significantly higher in the intervention compared with the comparison sites at follow-up (p=0.05) (Supplementary Table 2). All three analysis methods demonstrated that confidence was significantly better in intervention compared with comparison sites (Table 5). Analysis based on method 1 (Table 5), showed that confidence at follow-up was 2.4 points higher in the intervention arm than the comparison arm. In However, under method 3 (Table 5), the estimate of the effect

was not significant, though it was 1.5 point higher score in the intervention compared with the comparison group, (Table 5). Our analysis demonstrated that, controlling for other factors, being a trained health professional significantly increased confidence score by 3.1 (Method 1) or 3.7 (Method 3). Additionally, Methods 3 demonstrated that, controlling for other factors, working for less than 5 years significantly reduced the confidence score. We did not measure a dose-effect (one or two versus three workshops ( $p=0.4$ )); but numbers in each group may have been too small to assess this.

**Table 5: Adjusted effect of the intervention on health worker confidence scores, using different multivariable analysis methods (Effect estimate and 95% confidence interval (CI))**

Variable	Method 1		Method 3	
	Effect estimate	95% CI	Effect estimate	95% CI
Confidence score at baseline	0.4	0.3; 0.6*	N/A	N/A
Intervention	2.4	0.3; 4.5*	1.5	-2.2; 5.1
Follow-up time	N/A	N/A	0.5	-1.5; 2.5
<b>Cadre of health professional: vs community level</b>				
- Trained health professional	3.1	0.3; 5.9*	3.7	1.5; 5.9*
- Enrolled nurse	-0.8	-4.3; 2.7	-0.7	-3.1; 1.6
<b>Ugu District vs Tshwane District</b>	0.00	-2.1; 2.1	-1.	-3.2; 1.2
<b>Age category vs 23-35 yrs</b>				
- 36 to 41 yrs	-1.0	-3.7; 1.6	-0.1	-2.7; 2.5
- 42 to 46 yrs	0.3	-2.9; 3.4	0.4	-1.2; 2.9
- 47 to 54 yrs	1.4	-0.7; 3.5	-1.3	-3.4; 0.8
- over 54 yrs	-2.5	-5.7; 0.7	-0.9	-4.0; 2.2
<b>Work experience &lt;5 yrs vs ≥5 yrs</b>	-0.5	-3.4; 2.4	-1.9	-3.7; -0.2*
<b>Received training or information at work about the revised policy</b>	0.05	-1.5; 1.6	1.7	-0.3; 3.6
<b>Received any training about managing common breastfeeding problems?</b>	-0.6	-3.2; 2.1	1.8	-0.5; 4.1
<b>Ever received any training about how to assess and support ART adherence for HIV positive women?</b>	0.8	-2.1; 3.7	5.7	3.5; 7.9

\* $p<0.005$  N/A= not applicable yrs= years. NB: All analyses are adjusted for clustering

## Discussion

We demonstrate that a participatory, side-by side, team-based mentoring approach to disseminating updated HIV and infant feeding guidelines was associated with an improvement in health workers' attitudes. when controlling for other factors. There was also a significant improvement in mean knowledge score between intervention and control sites at follow-up. However, we were not successful in shifting knowledge and attitudes about mixed feeding

(breastmilk and formula milk) and health workers at the end of the study were not confident in advising that a shorter duration of breastfeeding is better than no breastfeeding at all. This demonstrates the success of at least 15 years of frequent publicity about the dangers of mixed feeding in the context of HIV and no ART, given that the two seminal papers on feeding practices and HIV were led by South African researchers.[35 36] A new pervasive broadcast highlighting the acceptability of mixed feeding in the context of ART and maternal viral load suppression is needed to facilitate a shift in knowledge about mixed feeding. Although some individual attitude and confidence items did not change, or only changed marginally, the overall analyses demonstrated an improvement in follow-up attitude and confidence scores. However, confidence in the intervention group was still low and health workers performed poorly on some of the more difficult confidence questions such as confidence with counselling when a mother is not ART adherent, managing high viral loads during breastfeeding, explaining HIV transmission risks to a mother with a high viral load, assisting mothers with HIV to safely formula feed and advising that some breastfeeding is better than no breastfeeding. The complexity of changing health workers' attitudes and confidence towards breastfeeding has been documented repeatedly in many African settings including South Africa.[11 25 37-40] We hypothesise that poor performance on some of the individual items or on the overall confidence score may be attributed to the short duration of the intervention. An alternative hypothesis is that HW's low confidence, around topics like non-adherence and high viral load, reflect more complex dynamics that are not easily addressed through counselling / mentoring interventions.[38] In fact a study from South Africa demonstrated how health workers personal beliefs affect their ability to provide supportive counselling.[11]

There is evidence that in-service training, supervision and follow-up improves the knowledge, skills and practices of health workers managing childhood undernutrition, and can improve health worker job satisfaction and motivation, but no data exist on how to improve health worker knowledge, skills and confidence in the tricky area of HIV and infant feeding.[41-43] For training / supervision interventions, implementation challenges include inadequately trained or shortages of supervisors, inappropriate job aids for follow-up, and poor alignment between community views/ practice and health programmes.[44] Our approach attempted to circumvent these challenges by using a low technology, mentorship model for skills development at clinic level. At the outset of the intervention we acknowledged that health workers were members of their community: we discussed their fears and beliefs, and then introduced facts and evidence to extend their knowledge, change their attitudes and increase their confidence to implement updated guidelines on HIV and infant feeding. Thus, we aimed to change inherent, deep seated beliefs and attitudes that are sustained in the absence of outside supervision.

We used a side-by-side mentorship approach, as reviewed by Schwerdtle et.al. to conduct team-based mentoring to empower health workers.[45] A team-based approach allowed collaborative learning between different cadres of health workers, facilitating any future change in practice. In accordance with Dee Fink's theory, a participatory mentorship approach allows participants to develop foundational knowledge, apply skills, integrate ideas, develop new feelings/ interests and values and learn how to learn.[26] Our experience suggests that such an approach allowed discussion of participant's attitudes towards performing the behaviour, beliefs about whether critical, important people will approve of the behaviour (subjective norms), and about their likelihood of successfully implementing the behaviour.[28 29] Our findings corroborate a scoping

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3 review which demonstrated that mentorship improves certain quality of care outcomes [45]; in our  
4 study it improved knowledge, attitudes and confidence. However, only four studies were included  
5 in this scoping review, and the nature of the mentorship varied from video-conferencing to  
6 monthly, six-weekly or annual visits interspersed with other contact forums, conducted over one  
7 day to an entire week. A list of desirable features of mentorship interventions, include at least one  
8 dedicated mentor per facility, ensuring an adequate mentor:mentee ratio so that all staff can be  
9 supported, forming meaningful relationships between mentors and mentees, ensuring cultural  
10 congruency between mentee and mentor, and using mentors for protocol-driven programmes, such  
11 as IMCI or HIV.[45] Our intervention related to HIV and infant feeding guidelines, was low cost  
12 and low technology (one mentor working with pen, flip chart and paper in the health facility), and  
13 was implemented by a dedicated mentor from the same cultural background as the mentees. She  
14 provided onsite support during the workshops, which lasted approximately one hour, and  
15 additional support through a WhatsApp messaging group.  
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20 There is an ongoing health worker crisis in resource limited settings, including maldistribution of  
21 staff, an imbalance in skills mix, increasingly complicated health programmes and complicated  
22 socio-cultural-political-economic environments. Against this background, questions arise about  
23 the feasibility of an on-site mentorship approach to guideline dissemination amongst health  
24 workers, and an on-site peer-peer mentorship approach to supporting mothers with infant feeding.  
25 In this study we chose to focus specifically on an onsite mentorship approach to guideline  
26 dissemination amongst health workers. We argue that strengthening investment in on-site  
27 mentorship rather than off-site training, may be a cost-saving approach. In our setting, all clinics  
28 receive regular visits from district primary health care (PHC) supervisors, but they mostly focus  
29 on administration and clinic management matters. These supervisors, as well as existing district  
30 PHC trainers, could be capacitated to provide clinical mentoring for health workers in the clinics  
31 they oversee. Our model of team-based learning and mentoring can be used for on-site mentoring,  
32 and avoids accommodation and travel costs, and absence from work that off-site training requires.  
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36 Our study had several limitations: We purposively selected districts for inclusion. We could not  
37 control for previous breastfeeding experience of health workers as we did not gather these data.  
38 The study tools were piloted before finalisation, but no factor analyses or validation exercises were  
39 conducted. The follow-up evaluation was conducted 3 months after the intervention; thus, we were  
40 only able to measure short term benefits. Additionally, we did not co-design the intervention with  
41 women living with HIV, did not measure the effect of improved knowledge, attitudes and  
42 confidence on health workers' counselling practices and on mothers' infant feeding practices and  
43 could not tease out whether the relationship between number of workshops and outcomes was due  
44 to staff motivation (more motivated staff attended more workshops) or the workshops themselves.  
45 Our study's strengths are that the design was quasi-experimental, measuring not only knowledge,  
46 but also attitudes and confidence. Additionally, results are robust as three different analytical  
47 methods yielded congruent results.  
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51 **Conclusion:** We demonstrated improved knowledge, attitudes and confidence of health workers  
52 following a participatory mentorship approach to HIV and infant feeding guideline dissemination  
53 compared with a standard approach. More research is needed to better understand how to change  
54 health workers' counselling practices, and whether this changes mothers' feeding practices.  
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### Authors contributions:

AG: Study conceptualization and tool development, protocol writing including intervention development, oversight of sampling and field work, writing of the first draft of this manuscript, receiving and incorporating co-author comments, finalization of the paper

TD: Study conceptualization and tool development, protocol writing including intervention development, set up the sample frame and sampling, contributed to the manuscript, reviewed and approved the final version of the manuscript

SM: Led the statistical components of the protocol; provided overall oversight on the statistical analysis, contributed to the manuscript, reviewed and approved the final version of the manuscript

TN: Performed the work on the statistical components of the protocol, under SM's guidance; provided data analysis under SM's guidance, contributed to the manuscript, reviewed and approved the final version of the manuscript

LH: Contributed to study conceptualization and tool development, protocol writing including intervention development; was overall Project Manager; established, managed and cleaned the database; contributed to the manuscript, reviewed and approved the final version of the manuscript

VJ: Provided guidance on intervention development. Contributed to the manuscript, reviewed and approved the final version of the manuscript

IMSE: Contributed to study conceptualization and tool development, protocol writing including intervention development; contributed to the manuscript, reviewed and approved the final version of the manuscript

UF: Contributed to study conceptualization, assisted with district level buy-in in Tshwane District, provided information on how routine dissemination of updated infant feeding guidelines; contributed to the manuscript, reviewed and approved the final version of the manuscript

AD: Contributed to study conceptualization and tool development; contributed to the manuscript, reviewed and approved the final version of the manuscript

NR: Contributed to study conceptualization; contributed to the manuscript, reviewed and approved the final version of the manuscript

MK: Contributed to study conceptualization and tool development; contributed to the manuscript, reviewed and approved the final version of the manuscript

DS: Contributed to study conceptualization and tool development; contributed to the manuscript, reviewed and approved the final version of the manuscript

SK: Contributed to study conceptualization, assisted with national level buy-in, provided information on how routine dissemination of updated infant feeding guidelines; contributed to the manuscript, reviewed and approved the final version of the manuscript

TT: Contributed to study conceptualization and tool development; contributed to the manuscript, reviewed and approved the final version of the manuscript

CH: Study conceptualization, protocol writing including intervention development, high level oversight of study implementation, contributed to the manuscript, reviewed and approved the final version of the manuscript

**Data sharing statement:** Data can be obtained by e-mailing the corresponding author, and upon reasonable request

**Figure legends:**

Figure 1: Study districts: Tshwane District in Gauteng Province and Ugu District in KwaZulu-Natal Province of South Africa

Figure 2: Theoretical frameworks which informed the development of the intervention

Figure 3: Study population at baseline and follow-up for intervention and comparison sites

Supplementary Figure 1: Prior training reported by participants at baseline (intervention versus comparison groups)

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**Figure 1: Study districts: Tshwane Metropolitan Municipality in Gauteng Province and Ugu District in KwaZulu-Natal Province of South Africa**

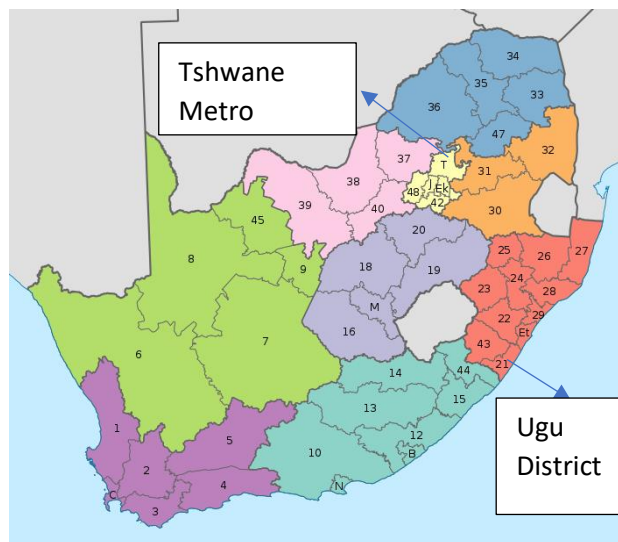
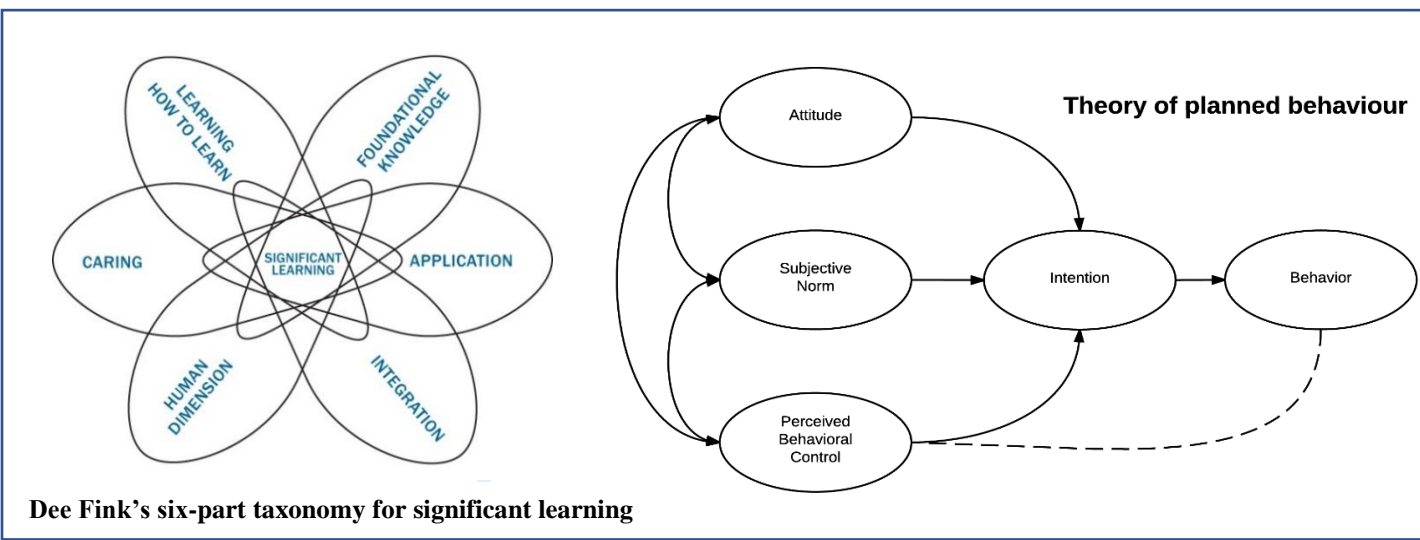


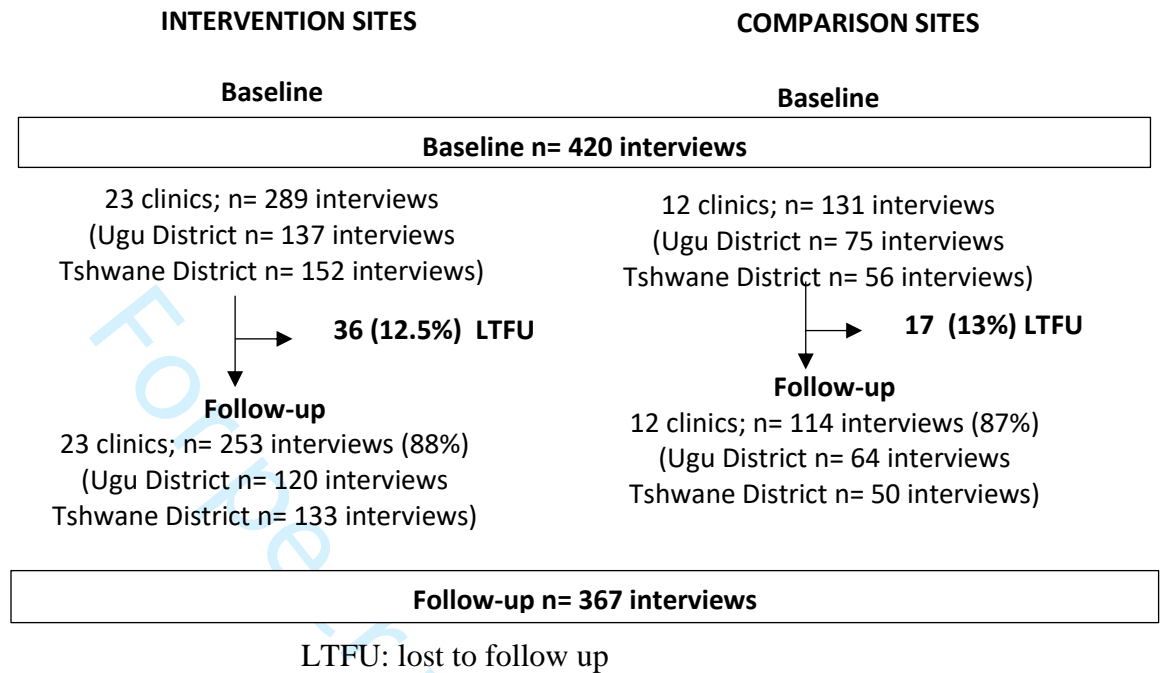
Figure 2: Theoretical frameworks which informed the development of the intervention



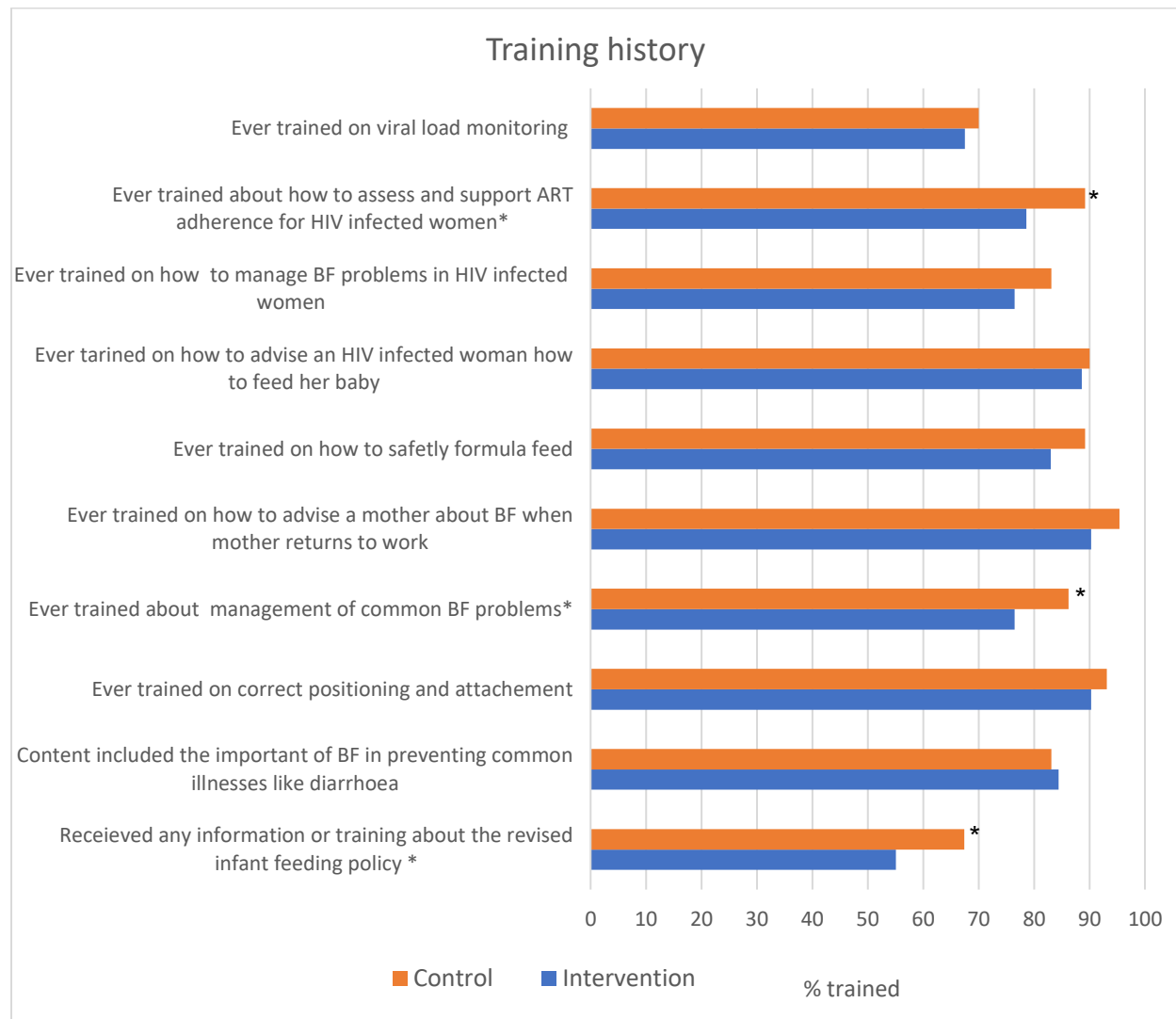
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**Figure 3: Study population at baseline and follow-up for intervention and comparison sites**

**Supplementary Figure 1: Prior training reported by participants at baseline (intervention versus comparison groups)**



\* $p < 0.05$

Abbreviations: ART= antiretroviral therapy; BF= breastfeeding

**Supplementary Table 1: Attitude scores of health workers at baseline and follow-up**

Attitude statements	Number (%) who agreed or strongly agreed with the statement at baseline			Number (%) who agreed or strongly agreed with the statement at follow-up		
	Intervention (n=289)	Comparison (n=131)	P-value *	Intervention (n=252)	Comparison (n=114)	p-value*
<i>Significant improvements between intervention and comparison groups at follow-up</i>						
There have been so many changes to the infant feeding guidelines and breastfeeding guidelines however I am NOT confused about what to tell mothers who are HIV-infected about breastfeeding	155 (53.6)	74 (56.9)	0.59	175 (69.4)	65 (57.0)	0.02
For an HIV-exposed infant any breastfeeding is better than no breastfeeding at all, as long as the mother is virally suppressed and on antiretroviral therapy	189 (65.4)	79 (61.2)	0.31	196 (77.8)	74 (64.9)	0.01
When a baby cries all the time it is NOT usually because the baby is hungry and needs more food than just breastmilk	260 (90.0)	107 (83.0)	0.02	230 (91.3)	91(79.8)	<0.01
Exclusive breastfeeding in the first 6 months of life is the best choice for all mothers and babies in South Africa	256 (88.6)	114 (88.4)	0.65	239 (94.8)	98 (86.0)	<0.01
The benefits of breastfeeding for protecting children from illness such as diarrhoea and pneumonia outweighs the risk of acquiring HIV if the mother is on antiretroviral treatment	224 (77.5)	93 (72.1)	0.15	218 (86.5)	87 (76.3)	0.02
I feel that an HIV-infected mother who has not disclosed to her partner is NOT at high risk of non-adherence to ART and should NOT stop breastfeeding as soon as possible	128 (44.3)	51 (39.5)	0.30	137 (54.4)	46 (40.4)	0.01
I should support all mothers, regardless of HIV status, to continue breastfeeding until 2 years, as long as HIV-infected women are virally suppressed	237 (82.0)	101 (78.3)	0.24	237 (94.1)	87 (76.3)	<0.01
I should NOT advise an HIV-positive virally suppressed mother who has cracked and bleeding nipples to temporarily stop breastfeeding	80 (27.7)	40 (31.3)	0.55	97 (38.5)	24 (21.1)	<0.01
Formula feeding is NOT the best choice for mothers living in good socio-economic circumstances who are going back to work	202 (70.0)	95 (74.2)	0.58	198 (78.6)	74 (64.9)	<0.01
It is safer for HIV-positive mothers to breastfeed than to formula feed	231 (79.9)	89 (69.5)	0.63	226 (89.7)	85 (74.6)	<0.01
It is NOT very difficult for mothers to express breastmilk while they are at work or school	164 (53.0)	57 (44.5)	0.01	168 (67.1)	51 (44.7)	<0.01
If an HIV-positive mother can afford to buy formula it is NOT better for her to formula feed her baby	170 (58.8)	83 (64.9)	0.38	185 (73.4)	68 (59.7)	<0.01
Promoting breastfeeding for two years for HIV-exposed infants is NOT a risk because	197 (68.2)	85 (66.4)	0.51	210 (83.3)	79 (69.3)	<0.01



mothers will be able to maintain good ART adherence for that long						
<b>Low levels of knowledge (&lt;80%) at baseline in both groups - no significant differences between intervention and comparison groups at follow-up [concept that this relates to]</b>						
For an HIV-positive mother on antiretroviral treatment and virally suppressed mixed feeding is better than not breastfeeding at all	39 (13.5)	15 (11.7)	0.56	57 (22.6)	16 (14.0)	0.06
In our community working mothers can successfully maintain exclusive breast feeding while going to work	219 (75.8)	89 (69.5)	0.09	208 (82.5)	92 (80.7)	0.67
There are exceptional circumstances where an HIV-positive mother would be advised not to breastfeed, such as failure of 2 <sup>nd</sup> or 3 <sup>rd</sup> line ART treatment, but these are not common	225 (77.9)	93 (72.7)	0.13	201 (79.7)	87 (76.3)	0.46
<b>High levels of knowledge (≥80%) at baseline in both groups – no significant differences between intervention and comparison groups at follow-up</b>						
HIV-exposed babies who are PCR negative must NOT stop breastfeeding as soon as possible	238 (82.4)	104 (81.3)	0.47	221 (87.7)	95 (83.3)	0.26
Exclusive breastfeeding for six months is an achievable goal for the majority of mothers	249 (86.2)	105 (82.0)	0.11	227 (90.1)	96 (84.1)	0.11
An HIV-positive mother who is on ART and not virally suppressed and is mixed feeding is putting her child at risk of acquiring HIV	256 (88.6)	109 (85.2)	0.13	219 (86.9)	97 (85.1)	0.64
In South Africa it is possible to improve exclusive breastfeeding rates	244 (84.7)	108 (84.4)	0.61	230 (91.3)	97 (85.1)	0.08
Formula feeding is NOT more convenient for a mother than breastfeeding	253 (87.5)	109 (85.2)	0.23	211 (83.7)	100(87.7)	0.32
<b><u>Number (%) participants whose attitude was to at least agree (Attitude score ≥84)*</u></b>	<b><u>71 (24.6)</u></b>	<b><u>23 (17.9)</u></b>	<b><u>0.12</u></b>	<b><u>123 (49.2)</u></b>	<b><u>27 (24.1)</u></b>	<b><u>&lt;0.01</u></b>
<b><u>Mean attitude score out of 105 (95% CI)</u></b>	<b><u>76.9 (75.9 – 77.9)</u></b>	<b><u>75.0 (73.0 – 77.0)</u></b>	<b><u>0.07</u></b>	<b><u>82.7 (81.6 – 83.8)</u></b>	<b><u>76.8 (75.0 – 78.5)</u></b>	<b><u>&lt;0.01</u></b>

\*84 was the minimum score obtainable if a participant at least agreed with all statements

**Supplementary Table 2: Confidence statements of health workers at baseline and follow-up**

Confidence statements	Number (%) who felt confident or very confident at baseline			Number (%) who felt confident or very confident at follow-up		
	Intervention (n=289)	Comparison (n=131)	p-value	Intervention (n=252)	Comparison (n=114)	p-value
<b><i>Significant improvements between intervention and comparison groups at follow-up</i></b>						
How confident do you feel about counselling an HIV-positive pregnant woman about how she will feed her baby	265 (91.7)	116 (88.6)	0.30	240 (95.2)	100 (87.7)	0.01
How confident do you feel about advising an HIV-positive mother about how to continue to breastfeed her baby when she returns to work or school	258 (89.3)	117 (89.3)	0.99	242 (96.0)	101 (88.6)	<0.01
How confident do you feel about advising an HIV-infected mother to continue breastfeeding for two years	216 (74.7)	105 (80.2)	0.23	236 (93.6)	93 (81.6)	<0.01
How confident do you feel about assessing ART compliance in an HIV-positive mother	240 (83.1)	111 (84.7)	0.67	230 (91.3)	94 (82.5)	0.02
How confident do you feel about advising an HIV-infected mother who is exclusively breastfeeding and has cracked nipples with bloody milk about how to feed her baby	196 (67.8)	84 (64.1)	0.45	201 (79.8)	80 (70.2)	0.04
<b><i>Low levels of knowledge (&lt;80%) at baseline in both groups - no significant differences between intervention and comparison groups at follow-up [concept that this relates to]</i></b>						
How confident do you feel about advising an HIV-infected mother about how to stop breastfeeding	214 (74.1)	89 (67.9)	0.20	188 (74.6)	86 (75.4)	0.87
How confident do you feel about identifying when an HIV-positive mother is not adhering to her ART treatment	224 (77.5)	104 (79.4)	0.67	218 (86.5)	90 (79.0)	0.07
How confident do you feel about reassuring a mother living with HIV who is virally suppressed that a shorter duration of breastfeeding is better than never initiating breastfeeding	227 (78.5)	103 (78.6)	0.99	215 (85.3)	96 (84.2)	0.78
How confident do you feel about assisting a mother with HIV to safely formula feed her baby	212 (73.4)	102 (77.9)	0.33	191 (75.8)	95 (83.3)	0.11
How confident do you feel about using the guidelines for safe replacement feeding when you counsel a mother who is not adherent to ART and has a viral load above 1000 copies/ml	191 (66.1)	99 (75.6)	0.05	185 (73.4)	75 (65.8)	0.14
How confident do you feel about advising an HIV-infected mother who is exclusively breastfeeding and has defaulted from her ART about how to feed her baby	205 (70.9)	97 (74.1)	0.51	189 (75.0)	80 (70.2)	0.33
How confident do you feel about managing poor ART compliance in an HIV-infected breastfeeding mother	215 (74.4)	104 (79.4)	0.27	209 (82.9)	89 (78.1)	0.27

A mother is not adherent to ART and her last viral load is 1000 copies per ml. How confident do you feel about counselling her about feeding her infant?	199 (68.9)	98 (74.8)	0.21	198 (78.6)	80 (70.2)	0.08
<b>High levels of knowledge (<math>\geq 80\%</math>) at baseline in both groups – no significant differences between intervention and comparison groups at follow-up</b>						
How confident do you feel about giving information about the risks and benefits of breastfeeding to an HIV-infected mother	268 (92.7)	120 (91.6)	0.67	238 (94.4)	102 (89.5)	0.09
How confident do you feel about assessing whether there is good positioning and attachment during breastfeeding	263 (91.0)	125 (95.4)	0.11	243(96.4)	107 (93.9)	0.27
How confident do you feel about advising an HIV-infected mother who is virally suppressed who is mixed feeding her infant	243 (84.1)	113 (86.3)	0.57	226 (89.7)	99 (86.8)	0.43
How confident do you feel about advising an HIV-positive mother about starting complementary feeds	251 (86.9)	115 (87.8)	0.79	229 (90.9)	103 (90.4)	0.87
How confident do you feel about explaining the risks of HIV transmission through breastmilk to an HIV-infected mother with high viral load	247 (85.5)	114 (87.0)	0.67	220 (87.3)	105 (92.1)	0.17
How confident do you feel about explaining to a mother about expressing and storing milk	269 (93.1)	124 (94.7)	0.54	237 (94.1)	109 (95.6)	0.54
<b>Number (%) participants who were confident or very confident (Sum Score <math>\geq 57</math>)</b>	<b><u>164 (56.8)</u></b>	<b><u>86 (67.2)</u></b>	<b><u>0.09</u></b>	<b><u>175 (70.0)</u></b>	<b><u>72 (64.3)</u></b>	<b><u>0.28</u></b>
<b>Mean confidence score out of 76 (95% CI)</b>	<b><u>59.1</u></b> <b><u>(58.0-60.2)</u></b>	<b><u>59.1</u></b> <b><u>(57.0-61.3)</u></b>	<b><u>1.0</u></b>	<b><u>61.2</u></b> <b><u>(60.8-63.1)</u></b>	<b><u>59.9</u></b> <b><u>(58.1-61.7)</u></b>	<b><u>0.05</u></b>

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**QUESTIONNAIRE FOR HEALTHCARE WORKERS**

For peer review only

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Section 1. Admin		
1.1.	Interview Date	<input type="text"/> <input type="text"/> / <input type="text"/> <input type="text"/> <input type="text"/> / <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> D D M M M Y Y Y Y
1.2.	District	<input type="radio"/> OTshwane <input type="radio"/> OUgu
1.3.	Sub district	<b>If Tshwane chosen above:</b> <input type="radio"/> OTshwane 1 <input type="radio"/> OTshwane 2 <input type="radio"/> OTshwane 3 <input type="radio"/> OTshwane 6 <b>If Ugu chosen above:</b> <input type="radio"/> Omdoni <input type="radio"/> UmZumbe <input type="radio"/> Hibiscus <input type="radio"/> uMuziwabantu
1.4.	Facility	<b>If Tshwane 1 selected the following clinics can be chosen:</b> <input type="radio"/> Soshang Block JJ clinic <input type="radio"/> KT Motubatse clinic <input type="radio"/> Boikhutsong clinic <input type="radio"/> Sedilega clinic <input type="radio"/> Shoshanguve 2 clinic <input type="radio"/> Soshang Block TT clinic <b>If Tshwane 2 selected:</b> <input type="radio"/> Jubilee gateway clinic <input type="radio"/> Kekanastad clinic <input type="radio"/> Suurman clinic <input type="radio"/> Ramotse clinic <input type="radio"/> Kekana gardens clinic <input type="radio"/> New Eersterus clinic <b>If Tshwane 3 selected</b> <input type="radio"/> Atteridgeville Clinic <input type="radio"/> Bophelong Clinic (Tshw 3) <input type="radio"/> Saulsville Clinic

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		<p><b>If Tshwane 6 selected</b></p> <ul style="list-style-type: none"> <li>S Bopape CHC</li> <li>Eersterust CHC</li> <li>Nellmapius Clinic</li> </ul> <p><b>If Omdoni selected</b></p> <ul style="list-style-type: none"> <li>GJ Crooke's Gateway</li> <li>Pennington Clinic</li> <li>Philani Clinic</li> <li>Scottburgh Clinic</li> <li>Umzinto Clinic</li> </ul> <p><b>If UmZumbe selected</b></p> <ul style="list-style-type: none"> <li>• Gqayinyanga clinic</li> <li>• St Faiths clinic</li> <li>• Phungashe clinic</li> <li>• Ntimbankulu clinic</li> <li>• Turton CHC</li> <li>• Ndelu clinic</li> </ul> <p><b>If Hibiscus coast selected:</b></p> <ul style="list-style-type: none"> <li>• Gamalakhe CHC</li> <li>• Southport Clinic</li> <li>• Marburg Clinic</li> </ul> <p><b>If uMuziwabantu selected</b></p> <ul style="list-style-type: none"> <li>• Santombe clinic</li> <li>• Meadowsweet clinic</li> <li>• Mbonwa clinic</li> </ul>
1.5.	Health worker number	Assigned number to each participant

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Section 2. Demographics	
2.1.	What is your date of birth? <input type="text"/> <input type="text"/> / <input type="text"/> <input type="text"/> / <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> D D M M Y Y Y Y
2.2.	Gender <input type="radio"/> Male <input type="radio"/> Female
2.3.	What is your role in this clinic? <input type="radio"/> Lay counsellor or nutritional advisor <input type="radio"/> Enrolled nurse assistant <input type="radio"/> Enrolled nurse <input type="radio"/> Registered nurse <input type="radio"/> Medical degree (MB ChB or equivalent) <input type="radio"/> community health worker (CCG) <input type="radio"/> dietician <input type="radio"/> Registered nurse operational manager <input type="radio"/> other specify below
2.4.	Other
2.5.	How long have you been working as a health worker? <input type="radio"/> less than 1 year <input type="radio"/> 1- <2 years <input type="radio"/> 2- <5 years <input type="radio"/> 5-< 10 years <input type="radio"/> 10 or more years

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Section 3	<b>Updated HIV and infant feeding guidelines. In this section you will be asked about new infant feeding guidelines adopted in South Africa.</b>	
3.1	During 2017 have you received any information or training at work about the revised Infant and Young Child Feeding Policy – in the form of a circular, letter, workshop, meeting or lecture	<input type="radio"/> Yes <input type="radio"/> No <input type="radio"/> SKIP
3.2	If yes, how did you receive this information?	1. <input type="radio"/> Circular/letter 2. <input type="radio"/> Meeting 3. <input type="radio"/> Workshop 4. <input type="radio"/> Feedback/information from colleague 5. <input type="radio"/> lecture 6. <input type="radio"/> other
3.3	Who gave you this information/ training?	1 <input type="radio"/> District trainer/ DoH staff member 2 <input type="radio"/> Outside/ private company
3.4	How long was this training?	_____ hours



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SECTION 4.	<b>TRAINING Topics</b> Have you received any training on the following topics (either in-service or formal training).  <b>Usuke wathola uqeqesho kulezihloko ezilandelayo?</b>		
4.1	Did the content of your training include the importance of breastfeeding in preventing common childhood illness such as diarrhoea?	1 <input type="radio"/> Yes	0 <input type="radio"/> No
4.2	Have you ever had any training about correct positioning and attachment of an infant during breastfeeding?	1 <input type="radio"/> Yes	0 <input type="radio"/> No
4.3	Have you ever had any training about the management of common breastfeeding problems?	1 <input type="radio"/> Yes	0 <input type="radio"/> No
4.4	Have you ever had any training about advising a mother about how to provide breastmilk for her baby when she returns to work or school	1 <input type="radio"/> Yes	0 <input type="radio"/> No
4.5	Have you ever had any training about how to advise a mother about formula feeding safely?	1 <input type="radio"/> Yes	0 <input type="radio"/> No
4.6	Have you ever had any training about how to advise an HIV infected woman about how to feed her baby?	1 <input type="radio"/> Yes	0 <input type="radio"/> No
4.7	Have you ever had any training about how to manage breastfeeding problems in HIV infected women (cracked nipples, mastitis etc.)?	1 <input type="radio"/> Yes	5.0 <input type="radio"/> No
4.8	Have you ever had any training about how to assess and support ART adherence for HIV infected women?	1 <input type="radio"/> Yes	0 <input type="radio"/> No
4.9	Have you ever had any training on viral load monitoring?	1 <input type="radio"/> Yes	0 <input type="radio"/> No

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Section 5	<b>ACTIVITIES:</b> <i>Think carefully about your work in this facility.</i> For the activity mentioned consider whether you ever perform this activity and if so how regularly do you perform this activity? If you do not perform this activity at all select the option 'Never'				
5.1	How often do you talk to groups of pregnant women attending the antenatal clinic about infant feeding (group counselling)	1 <input type="radio"/> one or more times per week	2 <input type="radio"/> one to three times per month	3 <input type="radio"/> Less than once a month	4 <input type="radio"/> Never
5.2	How often do you talk to a pregnant woman individually about her plan for feeding her baby	1 <input type="radio"/> one or more times per week	2 <input type="radio"/> one to three times per month	3 <input type="radio"/> Less than once a month	4 <input type="radio"/> Never
5.3	How often do you talk to an HIV infected pregnant woman about her plan for feeding her baby	1 <input type="radio"/> one or more times per week	2 <input type="radio"/> one to three times per month	3 <input type="radio"/> Less than once a month	4 <input type="radio"/> Never
5.4	How often do you assist a mother with breastfeeding within the first hour post delivery	1 <input type="radio"/> one or more times per week	2 <input type="radio"/> one to three times per month	3 <input type="radio"/> Less than once a month	4 <input type="radio"/> Never
5.5	How often do you talk to a mother about how she is feeding her baby?	1 <input type="radio"/> one or more times per week	2 <input type="radio"/> one to three times per month	3 <input type="radio"/> Less than once a month	4 <input type="radio"/> Never
5.6	How often do you observe a mother breastfeeding during a clinic or home visit	1 <input type="radio"/> one or more times per week	2 <input type="radio"/> one to three times per month	3 <input type="radio"/> Less than once a month	4 <input type="radio"/> Never
5.7	How often do you talk to a mother about positioning and attachment of the baby during breastfeeding	1 <input type="radio"/> one or more times per week	2 <input type="radio"/> one to three times per month	3 <input type="radio"/> Less than once a month	4 <input type="radio"/> Never
5.8	How often do you talk to an HIV infected mother about managing a breastfeeding problem (e.g. cracked nipples, baby crying all the time, mother says she does not have enough milk)	1 <input type="radio"/> one or more times per week	2 <input type="radio"/> one to three times per month	3 <input type="radio"/> Less than once a month	4 <input type="radio"/> Never
5.9	How often do you talk to a mother about how to maintain breastfeeding when away from the baby (going back to school or work)	1 <input type="radio"/> one or more times per week	2 <input type="radio"/> one to three times per month	3 <input type="radio"/> Less than once a month	4 <input type="radio"/> Never
5.10	How often do you talk to an HIV infected breastfeeding mother about taking ARVs	1 <input type="radio"/> one or more times per week	2 <input type="radio"/> one to three times per month	3 <input type="radio"/> Less than once a month	4 <input type="radio"/> Never

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SECTION 6	INFANT FEEDING KNOWLEDGE			
please state whether the statement is true or false or you do not know				
	Statement	True	False	Do not know
6.1	Exclusive breastfeeding is the recommended infant feeding method for ALL infants aged 0-6 months in SA, regardless of mother's HIV status	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>
6.2	Giving any formula milk during the first six months of life increases the risk of death from diarrhoea and/or pneumonia	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>
6.3	Continued breastfeeding for 2 years is the recommended infant method in SA for ALL children, regardless of mother's HIV status	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>
6.4	Mothers living with HIV who are receiving antiretroviral treatment and are virally suppressed should be advised not to breastfeed their infants	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>
6.5	When an HIV infected mother is ready to add complementary feeds she should stop breastfeeding rapidly over a 24hour period	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>
6.6	If an HIV exposed baby is receiving both breastmilk and formula milk, the mother should chose to either breastfeeding or formula feeding if she is adherent to ART	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>
6.7	A mother who is working and giving formula milk should mix the milk herself and leave for the carer to give during the day	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>
6.8	An HIV positive mother who is virally suppressed on antiretroviral treatment should breastfeed her child rather than not breastfeed to improve the child's survival	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>
6.9	When sterilising feeding bottles cover the bottles with water in a saucepan and place on the heat. As soon as the water boils remove from heat and leave the bottle in the water until completely cool	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>
6.10	In South Africa, the leading cause of death amongst children under 5 is pneumonia	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>
6.11	In South Africa, HIV infected women who are breastfeeding should be supported to adhere to antiretroviral treatment and should be counselled and supported to exclusively breastfeed their infants for the first six months of life whilst maintaining an undetectable viral load	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>
6.12	A baby under 4 months should be given soft porridge once he/she seems hungry	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>

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6.13	A mother living with HIV and adherent to antiretroviral treatment cannot exclusively breastfeed her 4-month old infant because she is working. It is better for this mother to give formula during the day and breastfeed at night rather than giving no breast milk at all	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>
6.14	An HIV exposed baby who is exclusively breastfeeding should be given some water when the weather is very hot	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>
6.15	If a baby has a positive PCR (HIV test) at birth the mother should stop breastfeeding if this is affordable and feasible in her situation	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>
6.16	Giving a baby expressed breastmilk is not as good as breastfeeding	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>
6.17	If a mother misses 2 doses of her ART in one month, she should be classified as a treatment failure	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>
6.18	An HIV positive mother who has cracked nipples should continue to breastfeed unless they are bleeding	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>
6.19	A mother who has missed 6 tablets of FDC in one month is considered to be poorly adherent and should stop breastfeeding immediately	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>
6.20	There are long term health benefits of breastfeeding for mother and child that last beyond the breastfeeding period	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>
6.21	In South Africa, HIV infected women who are breastfeeding should be supported to adhere to antiretroviral treatment and should introduce complementary foods around 6 months and be supported to continue breastfeeding for at least two years.	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>
6.22	It is safe to give the baby expressed breastmilk that has been kept outside the fridge for 8 hours	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>

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SECTION 7.	<b>INFANT FEEDING ATTITUDE</b> Please state whether you completely disagree, disagree, neutral, agree or completely agree with the statement					
		Completely disagree	Disagree	Neutral	Agree	Completely agree
7.1	There have been so many changes to the infant feeding guidelines and breastfeeding guidelines that I am confused about what to tell mothers who are HIV infected about	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>	4 <input type="radio"/>	5 <input type="radio"/>
7.2	When a baby cries all the time it is usually because the baby is hungry and needs more food than just breastmilk	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>	4 <input type="radio"/>	5 <input type="radio"/>
7.3	Exclusive breastfeeding in the first 6 months of life is the best choice for all mothers and babies in South Africa	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>	4 <input type="radio"/>	5 <input type="radio"/>
7.4	For an HIV exposed infant any breastfeeding is better than no breastfeeding at all, as long as the mother is virally suppressed and on antiretroviral therapy	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>	4 <input type="radio"/>	5 <input type="radio"/>
7.5	The benefits of breastfeeding for protecting children from illness such as diarrhoea and pneumonia outweighs the risk of acquiring HIV if the mother is on antiretroviral treatment	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>	4 <input type="radio"/>	5 <input type="radio"/>
7.6	I feel that an HIV infected mother who has not disclosed to her partner is at high risk of non-adherence to ART and should stop breastfeeding as soon as possible	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>	4 <input type="radio"/>	5 <input type="radio"/>
7.7	I should support all mothers, regardless of HIV status, to continue breastfeeding until 2 years, as long as HIV infected women are virally suppressed	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>	4 <input type="radio"/>	5 <input type="radio"/>
7.8	I should advise an HIV positive virally suppressed mother who has cracked and bleeding nipples to temporarily stop breastfeeding	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>	4 <input type="radio"/>	5 <input type="radio"/>
7.9	HIV exposed babies who are PCR negative must stop breastfeeding as soon as possible	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>	4 <input type="radio"/>	5 <input type="radio"/>

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7.10	Formula feeding is the best choice for mothers living in good socioeconomic circumstances who are going back to work	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>	4 <input type="radio"/>	5 <input type="radio"/>
7.11	For an HIV positive mother on antiretroviral treatment and virally suppressed mixed feeding is better than not breastfeeding at all	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>	4 <input type="radio"/>	5 <input type="radio"/>
7.12	Exclusive breastfeeding for six months is an achievable goal for the majority of mothers	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>	4 <input type="radio"/>	5 <input type="radio"/>
7.13	It is safer for HIV positive mothers to breastfeed than to formula feed	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>	4 <input type="radio"/>	5 <input type="radio"/>
7.14	In our community working mothers can successfully maintain exclusive breast feeding while going to work	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>	4 <input type="radio"/>	5 <input type="radio"/>
7.15	An HIV positive mother who is on ART and not virally suppressed and is mixed feeding is putting her child at risk of acquiring HIV	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>	4 <input type="radio"/>	5 <input type="radio"/>
7.16	It is very difficult for mothers to express breastmilk while they are at work or school	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>	4 <input type="radio"/>	5 <input type="radio"/>
7.17	If an HIV positive mother can afford to buy formula it is better for her to formula feed her baby	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>	4 <input type="radio"/>	5 <input type="radio"/>
7.18	Promoting breastfeeding for two years for HIV exposed infants is a risk because mothers will be unable to maintain good ART adherence for that long	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>	4 <input type="radio"/>	5 <input type="radio"/>
7.19	In South Africa it is possible to improve exclusive breastfeeding rates	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>	4 <input type="radio"/>	5 <input type="radio"/>
7.20	There are exceptional circumstances where an HIV positive mother would be advised not to breastfeed, such as failure of 2 <sup>nd</sup> or 3 <sup>rd</sup> line ART treatment, but these are not common	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>	4 <input type="radio"/>	5 <input type="radio"/>
7.21	Formula feeding is more convenient for a mother than breastfeeding	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>	4 <input type="radio"/>	5 <input type="radio"/>

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SECTION N 8.	<b>INFANT FEEDING COUNSELLING CONFIDENCE</b> For each activity below, please indicate how confident you feel to undertake each activity. Do you feel "Not at all confident", "Not very confident", "Somewhat confident" or "Very confident".				
		Not at all confident	Not very confident	Confident	Very confident
8.1	How confident do you feel about counselling an HIV positive pregnant woman about how she will feed her baby	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>	4 <input type="radio"/>
8.2	How confident do you feel about giving information about the risks and benefits of breastfeeding to an HIV infected mother	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>	4 <input type="radio"/>
8.3	How confident do you feel about assessing whether there is good positioning and attachment during breastfeeding	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>	4 <input type="radio"/>
8.4	How confident do you feel about advising an HIV positive mother about how to continue to breastfeed her baby when she	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>	4 <input type="radio"/>
8.5	How confident do you feel about advising an HIV infected mother who is virally suppressed who is mixed feeding her infant	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>	4 <input type="radio"/>
8.6	How confident do you feel about advising an HIV infected mother to continue breastfeeding for two years	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>	4 <input type="radio"/>
8.7	How confident do you feel about advising an HIV infected mother about how to stop breastfeeding	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>	4 <input type="radio"/>
8.8	How confident do you feel about advising an HIV positive mother about starting complementary feeds	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>	4 <input type="radio"/>
8.9	How confident do you feel about assessing ART compliance in an HIV positive mother	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>	4 <input type="radio"/>
8.10	How confident do you feel about identifying when an HIV positive mother is not adhering to her ART treatment	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>	4 <input type="radio"/>
8.11	How confident do you feel about reassuring a mother living with HIV who is virally suppressed that a shorter duration of breastfeeding is better than never initiating breastfeeding	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>	4 <input type="radio"/>
8.12	How confident do you feel about explaining the risks of HIV transmission through breastmilk to an HIV infected mother with high viral load	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>	4 <input type="radio"/>

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8.13	How confident do you feel about assisting a mother with HIV to safely formula feed her baby	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>	4 <input type="radio"/>
8.14	How confident do you feel about advising an HIV infected mother who is exclusively breastfeeding and has cracked nipples with bloody milk about how to feed her baby	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>	4 <input type="radio"/>
8.15	How confident do you feel about using the guidelines for safe replacement feeding when you counsel a mother who is not adherent to ART and has a viral load above 1000 copies/ml	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>	4 <input type="radio"/>
8.16	How confident do you feel about advising an HIV infected mother who is exclusively breastfeeding and has defaulted from her ART about how to feed her baby	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>	4 <input type="radio"/>
8.17	How confident do you feel about explaining to a mother about expressing and storing milk	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>	4 <input type="radio"/>
8.18	How confident do you feel about managing poor ART compliance in an HIV infected breastfeeding mother	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>	4 <input type="radio"/>
8.19	A mother is not adherent to ART and her last viral load is 1000 copies per ml. How confident do you feel about counselling her about feeding her infant?	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>	4 <input type="radio"/>



# BMJ Open

## Translating new evidence into clinical practice: A quasi-experimental controlled before-after study evaluating the effect of a novel outreach mentoring approach on knowledge, attitudes and confidence of health workers providing HIV and infant feeding counselling in South Africa

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3 **Translating new evidence into clinical practice: A quasi-experimental controlled before-after**  
4 **study evaluating the effect of a novel outreach mentoring approach on knowledge, attitudes**  
5 **and confidence of health workers providing HIV and infant feeding counselling in South**  
6 **Africa**  
7

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9 Ameena Goga<sup>1, 2, 3</sup>, Tanya Doherty<sup>1, 4, 5</sup>, Samuel Manda<sup>6, 7</sup>, Tshifhiwa Nkwenika<sup>6</sup>, Lyn Haskins<sup>8</sup>,  
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## Abstract

**Objectives:** We report the effectiveness of a mentoring approach to improve health workers' knowledge, attitudes and confidence with counselling on HIV and infant feeding.

**Design:** Quasi-experimental controlled before-after study.

**Setting:** Randomly selected primary health care clinics (n=24 intervention, n=12 comparison); two districts, South Africa.

**Participants:** All health workers (HW) providing infant feeding counselling in selected facilities were invited.

**Interventions:** three 1-2 hour, on-site workshops over 3-6 weeks.

**Primary outcome measures:** Knowledge (22 binary questions), attitude (21 questions - 5-point Likert scale) and confidence (19 questions - 3-point Likert scale). Individual item responses were added within each of the attitude and confidence domains. The respective sums were taken to be the domain composite index and used as a dependent variable to evaluate intervention effect. Linear regression models were used to estimate the mean score difference between intervention and comparison groups post-intervention, adjusting for the mean score difference between them at baseline. Analyses were adjusted for participant baseline characteristics and clustering at health facility level.

**Results:** In intervention and comparison sites, respectively: 289 and 131 baseline and 253 and 114 follow-up interviews were conducted (August-December 2017). At baseline there was no difference in mean number of correctly answered knowledge questions; this differed significantly at follow-up (15.2 in comparison; 17.2 in intervention sites ( $p<0.001$ )). At follow-up, the mean attitude and confidence scores towards breastfeeding were better in intervention versus comparison, sites ( $p<0.001$  and  $p=0.05$ , respectively). Controlling for possible confounders, interactions between time and intervention group and pre-intervention values, the attitude score was 5.1-points significantly higher in intervention versus comparison groups.

**Conclusion:** A participatory, low intensity on-site mentoring approach to disseminating updated infant feeding guidelines improved HWs' knowledge, attitudes and confidence more than standard dissemination via a circular. Further research is required to evaluate the effectiveness, feasibility and sustainability of this approach at scale.

### Strengths and Limitations of this study:

1. Fieldwork was conducted in two geographically and historically different provinces, facilitating generalisability of results.
2. The intervention was participatory, low intensity, on-site and integrated into routine services.
3. Several types of analyses were conducted which all yielded congruent results.
4. However, limitations were that (i) we purposively selected districts for inclusion (ii) we could not control for HWs' personal breastfeeding experience as we did not gather these data (iii) the follow-up evaluation was undertaken 3 months after the intervention - thus, we measured short term benefits, and (iv) we did not measure the direct effect of improved HWs' knowledge, attitudes and confidence on health workers' counselling and mothers' infant feeding practices and (v) we did not co-design the intervention with women living with HIV. Co-designing the intervention with others living with HIV may have resulted in a different intervention and results, and needs to be undertaken in future work.

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5. The finding that knowledge scores amongst participants who attended 3 workshops were significantly better than knowledge scores amongst participants who attended less than 3 workshops, may simply reflect better motivation amongst attendees of more workshops, rather than the effect of the workshops themselves. We could not tease out these effects.

### 9 **Funding statement**

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### 26 **Competing interests statement**

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No author has declared any competing interests.

### 54 **Introduction**

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The benefits of breastfeeding in all settings, and particularly in low-middle income settings with high HIV prevalence, are undisputed.[1 2] Policies and clinical practice guidelines on preventing vertical transmission of HIV (PVT), also known as preventing mother to child transmission of HIV (PMTCT) and infant feeding have undergone frequent evidence-based revisions. For example South African PMTCT policy and its accompanying infant feeding recommendations have been revised five times since 2001 (2008, 2010, 2013, 2015, 2019).[3-7] Additionally, in 2011 a national infant feeding declaration withdrew free commercial infant formula as part of the PVT programme [8], and in 2017 the infant and young child feeding policy was updated to recommend that women living with HIV may continue breastfeeding for up to 24 months or longer (similar to the general population) while being fully supported for antiretroviral therapy (ART) adherence. This followed a 2016 World Health Organization (WHO) update which also stated that mixed feeding is not a reason to stop breastfeeding in the presence of ARV drugs.[9] However, a key gap is that these policies have not been effectively communicated to all health workers – a requirement of the Mother-Baby Friendly Initiative.[10 11] Health workers play a critical role in guiding infant feeding choices and sustaining infant feeding practices [11-13]; they wield power and authority [12 14] but their potentially positive influence on infant feeding is compromised by confusion over HIV and infant feeding, which has eroded their confidence.[11 13] Identifying and implementing optimal strategies to effectively disseminate updated guidelines have lagged behind. Multi-component dissemination strategies, which aim to increase the reach, ability and motivation of health workers, are more effective than one strategy alone.[15] However, in reality there are few published studies that inform guideline dissemination. Most of these are from high-income settings and may not be relevant to low-income settings which have unique challenges.[15]

Research has demonstrated that improving HWs' capacity can significantly improve their skills, self-efficacy and confidence to counsel, support and promote breastfeeding among women living

with HIV.[16 17] Consequently, a key question was: What learning approach could best develop health worker capacity and confidence to implement the updated HIV and infant feeding guideline, using a methodology that is sustainable and feasible to implement at scale? Pedagogical research highlights the advantage of participatory training compared with standard didactic teaching for improving health worker skills.[18 19] Thus, we sought to determine whether a participatory outreach mentorship approach to disseminate the updated HIV and infant feeding guidelines, using simple low-technology activities, improves health workers' knowledge of, attitudes towards and confidence with counselling on HIV and infant feeding. We chose to focus on health workers knowledge, attitudes and confidence as health workers in South Africa consider themselves as advocates for babies.[20] Additionally, they are one of the key influential groups in the complex socio-ecology of infant feeding.[12 13 21 22]

## Methods

### Study design

A quasi-experimental before-after design with intervention and comparison sites was used. Two purposively selected districts (Ugu and Tshwane District) in South Africa in each of two geographically disparate provinces, KwaZulu-Natal (KZN) and Gauteng (Figure 1), were included. Both provinces experienced a policy change in June 2017, when the 2013 South African Infant and Young Child Feeding Policy was amended to align with the 2016 WHO/UNICEF update on HIV and Infant feeding guideline.

### Sampling

In Ugu District all four sub-districts were selected; within Tshwane District two of the seven service delivery regions were randomly selected.

Twelve intervention and six comparison primary health care clinics were randomly sampled in Ugu District and Tshwane District (separately). Only clinics with above the median number of annual clinic visits for children under-5 years in the district were eligible for inclusion in the sampling frame. The comparison clinics served to capture any temporal changes in health worker knowledge, confidence and attitudes due to other interventions or trainings; hence a smaller sample was required in comparison versus intervention sites as the latter required more precise estimates of the intervention effect. A two-stage process was used to recruit participants. Firstly, research staff explained the study and participant inclusion and exclusion criteria to each facility manager during face-to-face on-site introductory meetings. The facility manager compiled a list of all eligible health workers involved in the care of pregnant women and children, including nurses, midwives, visiting doctors, lay counsellors, dieticians, nutritionists, facility managers and community health workers (CHWs). In the second stage, research staff approached eligible health workers and invited them to participate in the research. We aimed to recruit a manageable size of 8-10 health workers per clinic for participation in the intervention, and in the evaluation. The same staff were approached for the baseline and follow-up evaluations.

### Sample size

The sample size was determined based on 80% power and alpha 0.05 to measure a 15-percentage points difference in health worker confidence in HIV and infant feeding counselling between the intervention and comparison clinics comparing baseline and follow-up. The expected effect was

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3 based on the researchers' experience and data from recent studies in South Africa with the baseline  
4 level of high confidence to counsel HIV-positive women on breastfeeding duration set at 45%. [23]  
5 It was assumed that the confidence score would remain unchanged in the comparison clinics,  
6 implying a two-sample test in the post-intervention period. Clinic-level analyses were used for the  
7 sample size calculations, assuming a sampling ratio of 2:1 for the intervention clinics and a  
8 standard deviation of 15% in the mean score between clinics. Based on these assumptions, and  
9 adjusting for clustering, the sample size was determined to be 24 intervention clinics and 12  
10 comparison clinics. [24] Within the intervention and comparison clinics, all health workers (nurses,  
11 midwives, visiting doctors, lay counsellors, dieticians, nutritionists, facility managers and CHWs),  
12 involved in caring for pregnant women and children were invited to participate in the study - we  
13 anticipated a mean number of health workers per participating facility to be 8-10.  
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### 19 **Description of the intervention**

20 We designed a participatory intervention comprising on-site mentoring through three workshops  
21 in each clinic, involving 303 selected health workers who provide care for pregnant women,  
22 breastfeeding mothers and their infants. This mentoring approach had five distinct features: 1) on-  
23 site: learning occurred in context 2) open to all cadres of health workers; 3) team-based;  
24 participants learned together; 4) content was led by self-identified gaps in knowledge and 5)  
25 activities were piloted and rooted in a theoretical framework. The intervention was delivered by  
26 the same trained facilitator (a nurse in Gauteng and nutritionist in KZN) in each intervention clinic.  
27 Each workshop lasted 1-2 hours over a 3-6-week period and had well-defined learning outcomes.  
28 The intervention has been described elsewhere. [25] In summary, our participatory intervention  
29 was guided by evidence that health workers' attitudes and practices are influenced by various  
30 factors, not just exposure to training and information. [26] We used Dee Fink's six part taxonomy  
31 as a guiding theory. This proposes that significant learning only occurs by developing foundational  
32 knowledge, applying skills, integrating ideas, developing new feelings/interests and values, and  
33 learning how to learn (encouraging the spirit of enquiry) (Figure 2). [27] Additionally, we applied  
34 the Theory of Planned Behaviour to the intervention design (Figure 2). [28 29] This states that an  
35 individual's intention to perform a behaviour is influenced by the person's attitudes towards  
36 performing the behaviour, their beliefs about whether people who are important to them will  
37 approve of the behaviour (subjective norms), and their beliefs about how likely they are to be able  
38 to implement the behaviour successfully. According to this theory, if health workers are to provide  
39 infant feeding counselling and support in accordance with updated infant feeding guidelines to  
40 HIV-positive or negative mothers, they need to agree with the change, believe that their colleagues  
41 and other stakeholders will approve of the action, and believe in their ability to implement it  
42 successfully. The workshops were tailored to achieve these goals: Workshop 1 covered knowledge  
43 gaps reported by participants, controversial statements, and advantages of breastfeeding.  
44 Following workshop 1, a poster or cards with key messages were placed in a prominent place in  
45 the clinic. Workshop 2 comprised a progressive case study discussed in small groups. Workshop  
46 3 involved one-to-one mentorship: each participant was observed providing infant feeding  
47 counselling or a case study was discussed if no mothers were available for counselling. The same  
48 facilitator conducted all three workshops at each clinic. In addition, a WhatsApp cell phone  
49 messaging group was established to support participants in intervention sites to facilitate sharing  
50 of concerns, tips for counselling and dealing with difficult situations. Key messages were posted  
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3 on the group approximately weekly. Comparison and intervention sub-districts were exposed to  
4 routine supervision and training activities that took place at district level. The study team  
5 documented that the June 2017 circular issued by the National Department of Health, informing  
6 health facilities of the change in Infant and Young Child feeding policy, was disseminated to  
7 comparison clinics as an announcement via e-mail and other electronic communication as well as  
8 during meetings or trainings. We documented that in Tshwane, 15 of the 18 clinics had received  
9 the circular; 11 via e-mail and three at a meeting. In Ugu nine of 17 clinics had received the  
10 circular; 8 received it via hand delivery and one via e-mail.  
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### 13 **Patient and Public Involvement**

14 Patients and the public were not involved in the design of this study, as the main population of  
15 interest were health workers. The intervention and tool were piloted amongst a separate group of  
16 health workers to determine length, complexity of questions and level of understanding. These  
17 details are explained in our intervention paper.[25]  
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### 20 **Data collection**

21 Data were collected between August and December 2017 by dedicated trained non-nurse data  
22 collectors who were independent of the intervention staff. As per study design, data collection staff  
23 were not part of any intervention activities and had never been exposed to the intervention. The  
24 primary outcome measure for the study was the confidence level of health workers to counsel on  
25 infant feeding, evaluated using a Likert-scale tool, developed after reviewing the WHO  
26 Breastfeeding Counselling Course, and the WHO HIV and Infant feeding counselling courses. [9  
27 30-33], see tool in Supplementary material. Secondary outcomes included health worker  
28 knowledge and attitude about breastfeeding counselling. A baseline assessment amongst all  
29 participating health workers in intervention and comparison sites was undertaken prior to the start  
30 of the intervention (August 2017). Health workers self-completed the assessment on study-  
31 provided electronic tablets at their workplaces. Questions covered basic demographic information,  
32 types of activities undertaken at work, knowledge, attitudes and confidence around counselling on  
33 infant feeding, see tool in Supplementary material. Approximately 12 weeks after the baseline  
34 assessment, a follow-up assessment using the same tool was conducted amongst the same group  
35 of health workers. Health workers who were not in the clinic on the day of the follow-up  
36 assessments were included in a special catch-up assessment. Questionnaire software had built in  
37 range and skip logic and data were transferred automatically to a database held at the University  
38 of KwaZulu-Natal.  
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### 43 **Data analysis**

44 There were three outcomes in the study: a) 22 knowledge statements which were scored 1 if  
45 correctly answered and 0 if not; evaluation of answers were based on existing literature and  
46 guidelines (binary outcomes); b) 21 attitude questions whose responses were measured on a 5-  
47 point Likert scale - given as completely disagree (1); disagree (2); neutral (3); agree (4) and  
48 completely agree (5); positive attitudes received higher scores; and c) 19 statements on confidence  
49 item questions which were also measured on a Likert scale, scored as such: not at all confident  
50 (1), not confident (2), confident (3) and very confident (4). For both attitude and confidence  
51 domains, a participant outcome was measured by the sum of the responses to the respective items  
52 (we verified that there was not a missing response on the items). Thus, the ranges for the attitude  
53 and confidence scores were 21 to 105, and 19 to 75, respectively.  
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Participants baseline and follow-up characteristics and outcomes between the intervention and control areas were compared using Chi-squared tests for categorical variables and two-sample t tests for continuous measures, after confirming that data were normally distributed. To assess the effect of the proposed intervention, several analysis methods for comparing intervention effect in before (pre)-after (post) quasi-experimental designs were considered. These included using post-measures and change from pre-intervention to post-intervention as the response variables. These approaches that use change and post measurements as the outcome, adjusting for pre-intervention measurements are recommended, and often give similar results.[34] In this paper, we considered three methods for estimating and testing the intervention effect using the sum of individual attitude or confidence scores as an outcome variable in a linear regression. The first method used the post-intervention measurements as the outcome variable but adjusted for the pre-intervention values; The second method analysed the change score as an outcome variable adjusting for pre-treatment values. The third method analysed the vectors of pre-and post-measurements as the outcome variable, and used time (coded 1 at follow-up and 0 at baseline) and treatment (coded:1 intervention group and 0: comparison group) as a covariates with an interaction term for time and treatment, in addition to an adjustment for pre-treatment values). Using methods 1 and 2 the coefficient for the intervention estimated the differences in the post intervention means and differences in the mean change of sum scores mean between the groups, controlling for the pre-intervention measurement. Using the third method, the sum of coefficients of intervention and the interaction terms was taken as the mean difference between groups post-treatment, allowing for pre-treatment mean differences between the groups. All analyses also controlled for baseline participant characteristics and prior training. Analyses adjusted for possible clustering effect at the site level, using a variance-correction method.[24] All the treatment effect comparison analyses were done on an intention to treat, rather than per-protocol, basis, Data can be obtained by e-mailing the corresponding author.

### Ethics

Ethics approval was obtained from the South African Medical Research Council (EC028-9/2016), the University of KwaZulu-Natal (RECIP348/17) and the WHO Ethics Review Committee (ERC0002833). Permission for undertaking the study was obtained from Tshwane and KZN Districts. Informed consent was sought from all study participants and no personal identifying information was captured in the questionnaires, only a study identification number.

### Results

At baseline and follow-up, 23 intervention clinics (one large clinic was sampled twice with two rounds of data collection per time point) and 12 comparison clinics were visited; 289 and 131 health worker interviews were conducted at baseline in intervention and comparison clinics, respectively (Figure 3). Loss to follow-up between baseline and follow-up did not differ between intervention and comparison sites (17 (13.0%) in comparison sites versus 36 (12.5%) in intervention sites).

Tshwane and Ugu Districts did not differ in the main outcome measures at baseline (knowledge, attitude and confidence). Additionally, they were similar in all health worker characteristics except three: Tshwane had significantly more participants with less than 2 years employment (14.4%

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3 versus 6.2%,  $p=0.007$ ), more registered nurses (57% versus 26.2%,  $p=0.02$ ), and fewer lay  
4 counsellors/CHWs (7.3% versus 50.0%, respectively,  $p=0.02$ ). Given the lack of significant  
5 difference in the main outcome variables at baseline, data from the two sites were combined for  
6 the analysis.  
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9 All staff approached agreed to participate in the interviews. There were no significant differences  
10 between intervention and comparison sites at baseline, regarding district of origin, median age of  
11 respondent, gender, cadre of health worker, and working duration (Table 1). The proportion of  
12 participants who had received previous training (through the routine health system) on specific  
13 topics was similar in intervention versus comparison sites, except for three topics which had better  
14 coverage in comparison sites (Supplementary Figure 1). These were: ever trained on how to assess  
15 and support ART adherence for HIV positive women (78.6% in intervention sites versus 89.2% in  
16 comparison sites,  $p=0.01$ ); ever trained about managing breastfeeding problems (76.5% in  
17 intervention sites and 86.2% in comparison sites,  $p=0.02$ ); and received any information or training  
18 about the revised infant feeding policy (55.1% in intervention sites versus 67.4% in comparison  
19 sites  $p=0.02$ ). At baseline, activities around breastfeeding counselling and management were  
20 similar between comparison and intervention sites in all respects except that comparison site  
21 participants reportedly spoke more frequently to HIV positive pregnant women about feeding than  
22 intervention participants (67% versus 71.6% spoke more than 1-3 times per month,  $p=0.04$ , data  
23 not shown).  
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**Table 1: Characteristics of the participants in the intervention and comparison groups at baseline**

Characteristic	Intervention group (n=289) (N (%))	Comparison group (n=131) (N (%))	p-value
<b>District:</b>			
- Tshwane	152 (52.6)	56 (42.8)	0.06
- Ugu	137 (47.4)	75 (57.3)	
<b>Age categories:</b>			
- 23 to 35 years	56 (19.4)	38 (29.7)	0.11
- 36 to 41 years	61 (21.2)	25 (19.5)	
- 42 to 46 years	53 (18.4)	26 (20.3)	
- 47 to 54 years	64 (22.2)	18 (14.1)	
- Over 54 years	54 (18.8)	21 (16.4)	
<b>Gender</b>			
- Female	267 (92.7)	118 (91.5)	0.66
- Male	21 (7.3)	11 (8.5)	
<b>Cadre of health worker</b>			
- Community level worker	84 (29.5)	52 (40.0)	0.05
- Trained health professional*	151 (53.0)	64 (49.2)	
- Enrolled nurse	50 (17.4)	14 (10.8)	
<b>Work experience in year (yr)/ years (yrs)</b>			
- Less than 1 yr	4 (1.4)	3 (2.3)	0.20
- 1 to <2 yrs	23 (8.0)	12 (9.3)	
- 2 to less than 5 yrs	36 (12.5)	18 (14.0)	
- 5 to less than 10 yrs	71 (24.7)	43 (33.3)	
- 10 yrs or more	154 (53.5)	53 (41.1)	

Abbreviations: \*includes 68% nurses in the intervention arm and 58% nurses in comparison arm. This group also includes operation managers, dieticians, doctors and nutritionists.

In intervention sites, workshops were attended by 84-88% of participants interviewed at follow-up (Table 2).

**Table 2: Attendance at workshops 1-3 measured at follow-up in intervention sites**

	Attended workshop n	Attended catch-up n	Total attended n/N (%)
<b>Number of staff attending each workshop:</b>			
Group workshop 1	202	63	265/303 (87.5)
Group workshop 2	223	34	257/303 (84.8)
Workshop 3 (Clinical mentoring)	216	40	256/303 (84.5)
<b>Number of workshops attended:</b>			
	number	%	
No workshop	42	13.9	
1 workshop	8	2.6	
2 workshops	6	2.0	
All 3 workshops	247	81.5	
<b>Total</b>	<b>303</b>	<b>100</b>	

## Effect of the intervention on health worker knowledge

At baseline, knowledge about key infant feeding statements or facts was similar between intervention and comparison sites, except for knowledge about soft porridge (Table 3). Although at baseline, more than 90% of intervention and comparison site participants knew that a baby under 4 months should not be given soft porridge if hungry, significantly more intervention site participants knew this recommendation (Table 3). The percentage of participants at baseline correctly answering the more difficult questions (on bottle sterilisation, storing expressed breastmilk, feeding HIV exposed infants) was low (Table 3). At follow-up significantly more intervention site participants correctly answered knowledge questions, regarding the leading cause of death in children under 5, the risk of formula feeding, duration of breastfeeding for HIV-negative mothers and women living with HIV, how to stop breastfeeding, complementary feeding, storing expressed breastmilk, feeding whilst at work, breastfeeding and viral suppression, mixed feeding in women living with HIV, adherence to ART and breastfeeding, breastfeeding difficulties in women living with HIV and managing women living with HIV who are breastfeeding, than comparison site participants (Table 3). The significant differences between intervention and comparison sites regarding soft porridge were not present at follow-up. Although improvements were seen in knowledge related to the risks of mixed feeding for women living with HIV, most health workers still provided incorrect responses at follow-up. At baseline, the mean number of correctly answered knowledge questions was 15.0 (68%) in comparison sites versus 15.2 (69%) in intervention sites,  $p=0.89$  (Table 3). At follow-up the mean number was 15.2 (69%) in comparison sites and 17.2 (78.2%) in intervention sites,  $p<0.001$  (Table 3). For the two questions measuring knowledge about the 2017 change in infant feeding guidelines, namely, “Continued breastfeeding for 2 years is the recommended infant method in SA for ALL children, regardless of mother’s HIV status” and “In South Africa, HIV-infected women who are breastfeeding should be supported to adhere to antiretroviral treatment and should introduce complementary foods at 6 months and be supported to continue breastfeeding for at least two years. (True)”, there was a 36% improvement in knowledge in the intervention group at follow-up compared with a 13% increase in knowledge in the control group. For the second question there was a 15% increase in correct knowledge in the intervention group at follow-up while for the comparison group knowledge decreased from 89-81%. At follow-up, knowledge scores of participants who attended 3 workshops compared with knowledge scores of participants who attended less than 3 workshops was significantly better ( $p<0.001$ ).

**Table 3: Knowledge of health workers about breastfeeding in the intervention and comparison sites at baseline and follow-up**

Knowledge statements	Number (%) with correct answers at BASELINE			Number (%) with correct answers at FOLLOW-UP		
	Intervention (n=289)	Comparison (n=131)	P-value *	Intervention (n=250)	Comparison (n=112)	P-value *
<b>Knowledge relating to updates in the HIV and Infant feeding guidelines</b>						
<i>Significant improvements between intervention and comparison groups at follow-up</i>						
Continued breastfeeding for 2 years is the recommended infant method in SA for ALL children, regardless of mother's HIV status (True)†	190 (65.7)	91 (70.0)	0.39	224 (89.6)	88 (78.6)	<0.01
An HIV-positive mother who is virally suppressed on antiretroviral treatment should breastfeed her child rather than not breastfeed to improve the child's survival (True) †	237 (82.0)	108 (83.1)	0.79	236 (94.4)	96 (85.7)	<0.01
A mother who has missed 6 tablets of Fixed Dose Combination ART in one month is considered to be poorly adherent and should stop breastfeeding immediately (False)** †	181 (62.6)	89 (68.5)	0.25	201 (80.4)	72 (64.3)	<0.01
In South Africa, HIV-infected women who are breastfeeding should be supported to adhere to antiretroviral treatment and should introduce complementary foods at 6 months and be supported to continue breastfeeding for at least two years. (True) †	245 (84.8)	116 (89.2)	0.220	244 (97.6)	91 (81.3)	<0.01
When an HIV-infected mother is ready to add complementary feeds she should stop breastfeeding rapidly over a 24-hour period (False) †	214 (74.1)	103 (79.2)	0.25	217 (86.8)	86 (76.8)	<0.05
If a mother misses 2 doses of her ART in one month, she should be classified as a treatment failure (False)** †	185 (64.0)	82 (63.1)	0.85	191 (76.4)	73 (65.2)	<0.05
<i>Low levels of knowledge (&lt;80%) at baseline in both groups - – no significant differences between intervention and comparison groups at follow-up [concept that this relates to]</i>						
If an HIV exposed baby is receiving both breastmilk and formula milk, the mother should choose either breastfeeding or formula feeding if she is adherent to ART (False) † [mixed feeding with formula and breastmilk]	69 (23.9)	29 (22.3)	0.71	75 (30.0)	28 (25.0)	0.33
A mother living with HIV and adherent to antiretroviral treatment cannot exclusively breastfeed her 4-month old infant because she is working. It is better for this mother to give formula during the day and breastfeed at night rather than giving no breast milk at all (True) † [mixed feeding with formula and breastmilk]	22 (7.6)	14 (10.8)	0.29	40 (16.0)	14 (12.5)	0.38

<b>High levels of knowledge (<math>\geq 80\%</math>) at baseline in both groups – no significant differences between intervention and comparison groups at follow-up</b>						
In South Africa, HIV-infected women who are breastfeeding should be supported to adhere to antiretroviral treatment and should be counselled and supported to exclusively breastfeed their infants for the first six months of life whilst maintaining an undetectable viral load (True) <sup>†</sup>	281 (97.2)	123 (94.6)	0.18	242 (96.8)	109 (97.3)	0.79
Mothers living with HIV who are receiving antiretroviral treatment and are virally suppressed should be advised not to breastfeed their infants (False) <sup>†</sup>	252 (87.2)	115 (88.5)	0.85	230 (92.0)	99 (88.4)	0.27
<b>General breastfeeding</b>						
<b>Significant improvements between intervention and comparison groups at follow-up</b>						
In South Africa, the leading cause of death amongst children under 5 is pneumonia (True)	189 (65.4)	82 (63.1)	0.65	230 (92.0)	75 (67.0)	<0.01
Giving any formula milk during the first six months of life increases the risk of death from diarrhoea and/or pneumonia (True)	246 (85.1)	104 (80.0)	0.17	232 (92.8)	95 (84.8)	0.02
It is safe to give the baby expressed breastmilk that has been kept outside the fridge for 8 hours (True)	106 (36.7)	43 (33.1)	0.48	120 (48.0)	38 (33.9)	<0.05
A mother who is working and giving formula milk should mix the milk herself and leave for the carer to give during the day (False)	218 (75.4)	94 (72.3)	0.50	189 (75.6)	68 (60.7)	<0.01
<b>Low levels of knowledge (&lt;80%) at baseline in both groups - - no significant differences between intervention and comparison groups at follow-up</b>						
When sterilising feeding bottles cover the bottles with water in a saucepan and place on the heat. As soon as the water boils remove from heat and do not leave the bottles in the water until completely cool (False)	64 (22.2)	27 (20.8)	0.75	53 (21.2)	25 (22.3)	0.81
<b>High levels of knowledge (<math>\geq 80\%</math>) at baseline in both groups – no significant differences between intervention and comparison groups at follow-up</b>						
Exclusive breastfeeding is the recommended infant feeding method for ALL infants aged 0-6 months in SA, regardless of mother's HIV status (True)	271 (93.8)	118 (90.8)	0.27	234 (93.6)	102 (91.1)	0.32
A baby under 4 months should be given soft porridge once he/she seems hungry (False)	284 (98.3)	124 (95.4)	0.09	247 (98.8)	108 (96.4)	0.13
Giving a baby expressed breastmilk is not as good as breastfeeding (False)	234 (81.0)	106 (81.5)	0.89	218 (87.2)	96 (85.7)	0.70
There are long term health benefits of breastfeeding for mother and child that last beyond the breastfeeding period (True)	264 (91.4)	116 (89.2)	0.49	232 (92.8)	100 (89.3)	0.26

<b>Breastfeeding and HIV</b>						
<i>Significant improvements between intervention and comparison groups at follow-up</i>						
An HIV-positive mother who has cracked nipples should continue to breastfeed unless they are bleeding (True)	143 (49.5)	64 (49.2)	0.96	187 (74.8)	59 (52.7)	<0.01
If a baby has a positive PCR (HIV test) at birth the mother should stop breastfeeding if this is affordable and feasible in her situation (False)**	224 (81.0)	100 (76.9)	0.90	214 (85.6)	82 (73.2)	<0.01
<i>High levels of knowledge (&lt;80%) at baseline in both groups – no significant differences between intervention and comparison groups at follow-up</i>						
An HIV-exposed baby who is exclusively breastfeeding should be given some water when the weather is very hot (False)**	270 (93.4)	122 (93.9)	0.87	239 (95.6)	105 (93.8)	0.45
<b>Mean knowledge score (standard deviation) out of 22</b>	<u>15.2 (2.6)</u>	<u>15.0 (3.1)</u>	<u>0.61*</u>	<u>17.2 (2.1)</u>	<u>15.2 (2.8)</u>	<u>&lt;0.01</u>

\*\*The Statement is false; thus, the scales were inverted during data analysis. † these questions measure the change in knowledge relating to the South African Department of Health June 2017 circular and the WHO 2016 updated HIV and Infant feeding guidelines

\*independent t-test comparing intervention and comparison sites at the relevant time point.

Note: the tables displays numbers with correct knowledge

### **Effect of the intervention on attitudes**

At baseline, intervention and comparison sites were similar in HW attitudes except for attitudes towards feeding a crying baby and expressing breastmilk, which were significantly better in intervention sites (Supplementary Table 1). At follow-up attitudes to breastfeeding and HIV were significantly better in the intervention group for 13 of the 21 questions and the mean attitude score towards breastfeeding was significantly better in intervention sites ( $p < 0.001$ ) (Supplementary Table 1). At follow-up HW in the intervention group were significantly less confused about what to tell women living with HIV about infant feeding mothers about HIV and infant feeding. Methods 1 and 2 yielded the same results, except for the effect of baseline attitude score. Thus, in Table 4 below, we only show results for Methods 1 and 3. Controlling for other variables, post intervention attitude was significantly better in intervention, compared with comparison, sites (Table 4). Using Methods 1, attitude at follow-up was 5.4 points higher in the intervention group than the comparison group; Method 3 analysis showed a significant 5.1-point higher score in the intervention compared with the comparison group. Using Method 1, being an enrolled nurse, and being in the youngest (36-41 years) or oldest (>54 years) age group was associated with a significantly lower attitude score. Using Methods 3, trained health professionals had a significantly higher attitude score at follow-up ( $p < 0.05$ ).



**Table 4: Adjusted effect of the intervention on health worker attitude score using different methods (Effect estimate and 95% confidence interval (CI))**

Variable	Method 1		Method 3	
	Effect estimate	95% CI	Effect estimate	95% CI
Attitude score at baseline	0.5	0.3; 0.7*	N/A	N/A
Intervention	5.4	3.9; 6.9*	5.1	2.1; 8.1*
Follow-up Period	N/A	N/A	1.8	0.2-3.4*
<b>Professional role: vs community level</b>				
- Trained health professional	1.6	-0.05; 3.2	4.8	2.8; 6.7*
- Enrolled nurse	-2.4	-5.0; -0.2*	0.9	-1.4; 3.2
<b>Ugu District vs Tshwane District</b>	-0.83	-2.2; 0.5	-1.4	-3.1; 0.2
<b>Age category: vs 23-35 yrs</b>				
- 36 to 41 yrs	-2.8	-5.4; -0.2*	-1.8	-4.1; 0.6
- 42 to 46 yrs	-0.9	-3.3; 1.5	-0.2	-2.5; 2.2
- 47 to 54 yrs	0.5	-2.0; 2.9	-1.2	-3.1; 0.8
- over 54 yrs	-3.3	-5.7; -1.0*	-2.2	-4.8; 0.3
<b>Work experience &lt;5 yrs vs ≥5yrs</b>	-0.3	-2.5; 1.9	-1.3	-3.4; 0.8
<b>Received training or information at work about the revised policy</b>	0.5	-1.4; 2.3	1.7	0.1-3.24
<b>Received any training about managing common breastfeeding problems?</b>	0.3	-2.5; 3.0	3.2	0.9-5.5
<b>Ever received any training about how to assess and support ART adherence for HIV positive women?</b>	-0.1	-2.2; 2.0	1.6	-0.5-3.8

\*p<0.05 N/A: not applicable. Note: All analyses are adjusted for clustering

### Effect of the intervention on confidence

At baseline there was no difference in the percentage of participants in the intervention and control sites who were confident or very confident in counselling mothers on HIV / infant feeding (Supplementary Table 2). However, at follow-up HWs from intervention sites were significantly more confident in counselling an HIV positive women about HIV and infant feeding, advising HIV positive women about return to school/work, advising HIV positive mothers to continue breastfeeding for two years, assessing ART adherence in HIV positive mothers, and advising HIV positive mothers about breastfeeding with cracked nipples (Supplementary table 2). Confidence had not shifted about how to stop breastfeeding, identifying when a mother is not ART adherent and managing poor adherence, advising on formula feeding and counselling that a shorter breastfeeding duration is better than no breastfeeding. The mean confidence score at follow-up was significantly higher in the intervention compared with the comparison sites at follow-up (p=0.05) (Supplementary Table 2). Methods 1 and 2 yielded the same results, except for the effect of baseline confidence score. Thus, in Table 5 below, we only show results for Methods 1 and 3. Controlling for other variables, post intervention confidence was significantly better in intervention, compared with comparison, sites; however this was only statistically significant

under Method 1. Our analysis demonstrated that, controlling for other factors, being a trained health professional significantly increased confidence score by 3.1 (Method 1) or 3.7 (Method 3). Additionally, Method 3 demonstrated that, controlling for other factors, working for less than 5 years significantly reduced the confidence score.

**Table 5: Adjusted effect of the intervention on health worker confidence scores, using different multivariable analysis methods (Effect estimate and 95% confidence interval (CI))**

Variable	Method 1		Method 3	
	Effect estimate	95% CI	Effect estimate	95% CI
Confidence score at baseline	0.4	0.3; 0.6*	N/A	N/A
Intervention	2.4	0.3; 4.5*	1.5	-2.2; 5.1
Follow-up time	N/A	N/A	0.5	-1.5; 2.5
<b>Cadre of health professional: vs community level</b>				
- Trained health professional	3.1	0.3; 5.9*	3.7	1.5; 5.9*
- Enrolled nurse	-0.8	-4.3; 2.7	-0.7	-3.1; 1.6
<b>Ugu District vs Tshwane District</b>	0.00	-2.1; 2.1	-1.	-3.2; 1.2
<b>Age category vs 23-35 yrs</b>				
- 36 to 41 yrs	-1.0	-3.7; 1.6	-0.1	-2.7; 2.5
- 42 to 46 yrs	0.3	-2.9; 3.4	0.4	-1.2; 2.9
- 47 to 54 yrs	1.4	-0.7; 3.5	-1.3	-3.4; 0.8
- over 54 yrs	-2.5	-5.7; 0.7	-0.9	-4.0; 2.2
<b>Work experience &lt;5 yrs vs ≥5 yrs</b>	-0.5	-3.4; 2.4	-1.9	-3.7; -0.2*
<b>Received training or information at work about the revised policy</b>	0.05	-1.5; 1.6	1.7	-0.3; 3.6
<b>Received any training about managing common breastfeeding problems?</b>	-0.6	-3.2; 2.1	1.8	-0.5; 4.1
<b>Ever received any training about how to assess and support ART adherence for HIV positive women?</b>	0.8	-2.1; 3.7	5.7	3.5; 7.9

\*p<0.005 N/A= not applicable yrs= years. NB: All analyses are adjusted for clustering

### Dose response analysis

We also conducted a dose-response analysis to assess whether or not the mentored health workers responded differently according to the number of workshops attended. The number of workshops grouped into 0, 1 or 2 and 3. Even though post intervention attitude and confidence scores as well as their increases were higher in the higher workshop attendance participants, none had statistically significant dose-response effect (p-value >0.05, data not shown)

## Discussion

We demonstrate that a participatory, side-by side, team-based mentoring approach to disseminating updated HIV and infant feeding guidelines was associated with an improvement in health workers' attitudes. when controlling for other factors. There was also a significant improvement in mean knowledge score between intervention and control sites at follow-up. However, we were not successful in shifting knowledge and attitudes about mixed feeding (breastmilk and formula milk) and health workers at the end of the study were not confident in advising that a shorter duration of breastfeeding is better than no breastfeeding at all. This demonstrates the success of at least 15 years of frequent publicity about the dangers of mixed feeding in the context of HIV and no ART, given that the two seminal papers on feeding practices and HIV were led by South African researchers.[35 36] Concerted communication? efforts are needed to highlight the acceptability of mixed feeding in the context of ART and maternal viral load suppression to facilitate a shift in knowledge about mixed feeding. Although some individual attitude and confidence items did not change, or only changed marginally, the overall analyses demonstrated an improvement in follow-up attitude and confidence scores. However, confidence in the intervention group was still low and health workers performed poorly on some of the more difficult confidence questions such as confidence with counselling when a mother is not ART adherent, managing high viral loads during breastfeeding, explaining HIV transmission risks to a mother with a high viral load, assisting mothers with HIV to safely formula feed and advising that some breastfeeding is better than no breastfeeding. The complexity of changing health workers' attitudes and confidence towards breastfeeding has been documented repeatedly in many African settings including South Africa.[11 25 37-39] We hypothesise that poor performance on some of the individual items or on the overall confidence score may be attributed to the short duration of the intervention. An alternative hypothesis is that HW's low confidence, around topics like non-adherence and high viral load, reflect more complex dynamics that are not easily addressed through counselling / mentoring interventions.[39] In fact a study from South Africa demonstrated how health workers personal beliefs affect their ability to provide supportive counselling.[11]

There is evidence that in-service training, supervision and follow-up improves the knowledge, skills and practices of health workers managing childhood undernutrition, and can improve health worker job satisfaction and motivation, but no data exist on how to improve health worker knowledge, skills and confidence in the tricky area of HIV and infant feeding.[40-42] For training / supervision interventions, implementation challenges include inadequately trained or shortages of supervisors, inappropriate job aids for follow-up, and poor alignment between community views/ practice and health programmes.[43] Our approach attempted to circumvent these challenges by using a low technology, mentorship model for skills development at clinic level. At the outset of the intervention we acknowledged that health workers were members of their community: we discussed their fears and beliefs, and then introduced facts and evidence to extend their knowledge, change their attitudes and increase their confidence to implement updated guidelines on HIV and infant feeding. Thus, we aimed to change inherent, deep seated beliefs and attitudes that are sustained in the absence of outside supervision.

We used a side-by-side mentorship approach, as reviewed by Schwerdtte et.al. to conduct team-based mentoring to empower health workers.[44] A team-based approach allowed collaborative

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3 learning between different cadres of health workers, facilitating any future change in practice. In  
4 accordance with Dee Fink's theory, a participatory mentorship approach allows participants to  
5 develop foundational knowledge, apply skills, integrate ideas, develop new feelings/ interests and  
6 values and learn how to learn.[26] Our experience suggests that such an approach allowed  
7 discussion of participants' attitudes towards performing the behaviour, beliefs about whether  
8 critical, important people will approve of the behaviour (subjective norms), and about their  
9 likelihood of successfully implementing the behaviour.[28 29] Our findings corroborate a scoping  
10 review which demonstrated that mentorship improves certain quality of care outcomes [44]; in our  
11 study it improved knowledge, attitudes and confidence. However, only four studies were included  
12 in this scoping review, and the nature of the mentorship varied from video-conferencing to  
13 monthly, six-weekly or annual visits interspersed with other contact forums, conducted over one  
14 day to an entire week. A list of desirable features of mentorship interventions, include at least one  
15 dedicated mentor per facility, ensuring an adequate mentor: mentee ratio so that all staff can be  
16 supported, forming meaningful relationships between mentors and mentees, ensuring cultural  
17 congruency between mentee and mentor, and using mentors for protocol-driven programmes, such  
18 as IMCI or HIV.[44] Our intervention related to HIV and infant feeding guidelines, was low cost  
19 and low technology (one mentor working with pen, flip chart and paper in the health facility), and  
20 was implemented by a dedicated mentor from the same cultural background as the mentees. She  
21 provided onsite support during the workshops, which lasted approximately one hour, and  
22 additional support through a WhatsApp messaging group.

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29 There is an ongoing health worker crisis in resource limited settings, including maldistribution of  
30 staff, an imbalance in skills mix, increasingly complicated health programmes and complicated  
31 socio-cultural-political-economic environments. Against this background, questions arise about  
32 the feasibility of an on-site mentorship approach to guideline dissemination amongst health  
33 workers, and an on-site peer-peer mentorship approach between women living with HIV to  
34 supporting mothers with infant feeding. In this study we chose to focus specifically on an onsite  
35 mentorship approach to guideline dissemination amongst health workers. We argue that  
36 strengthening investment in on-site mentorship rather than off-site training, may be a cost-saving  
37 approach. In our setting, all clinics receive regular visits from district primary health care (PHC)  
38 supervisors, but they mostly focus on administration and clinic management matters. These  
39 supervisors, as well as existing district PHC trainers, could be capacitated to provide clinical  
40 mentoring for health workers in the clinics they oversee. Our model of team-based learning and  
41 mentoring can be used for on-site mentoring, and avoids accommodation and travel costs, and  
42 absence from work that off-site training requires.

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60 Our study had several limitations: We purposively selected districts for inclusion. We could not  
control for previous breastfeeding experience of health workers as we did not gather these data.  
The study tools were piloted before finalisation, but no factor analyses or validation exercises were  
conducted. The follow-up evaluation was conducted 3 months after the intervention; thus, we were  
only able to measure short term benefits. Additionally, we did not co-design the intervention with  
women living with HIV, did not measure the effect of improved knowledge, attitudes and  
confidence on health workers' counselling practices and on mothers' infant feeding practices and  
could not tease out whether the relationship between number of workshops and outcomes was due  
to staff motivation (more motivated staff attended more workshops) or the workshops themselves.

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3 Co-designing the intervention with mothers living with HIV may have resulted in a different  
4 intervention and results, this needs to be considered in future work. Our study's strengths are that  
5 the design was quasi-experimental, measuring not only knowledge, but also attitudes and  
6 confidence. Additionally, results are robust as three different analytical methods yielded congruent  
7 results.  
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10 **Conclusion:** We demonstrated improved knowledge, attitudes and confidence of health workers  
11 following a participatory mentorship approach to HIV and infant feeding guideline dissemination  
12 compared with a standard approach. More research is needed to better understand how to change  
13 health workers' counselling practices, and whether this changes mothers' feeding practices.  
14

#### 15 **Authors contributions:**

16  
17 AG: Study conceptualization and tool development, protocol writing including intervention  
18 development, oversight of sampling and field work, writing of the first draft of this manuscript,  
19 receiving and incorporating co-author comments, finalization of the paper

20 TD: Study conceptualization and tool development, protocol writing including intervention  
21 development, set up the sample frame and sampling, contributed to the manuscript, reviewed and  
22 approved the final version of the manuscript

23 SM: Led the statistical components of the protocol; provided overall oversight on the statistical  
24 analysis, contributed to the manuscript, reviewed and approved the final version of the  
25 manuscript

26 TN: Performed the work on the statistical components of the protocol, under SM's guidance;  
27 provided data analysis under SM's guidance, contributed to the manuscript, reviewed and  
28 approved the final version of the manuscript

29 LH: Contributed to study conceptualization and tool development, protocol writing including  
30 intervention development; was overall Project Manager; established, managed and cleaned the  
31 database; contributed to the manuscript, reviewed and approved the final version of the  
32 manuscript

33 VJ: Provided guidance on intervention development. Contributed to the manuscript, reviewed  
34 and approved the final version of the manuscript

35 IMSE: Contributed to study conceptualization and tool development, protocol writing including  
36 intervention development; contributed to the manuscript, reviewed and approved the final  
37 version of the manuscript

38 UF: Contributed to study conceptualization, assisted with district level buy-in in Tshwane  
39 District, provided information on how routine dissemination of updated infant feeding  
40 guidelines; contributed to the manuscript, reviewed and approved the final version of the  
41 manuscript

42 AD: Contributed to study conceptualization and tool development; contributed to the manuscript,  
43 reviewed and approved the final version of the manuscript

44 NR: Contributed to study conceptualization; contributed to the manuscript, reviewed and  
45 approved the final version of the manuscript

46 MK: Contributed to study conceptualization and tool development; contributed to the  
47 manuscript, reviewed and approved the final version of the manuscript

48 DS: Contributed to study conceptualization and tool development; contributed to the manuscript,  
49 reviewed and approved the final version of the manuscript  
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3 SK: Contributed to study conceptualization, assisted with national level buy-in, provided  
4 information on how routine dissemination of updated infant feeding guidelines; contributed to  
5 the manuscript, reviewed and approved the final version of the manuscript

6 TT: Contributed to study conceptualization and tool development; contributed to the manuscript,  
7 reviewed and approved the final version of the manuscript

8 CH: Study conceptualization, protocol writing including intervention development, high level  
9 oversight of study implementation, contributed to the manuscript, reviewed and approved the  
10 final version of the manuscript  
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14 **Data sharing statement:** Data can be obtained by e-mailing the corresponding author, and upon  
15 reasonable request

16  
17 **Figure legends:**

18  
19 Figure 1: Study districts: Tshwane District in Gauteng Province and Ugu District in KwaZulu-Natal  
20 Province of South Africa

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22 Figure 2: Theoretical frameworks which informed the development of the intervention

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24 Figure 3: Study population at baseline and follow-up for intervention and comparison sites

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26 Supplementary Figure 1: Prior training reported by participants at baseline (intervention versus  
27 comparison groups)  
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**Figure 1: Study districts: Tshwane Metropolitan Municipality in Gauteng Province and Ugu District in KwaZulu-Natal Province of South Africa**

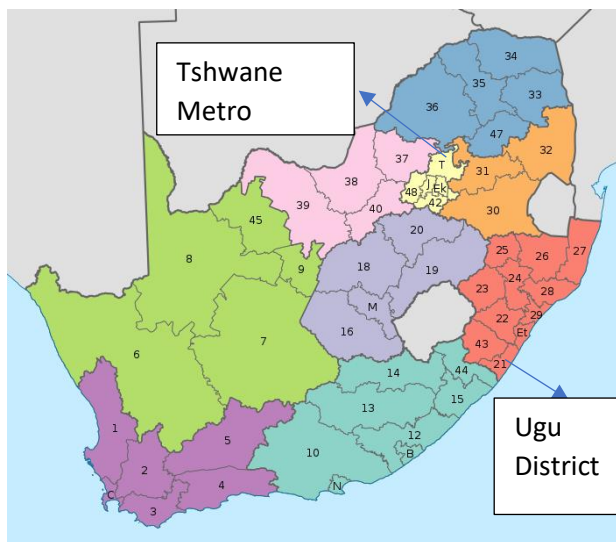
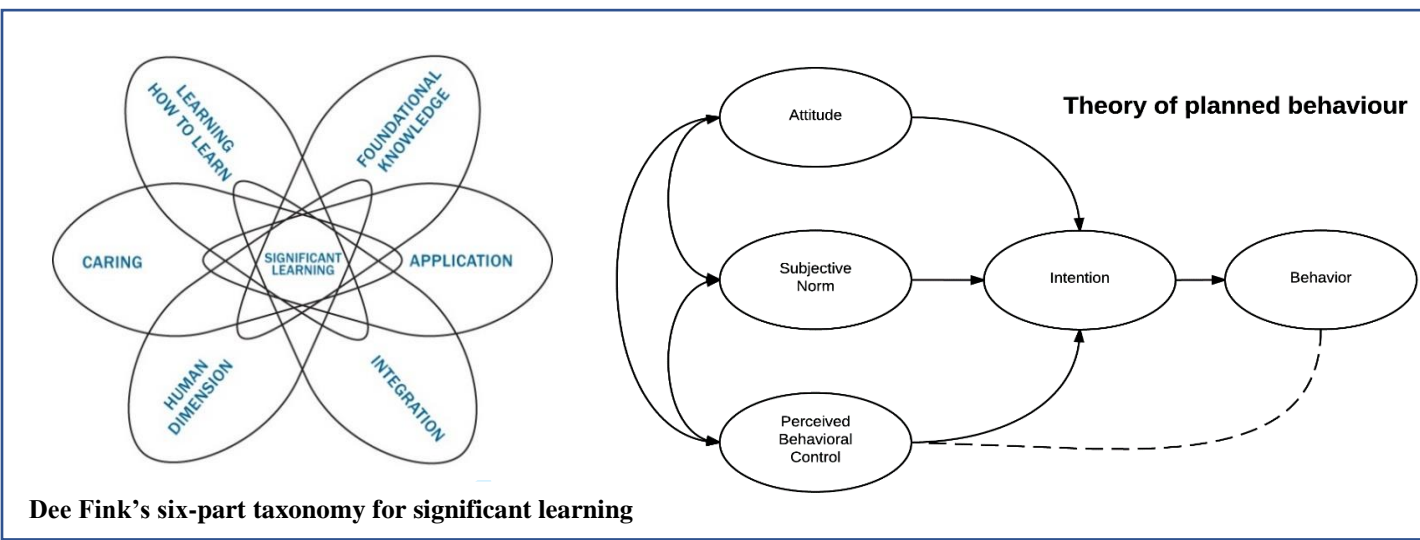


Figure 2: Theoretical frameworks which informed the development of the intervention

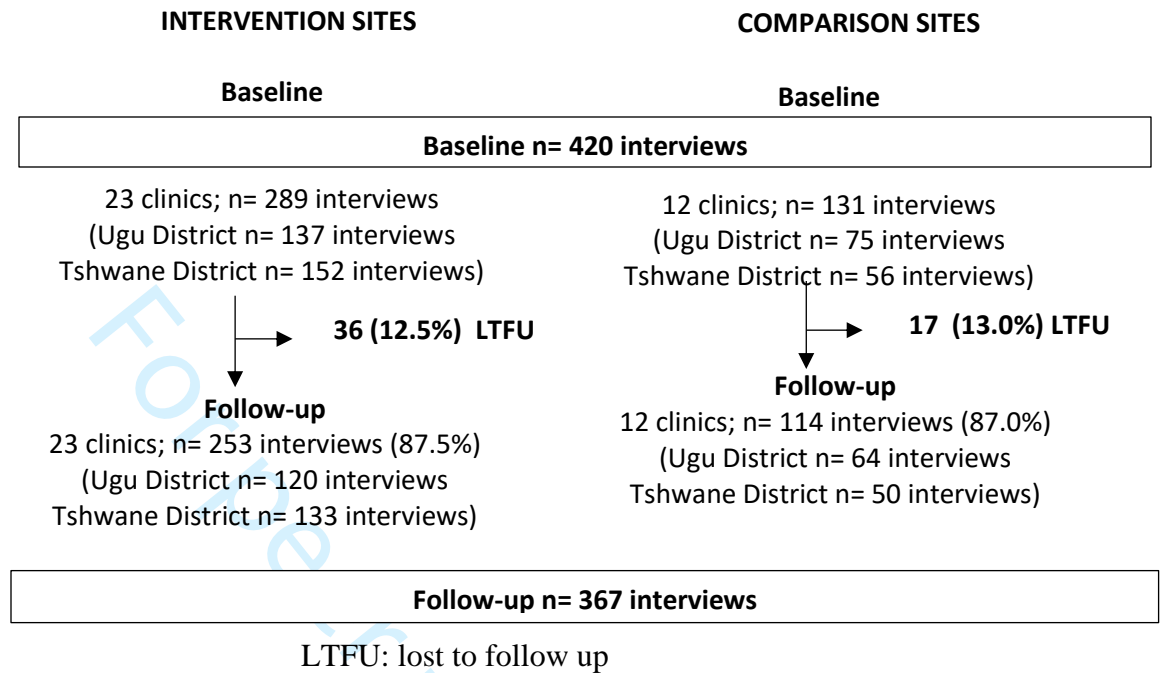


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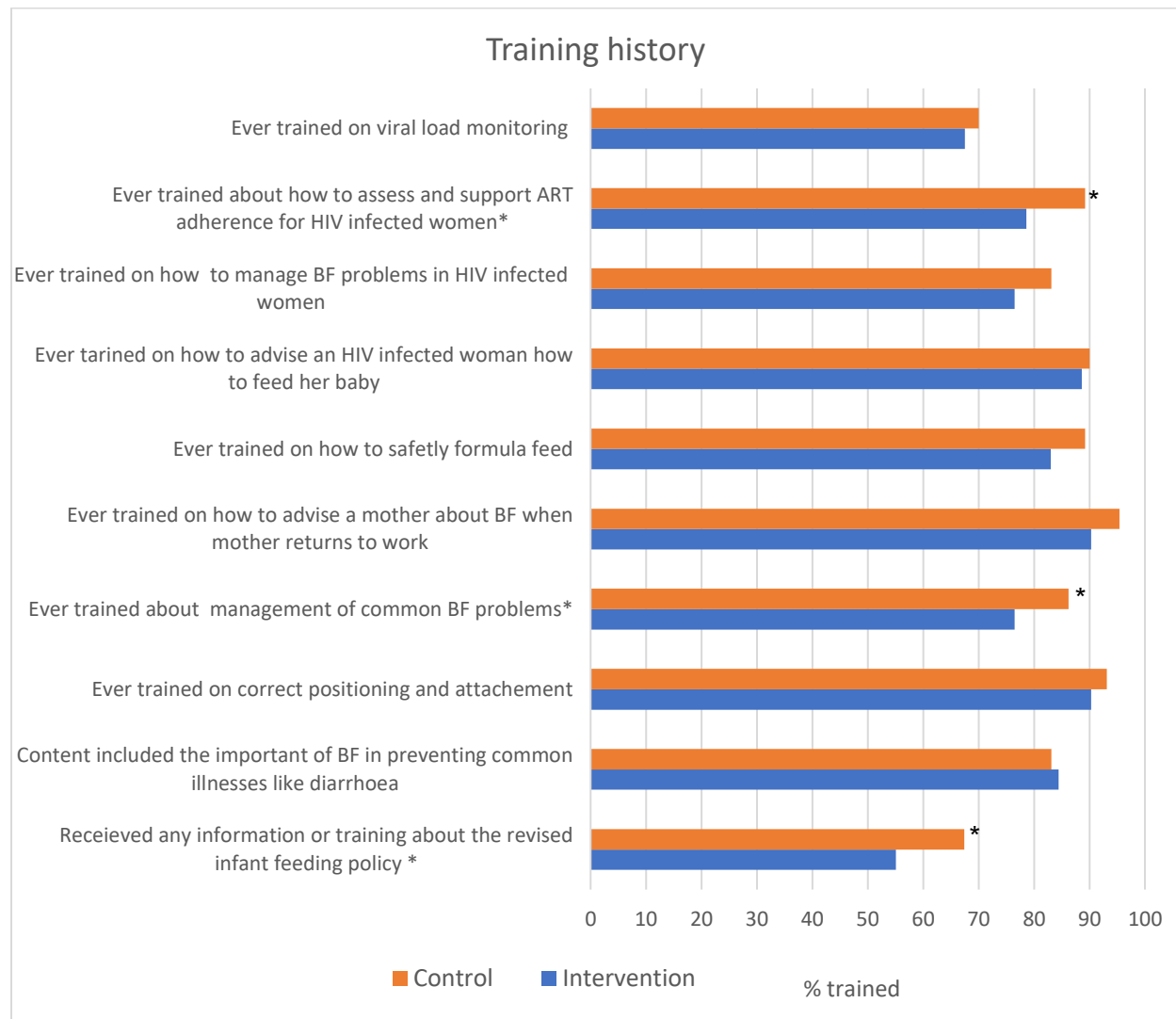
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**Figure 3: Study population at baseline and follow-up for intervention and comparison sites**



**Supplementary Figure 1: Prior training reported by participants at baseline (intervention versus comparison groups)**



\* $p < 0.05$

Abbreviations: ART= antiretroviral therapy; BF= breastfeeding

**Supplementary Table 1: Attitude scores of health workers at baseline and follow-up**

Attitude statements	Number (%) who agreed or strongly agreed with the statement at baseline			Number (%) who agreed or strongly agreed with the statement at follow-up		
	Intervention (n=289)	Comparison (n=131)	P-value *	Intervention (n=252)	Comparison (n=114)	p-value*
<i>Significant improvements between intervention and comparison groups at follow-up</i>						
There have been so many changes to the infant feeding guidelines and breastfeeding guidelines however I am NOT confused about what to tell mothers who are HIV-infected about breastfeeding	155 (53.6)	74 (56.9)	0.59	175 (69.4)	65 (57.0)	0.02
For an HIV-exposed infant any breastfeeding is better than no breastfeeding at all, as long as the mother is virally suppressed and on antiretroviral therapy	189 (65.4)	79 (61.2)	0.31	196 (77.8)	74 (64.9)	0.01
When a baby cries all the time it is NOT usually because the baby is hungry and needs more food than just breastmilk	260 (90.0)	107 (83.0)	0.02	230 (91.3)	91(79.8)	<0.01
Exclusive breastfeeding in the first 6 months of life is the best choice for all mothers and babies in South Africa	256 (88.6)	114 (88.4)	0.65	239 (94.8)	98 (86.0)	<0.01
The benefits of breastfeeding for protecting children from illness such as diarrhoea and pneumonia outweighs the risk of acquiring HIV if the mother is on antiretroviral treatment	224 (77.5)	93 (72.1)	0.15	218 (86.5)	87 (76.3)	0.02
I feel that an HIV-infected mother who has not disclosed to her partner is NOT at high risk of non-adherence to ART and should NOT stop breastfeeding as soon as possible	128 (44.3)	51 (39.5)	0.30	137 (54.4)	46 (40.4)	0.01
I should support all mothers, regardless of HIV status, to continue breastfeeding until 2 years, as long as HIV-infected women are virally suppressed	237 (82.0)	101 (78.3)	0.24	237 (94.1)	87 (76.3)	<0.01
I should NOT advise an HIV-positive virally suppressed mother who has cracked and bleeding nipples to temporarily stop breastfeeding	80 (27.7)	40 (31.3)	0.55	97 (38.5)	24 (21.1)	<0.01
Formula feeding is NOT the best choice for mothers living in good socio-economic circumstances who are going back to work	202 (70.0)	95 (74.2)	0.58	198 (78.6)	74 (64.9)	<0.01
It is safer for HIV-positive mothers to breastfeed than to formula feed	231 (79.9)	89 (69.5)	0.63	226 (89.7)	85 (74.6)	<0.01
It is NOT very difficult for mothers to express breastmilk while they are at work or school	164 (53.0)	57 (44.5)	0.01	168 (67.1)	51 (44.7)	<0.01
If an HIV-positive mother can afford to buy formula it is NOT better for her to formula feed her baby	170 (58.8)	83 (64.9)	0.38	185 (73.4)	68 (59.7)	<0.01
Promoting breastfeeding for two years for HIV-exposed infants is NOT a risk because	197 (68.2)	85 (66.4)	0.51	210 (83.3)	79 (69.3)	<0.01

mothers will be able to maintain good ART adherence for that long						
<b>Low levels of knowledge (&lt;80%) at baseline in both groups - no significant differences between intervention and comparison groups at follow-up [concept that this relates to]</b>						
For an HIV-positive mother on antiretroviral treatment and virally suppressed mixed feeding is better than not breastfeeding at all	39 (13.5)	15 (11.7)	0.56	57 (22.6)	16 (14.0)	0.06
In our community working mothers can successfully maintain exclusive breast feeding while going to work	219 (75.8)	89 (69.5)	0.09	208 (82.5)	92 (80.7)	0.67
There are exceptional circumstances where an HIV-positive mother would be advised not to breastfeed, such as failure of 2 <sup>nd</sup> or 3 <sup>rd</sup> line ART treatment, but these are not common	225 (77.9)	93 (72.7)	0.13	201 (79.7)	87 (76.3)	0.46
<b>High levels of knowledge (≥80%) at baseline in both groups – no significant differences between intervention and comparison groups at follow-up</b>						
HIV-exposed babies who are PCR negative must NOT stop breastfeeding as soon as possible	238 (82.4)	104 (81.3)	0.47	221 (87.7)	95 (83.3)	0.26
Exclusive breastfeeding for six months is an achievable goal for the majority of mothers	249 (86.2)	105 (82.0)	0.11	227 (90.1)	96 (84.1)	0.11
An HIV-positive mother who is on ART and not virally suppressed and is mixed feeding is putting her child at risk of acquiring HIV	256 (88.6)	109 (85.2)	0.13	219 (86.9)	97 (85.1)	0.64
In South Africa it is possible to improve exclusive breastfeeding rates	244 (84.7)	108 (84.4)	0.61	230 (91.3)	97 (85.1)	0.08
Formula feeding is NOT more convenient for a mother than breastfeeding	253 (87.5)	109 (85.2)	0.23	211 (83.7)	100(87.7)	0.32
<b><u>Number (%) participants whose attitude was to at least agree (Attitude score ≥84)*</u></b>	<b><u>71 (24.6)</u></b>	<b><u>23 (17.9)</u></b>	<b><u>0.12</u></b>	<b><u>123 (49.2)</u></b>	<b><u>27 (24.1)</u></b>	<b><u>&lt;0.01</u></b>
<b><u>Mean attitude score out of 105 (95% CI)</u></b>	<b><u>76.9 (75.9 – 77.9)</u></b>	<b><u>75.0 (73.0 – 77.0)</u></b>	<b><u>0.07</u></b>	<b><u>82.7 (81.6 – 83.8)</u></b>	<b><u>76.8 (75.0 – 78.5)</u></b>	<b><u>&lt;0.01</u></b>

\*84 was the minimum score obtainable if a participant at least agreed with all statements



**Supplementary Table 2: Confidence statements of health workers at baseline and follow-up**

Confidence statements	Number (%) who felt confident or very confident at baseline			Number (%) who felt confident or very confident at follow-up		
	Intervention (n=289)	Comparison (n=131)	p-value	Intervention (n=252)	Comparison (n=114)	p-value
<b>Significant improvements between intervention and comparison groups at follow-up</b>						
How confident do you feel about counselling an HIV-positive pregnant woman about how she will feed her baby	265 (91.7)	116 (88.6)	0.30	240 (95.2)	100 (87.7)	0.01
How confident do you feel about advising an HIV-positive mother about how to continue to breastfeed her baby when she returns to work or school	258 (89.3)	117 (89.3)	0.99	242 (96.0)	101 (88.6)	<0.01
How confident do you feel about advising an HIV-infected mother to continue breastfeeding for two years	216 (74.7)	105 (80.2)	0.23	236 (93.6)	93 (81.6)	<0.01
How confident do you feel about assessing ART compliance in an HIV-positive mother	240 (83.1)	111 (84.7)	0.67	230 (91.3)	94 (82.5)	0.02
How confident do you feel about advising an HIV-infected mother who is exclusively breastfeeding and has cracked nipples with bloody milk about how to feed her baby	196 (67.8)	84 (64.1)	0.45	201 (79.8)	80 (70.2)	0.04
<b>Low levels of knowledge (&lt;80%) at baseline in both groups - no significant differences between intervention and comparison groups at follow-up [concept that this relates to]</b>						
How confident do you feel about advising an HIV-infected mother about how to stop breastfeeding	214 (74.1)	89 (67.9)	0.20	188 (74.6)	86 (75.4)	0.87
How confident do you feel about identifying when an HIV-positive mother is not adhering to her ART treatment	224 (77.5)	104 (79.4)	0.67	218 (86.5)	90 (79.0)	0.07
How confident do you feel about reassuring a mother living with HIV who is virally suppressed that a shorter duration of breastfeeding is better than never initiating breastfeeding	227 (78.5)	103 (78.6)	0.99	215 (85.3)	96 (84.2)	0.78
How confident do you feel about assisting a mother with HIV to safely formula feed her baby	212 (73.4)	102 (77.9)	0.33	191 (75.8)	95 (83.3)	0.11
How confident do you feel about using the guidelines for safe replacement feeding when you counsel a mother who is not adherent to ART and has a viral load above 1000 copies/ml	191 (66.1)	99 (75.6)	0.05	185 (73.4)	75 (65.8)	0.14
How confident do you feel about advising an HIV-infected mother who is exclusively breastfeeding and has defaulted from her ART about how to feed her baby	205 (70.9)	97 (74.1)	0.51	189 (75.0)	80 (70.2)	0.33
How confident do you feel about managing poor ART compliance in an HIV-infected breastfeeding mother	215 (74.4)	104 (79.4)	0.27	209 (82.9)	89 (78.1)	0.27

A mother is not adherent to ART and her last viral load is 1000 copies per ml. How confident do you feel about counselling her about feeding her infant?	199 (68.9)	98 (74.8)	0.21	198 (78.6)	80 (70.2)	0.08
<b>High levels of knowledge (<math>\geq 80\%</math>) at baseline in both groups – no significant differences between intervention and comparison groups at follow-up</b>						
How confident do you feel about giving information about the risks and benefits of breastfeeding to an HIV-infected mother	268 (92.7)	120 (91.6)	0.67	238 (94.4)	102 (89.5)	0.09
How confident do you feel about assessing whether there is good positioning and attachment during breastfeeding	263 (91.0)	125 (95.4)	0.11	243(96.4)	107 (93.9)	0.27
How confident do you feel about advising an HIV-infected mother who is virally suppressed who is mixed feeding her infant	243 (84.1)	113 (86.3)	0.57	226 (89.7)	99 (86.8)	0.43
How confident do you feel about advising an HIV-positive mother about starting complementary feeds	251 (86.9)	115 (87.8)	0.79	229 (90.9)	103 (90.4)	0.87
How confident do you feel about explaining the risks of HIV transmission through breastmilk to an HIV-infected mother with high viral load	247 (85.5)	114 (87.0)	0.67	220 (87.3)	105 (92.1)	0.17
How confident do you feel about explaining to a mother about expressing and storing milk	269 (93.1)	124 (94.7)	0.54	237 (94.1)	109 (95.6)	0.54
<b>Number (%) participants who were confident or very confident (Sum Score <math>\geq 57</math>)</b>	<b><u>164 (56.8)</u></b>	<b><u>86 (67.2)</u></b>	<b><u>0.09</u></b>	<b><u>175 (70.0)</u></b>	<b><u>72 (64.3)</u></b>	<b><u>0.28</u></b>
<b>Mean confidence score out of 76 (95% CI)</b>	<b><u>59.1</u></b> <b><u>(58.0-60.2)</u></b>	<b><u>59.1</u></b> <b><u>(57.0-61.3)</u></b>	<b><u>1.0</u></b>	<b><u>61.2</u></b> <b><u>(60.8-63.1)</u></b>	<b><u>59.9</u></b> <b><u>(58.1-61.7)</u></b>	<b><u>0.05</u></b>

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**QUESTIONNAIRE FOR HEALTHCARE WORKERS**

For peer review only

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Section 1. Admin		
1.1.	Interview Date	<input type="text"/> <input type="text"/> / <input type="text"/> <input type="text"/> <input type="text"/> / <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> D D M M M Y Y Y Y
1.2.	District	<input type="radio"/> OTshwane <input type="radio"/> OUgu
1.3.	Sub district	<b>If Tshwane chosen above:</b> <input type="radio"/> OTshwane 1 <input type="radio"/> OTshwane 2 <input type="radio"/> OTshwane 3 <input type="radio"/> OTshwane 6 <b>If Ugu chosen above:</b> <input type="radio"/> Omdoni <input type="radio"/> UmZumbe <input type="radio"/> Hibiscus <input type="radio"/> uMuziwabantu
1.4.	Facility	<b>If Tshwane 1 selected the following clinics can be chosen:</b> <input type="radio"/> Soshang Block JJ clinic <input type="radio"/> KT Motubatse clinic <input type="radio"/> Boikhutsong clinic <input type="radio"/> Sedilega clinic <input type="radio"/> Shoshanguve 2 clinic <input type="radio"/> Soshang Block TT clinic <b>If Tshwane 2 selected:</b> <input type="radio"/> Jubilee gateway clinic <input type="radio"/> Kekanastad clinic <input type="radio"/> Suurman clinic <input type="radio"/> Ramotse clinic <input type="radio"/> Kekana gardens clinic <input type="radio"/> New Eersterus clinic <b>If Tshwane 3 selected</b> <input type="radio"/> Atteridgeville Clinic <input type="radio"/> Bophelong Clinic (Tshw 3) <input type="radio"/> Saulsville Clinic

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		<p><b>If Tshwane 6 selected</b></p> <ul style="list-style-type: none"> <li>S Bopape CHC</li> <li>Eersterust CHC</li> <li>Nellmapius Clinic</li> </ul> <p><b>If Omdoni selected</b></p> <ul style="list-style-type: none"> <li>GJ Crooke's Gateway</li> <li>Pennington Clinic</li> <li>Philani Clinic</li> <li>Scottburgh Clinic</li> <li>Umzinto Clinic</li> </ul> <p><b>If UmZumbe selected</b></p> <ul style="list-style-type: none"> <li>• Gqayinyanga clinic</li> <li>• St Faiths clinic</li> <li>• Phungashe clinic</li> <li>• Ntimbankulu clinic</li> <li>• Turton CHC</li> <li>• Ndelu clinic</li> </ul> <p><b>If Hibiscus coast selected:</b></p> <ul style="list-style-type: none"> <li>• Gamalakhe CHC</li> <li>• Southport Clinic</li> <li>• Marburg Clinic</li> </ul> <p><b>If uMuziwabantu selected</b></p> <ul style="list-style-type: none"> <li>• Santombe clinic</li> <li>• Meadowsweet clinic</li> <li>• Mbonwa clinic</li> </ul>
1.5.	Health worker number	Assigned number to each participant

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Section 2. Demographics	
2.1.	What is your date of birth? <input type="text"/> <input type="text"/> / <input type="text"/> <input type="text"/> / <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> D D M M Y Y Y Y
2.2.	Gender <input type="radio"/> Male <input type="radio"/> Female
2.3.	What is your role in this clinic? <input type="radio"/> Lay counsellor or nutritional advisor <input type="radio"/> Enrolled nurse assistant <input type="radio"/> Enrolled nurse <input type="radio"/> Registered nurse <input type="radio"/> Medical degree (MB ChB or equivalent) <input type="radio"/> community health worker (CCG) <input type="radio"/> dietician <input type="radio"/> Registered nurse operational manager <input type="radio"/> other specify below
2.4.	Other
2.5.	How long have you been working as a health worker? <input type="radio"/> less than 1 year <input type="radio"/> 1- <2 years <input type="radio"/> 2- <5 years <input type="radio"/> 5-< 10 years <input type="radio"/> 10 or more years

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Section 3	<b>Updated HIV and infant feeding guidelines. In this section you will be asked about new infant feeding guidelines adopted in South Africa.</b>	
3.1	During 2017 have you received any information or training at work about the revised Infant and Young Child Feeding Policy – in the form of a circular, letter, workshop, meeting or lecture	<input type="radio"/> Yes <input type="radio"/> No <input type="radio"/> SKIP
3.2	If yes, how did you receive this information?	1. <input type="radio"/> Circular/letter 2. <input type="radio"/> Meeting 3. <input type="radio"/> Workshop 4. <input type="radio"/> Feedback/information from colleague 5. <input type="radio"/> lecture 6. <input type="radio"/> other
3.3	Who gave you this information/ training?	1 <input type="radio"/> District trainer/ DoH staff member 2 <input type="radio"/> Outside/ private company
3.4	How long was this training?	_____ hours

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SECTION 4.	<b>TRAINING Topics</b> Have you received any training on the following topics (either in-service or formal training).  <b>Usuke wathola uqeqesho kulezihloko ezilandelayo?</b>		
4.1	Did the content of your training include the importance of breastfeeding in preventing common childhood illness such as diarrhoea?	1 <input type="radio"/> Yes	0 <input type="radio"/> No
4.2	Have you ever had any training about correct positioning and attachment of an infant during breastfeeding?	1 <input type="radio"/> Yes	0 <input type="radio"/> No
4.3	Have you ever had any training about the management of common breastfeeding problems?	1 <input type="radio"/> Yes	0 <input type="radio"/> No
4.4	Have you ever had any training about advising a mother about how to provide breastmilk for her baby when she returns to work or school	1 <input type="radio"/> Yes	0 <input type="radio"/> No
4.5	Have you ever had any training about how to advise a mother about formula feeding safely?	1 <input type="radio"/> Yes	0 <input type="radio"/> No
4.6	Have you ever had any training about how to advise an HIV infected woman about how to feed her baby?	1 <input type="radio"/> Yes	0 <input type="radio"/> No
4.7	Have you ever had any training about how to manage breastfeeding problems in HIV infected women (cracked nipples, mastitis etc.)?	1 <input type="radio"/> Yes	5.0 <input type="radio"/> No
4.8	Have you ever had any training about how to assess and support ART adherence for HIV infected women?	1 <input type="radio"/> Yes	0 <input type="radio"/> No
4.9	Have you ever had any training on viral load monitoring?	1 <input type="radio"/> Yes	0 <input type="radio"/> No



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Section 5	<b>ACTIVITIES:</b> <i>Think carefully about your work in this facility.</i> For the activity mentioned consider whether you ever perform this activity and if so how regularly do you perform this activity? If you do not perform this activity at all select the option 'Never'				
5.1	How often do you talk to groups of pregnant women attending the antenatal clinic about infant feeding (group counselling)	1 <input type="radio"/> one or more times per week	2 <input type="radio"/> one to three times per month	3 <input type="radio"/> Less than once a month	4 <input type="radio"/> Never
5.2	How often do you talk to a pregnant woman individually about her plan for feeding her baby	1 <input type="radio"/> one or more times per week	2 <input type="radio"/> one to three times per month	3 <input type="radio"/> Less than once a month	4 <input type="radio"/> Never
5.3	How often do you talk to an HIV infected pregnant woman about her plan for feeding her baby	1 <input type="radio"/> one or more times per week	2 <input type="radio"/> one to three times per month	3 <input type="radio"/> Less than once a month	4 <input type="radio"/> Never
5.4	How often do you assist a mother with breastfeeding within the first hour post delivery	1 <input type="radio"/> one or more times per week	2 <input type="radio"/> one to three times per month	3 <input type="radio"/> Less than once a month	4 <input type="radio"/> Never
5.5	How often do you talk to a mother about how she is feeding her baby?	1 <input type="radio"/> one or more times per week	2 <input type="radio"/> one to three times per month	3 <input type="radio"/> Less than once a month	4 <input type="radio"/> Never
5.6	How often do you observe a mother breastfeeding during a clinic or home visit	1 <input type="radio"/> one or more times per week	2 <input type="radio"/> one to three times per month	3 <input type="radio"/> Less than once a month	4 <input type="radio"/> Never
5.7	How often do you talk to a mother about positioning and attachment of the baby during breastfeeding	1 <input type="radio"/> one or more times per week	2 <input type="radio"/> one to three times per month	3 <input type="radio"/> Less than once a month	4 <input type="radio"/> Never
5.8	How often do you talk to an HIV infected mother about managing a breastfeeding problem (e.g. cracked nipples, baby crying all the time, mother says she does not have enough milk)	1 <input type="radio"/> one or more times per week	2 <input type="radio"/> one to three times per month	3 <input type="radio"/> Less than once a month	4 <input type="radio"/> Never
5.9	How often do you talk to a mother about how to maintain breastfeeding when away from the baby (going back to school or work)	1 <input type="radio"/> one or more times per week	2 <input type="radio"/> one to three times per month	3 <input type="radio"/> Less than once a month	4 <input type="radio"/> Never
5.10	How often do you talk to an HIV infected breastfeeding mother about taking ARVs	1 <input type="radio"/> one or more times per week	2 <input type="radio"/> one to three times per month	3 <input type="radio"/> Less than once a month	4 <input type="radio"/> Never

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SECTION 6	INFANT FEEDING KNOWLEDGE			
please state whether the statement is true or false or you do not know				
	Statement	True	False	Do not know
6.1	Exclusive breastfeeding is the recommended infant feeding method for ALL infants aged 0-6 months in SA, regardless of mother's HIV status	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>
6.2	Giving any formula milk during the first six months of life increases the risk of death from diarrhoea and/or pneumonia	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>
6.3	Continued breastfeeding for 2 years is the recommended infant method in SA for ALL children, regardless of mother's HIV status	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>
6.4	Mothers living with HIV who are receiving antiretroviral treatment and are virally suppressed should be advised not to breastfeed their infants	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>
6.5	When an HIV infected mother is ready to add complementary feeds she should stop breastfeeding rapidly over a 24hour period	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>
6.6	If an HIV exposed baby is receiving both breastmilk and formula milk, the mother should chose to either breastfeeding or formula feeding if she is adherent to ART	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>
6.7	A mother who is working and giving formula milk should mix the milk herself and leave for the carer to give during the day	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>
6.8	An HIV positive mother who is virally suppressed on antiretroviral treatment should breastfeed her child rather than not breastfeed to improve the child's survival	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>
6.9	When sterilising feeding bottles cover the bottles with water in a saucepan and place on the heat. As soon as the water boils remove from heat and leave the bottle in the water until completely cool	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>
6.10	In South Africa, the leading cause of death amongst children under 5 is pneumonia	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>
6.11	In South Africa, HIV infected women who are breastfeeding should be supported to adhere to antiretroviral treatment and should be counselled and supported to exclusively breastfeed their infants for the first six months of life whilst maintaining an undetectable viral load	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>
6.12	A baby under 4 months should be given soft porridge once he/she seems hungry	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>

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6.13	A mother living with HIV and adherent to antiretroviral treatment cannot exclusively breastfeed her 4-month old infant because she is working. It is better for this mother to give formula during the day and breastfeed at night rather than giving no breast milk at all	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>
6.14	An HIV exposed baby who is exclusively breastfeeding should be given some water when the weather is very hot	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>
6.15	If a baby has a positive PCR (HIV test) at birth the mother should stop breastfeeding if this is affordable and feasible in her situation	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>
6.16	Giving a baby expressed breastmilk is not as good as breastfeeding	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>
6.17	If a mother misses 2 doses of her ART in one month, she should be classified as a treatment failure	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>
6.18	An HIV positive mother who has cracked nipples should continue to breastfeed unless they are bleeding	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>
6.19	A mother who has missed 6 tablets of FDC in one month is considered to be poorly adherent and should stop breastfeeding immediately	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>
6.20	There are long term health benefits of breastfeeding for mother and child that last beyond the breastfeeding period	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>
6.21	In South Africa, HIV infected women who are breastfeeding should be supported to adhere to antiretroviral treatment and should introduce complementary foods around 6 months and be supported to continue breastfeeding for at least two years.	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>
6.22	It is safe to give the baby expressed breastmilk that has been kept outside the fridge for 8 hours	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>

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<b>SECTION 7.</b>		<b>INFANT FEEDING ATTITUDE</b>				
		Please state whether you completely disagree, disagree, neutral, agree or completely agree with the statement				
		Completely disagree	Disagree	Neutral	Agree	Completely agree
7.1	There have been so many changes to the infant feeding guidelines and breastfeeding guidelines that I am confused about what to tell mothers who are HIV infected about	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>	4 <input type="radio"/>	5 <input type="radio"/>
7.2	When a baby cries all the time it is usually because the baby is hungry and needs more food than just breastmilk	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>	4 <input type="radio"/>	5 <input type="radio"/>
7.3	Exclusive breastfeeding in the first 6 months of life is the best choice for all mothers and babies in South Africa	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>	4 <input type="radio"/>	5 <input type="radio"/>
7.4	For an HIV exposed infant any breastfeeding is better than no breastfeeding at all, as long as the mother is virally suppressed and on antiretroviral therapy	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>	4 <input type="radio"/>	5 <input type="radio"/>
7.5	The benefits of breastfeeding for protecting children from illness such as diarrhoea and pneumonia outweighs the risk of acquiring HIV if the mother is on antiretroviral treatment	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>	4 <input type="radio"/>	5 <input type="radio"/>
7.6	I feel that an HIV infected mother who has not disclosed to her partner is at high risk of non-adherence to ART and should stop breastfeeding as soon as possible	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>	4 <input type="radio"/>	5 <input type="radio"/>
7.7	I should support all mothers, regardless of HIV status, to continue breastfeeding until 2 years, as long as HIV infected women are virally suppressed	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>	4 <input type="radio"/>	5 <input type="radio"/>
7.8	I should advise an HIV positive virally suppressed mother who has cracked and bleeding nipples to temporarily stop breastfeeding	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>	4 <input type="radio"/>	5 <input type="radio"/>
7.9	HIV exposed babies who are PCR negative must stop breastfeeding as soon as possible	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>	4 <input type="radio"/>	5 <input type="radio"/>

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7.10	Formula feeding is the best choice for mothers living in good socioeconomic circumstances who are going back to work	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>	4 <input type="radio"/>	5 <input type="radio"/>
7.11	For an HIV positive mother on antiretroviral treatment and virally suppressed mixed feeding is better than not breastfeeding at all	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>	4 <input type="radio"/>	5 <input type="radio"/>
7.12	Exclusive breastfeeding for six months is an achievable goal for the majority of mothers	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>	4 <input type="radio"/>	5 <input type="radio"/>
7.13	It is safer for HIV positive mothers to breastfeed than to formula feed	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>	4 <input type="radio"/>	5 <input type="radio"/>
7.14	In our community working mothers can successfully maintain exclusive breast feeding while going to work	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>	4 <input type="radio"/>	5 <input type="radio"/>
7.15	An HIV positive mother who is on ART and not virally suppressed and is mixed feeding is putting her child at risk of acquiring HIV	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>	4 <input type="radio"/>	5 <input type="radio"/>
7.16	It is very difficult for mothers to express breastmilk while they are at work or school	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>	4 <input type="radio"/>	5 <input type="radio"/>
7.17	If an HIV positive mother can afford to buy formula it is better for her to formula feed her baby	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>	4 <input type="radio"/>	5 <input type="radio"/>
7.18	Promoting breastfeeding for two years for HIV exposed infants is a risk because mothers will be unable to maintain good ART adherence for that long	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>	4 <input type="radio"/>	5 <input type="radio"/>
7.19	In South Africa it is possible to improve exclusive breastfeeding rates	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>	4 <input type="radio"/>	5 <input type="radio"/>
7.20	There are exceptional circumstances where an HIV positive mother would be advised not to breastfeed, such as failure of 2 <sup>nd</sup> or 3 <sup>rd</sup> line ART treatment, but these are not common	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>	4 <input type="radio"/>	5 <input type="radio"/>
7.21	Formula feeding is more convenient for a mother than breastfeeding	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>	4 <input type="radio"/>	5 <input type="radio"/>

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SECTION N 8.	<b>INFANT FEEDING COUNSELLING CONFIDENCE</b> For each activity below, please indicate how confident you feel to undertake each activity. Do you feel "Not at all confident", "Not very confident", "Somewhat confident" or "Very confident".				
		Not at all confident	Not very confident	Confident	Very confident
8.1	How confident do you feel about counselling an HIV positive pregnant woman about how she will feed her baby	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>	4 <input type="radio"/>
8.2	How confident do you feel about giving information about the risks and benefits of breastfeeding to an HIV infected mother	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>	4 <input type="radio"/>
8.3	How confident do you feel about assessing whether there is good positioning and attachment during breastfeeding	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>	4 <input type="radio"/>
8.4	How confident do you feel about advising an HIV positive mother about how to continue to breastfeed her baby when she	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>	4 <input type="radio"/>
8.5	How confident do you feel about advising an HIV infected mother who is virally suppressed who is mixed feeding her infant	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>	4 <input type="radio"/>
8.6	How confident do you feel about advising an HIV infected mother to continue breastfeeding for two years	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>	4 <input type="radio"/>
8.7	How confident do you feel about advising an HIV infected mother about how to stop breastfeeding	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>	4 <input type="radio"/>
8.8	How confident do you feel about advising an HIV positive mother about starting complementary feeds	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>	4 <input type="radio"/>
8.9	How confident do you feel about assessing ART compliance in an HIV positive mother	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>	4 <input type="radio"/>
8.10	How confident do you feel about identifying when an HIV positive mother is not adhering to her ART treatment	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>	4 <input type="radio"/>
8.11	How confident do you feel about reassuring a mother living with HIV who is virally suppressed that a shorter duration of breastfeeding is better than never initiating breastfeeding	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>	4 <input type="radio"/>
8.12	How confident do you feel about explaining the risks of HIV transmission through breastmilk to an HIV infected mother with high viral load	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>	4 <input type="radio"/>

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8.13	How confident do you feel about assisting a mother with HIV to safely formula feed her baby	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>	4 <input type="radio"/>
8.14	How confident do you feel about advising an HIV infected mother who is exclusively breastfeeding and has cracked nipples with bloody milk about how to feed her baby	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>	4 <input type="radio"/>
8.15	How confident do you feel about using the guidelines for safe replacement feeding when you counsel a mother who is not adherent to ART and has a viral load above 1000 copies/ml	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>	4 <input type="radio"/>
8.16	How confident do you feel about advising an HIV infected mother who is exclusively breastfeeding and has defaulted from her ART about how to feed her baby	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>	4 <input type="radio"/>
8.17	How confident do you feel about explaining to a mother about expressing and storing milk	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>	4 <input type="radio"/>
8.18	How confident do you feel about managing poor ART compliance in an HIV infected breastfeeding mother	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>	4 <input type="radio"/>
8.19	A mother is not adherent to ART and her last viral load is 1000 copies per ml. How confident do you feel about counselling her about feeding her infant?	1 <input type="radio"/>	2 <input type="radio"/>	3 <input type="radio"/>	4 <input type="radio"/>