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RESEARCH ARTICLE

Healthcare Workers' Knowledge of HIV-Exposed Infant Feeding Options and Infant Feeding Counseling Practice in Northern Nigeria

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Abstract: ***Background*:** Despite the existence of evidence-based HIV-exposed infant feeding guidelines, infants in Africa still acquire HIV through inappropriate feeding practices.

***Objective*:** To identify predictors of HIV-exposed infant feeding knowledge and counseling practice among health care workers (HCW) in Nigeria.

***Methods*:** Structured, pretested questionnaires were administered to HCW (n=262) in a tertiary health facility in Kano, Nigeria. Multivariate logistic regression was used to determine predictors of HIV-exposed infant feeding knowledge and counseling practice.

***Results*:** Of 262 respondents, (58.0%, *n*=152) had good knowledge of recommended feeding options. Respondents listed exclusive breastfeeding (57.6%, *n*=151), human milk substitutes (45.4%, *n*=119), HIV-negative wet-nursing (37.0%, *n*=97), heated expressed human milk (20.6%, *n*=54) and mixed feeding (13.4%, *n*=35) as appropriate feeding choices. Over half (57.3%, *n*=150) of the respondents have ever counseled a HIV-positive mother on infant feeding. Knowledge was predicted by female sex (Adjusted Odds Ratio (AOR)=2.47, 95% Confidence Interval (CI):1.35-4.52), profession (physician vs. laboratory scientist, AOR=4.00, 95%CI:1.25-12.87; nurse/midwife vs. laboratory scientist, AOR=2.75, 95%CI:1.17-9.28), infant feeding counseling training (AOR=3.27, 95%CI:1.87-5.71), and number of children (2-4 vs. 0, AOR=1.75, 95%CI:1.23-3.92). Infant feeding counseling was predicted by female sex (AOR=2.85, 95%CI:1.39-5.85), age (>40 vs. <30 years, AOR=3.87, 95%CI:1.27-15.65), knowledge of infant feeding options (good vs. fair/poor, AOR=3.96, 95%CI:2.07-7.59), training (AOR=2.60, 95%CI:1.42-5.32), and profession (physician vs. laboratory scientist, AOR=10.7, 95%CI:2.85-40.54; nurse/midwife vs. laboratory scientist, AOR=4.8, 95%CI:1.26-18.02).

***Conclusion*:** The practice of infant feeding counseling among HCW in Nigeria is associated with sex, knowledge, and profession. Our findings may inform the development of targeted training programs for HCW in similar settings.

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1. INTRODUCTION

Human milk is the ideal source of nutrients for the newborn, but mother's milk is also a vehicle for the transmission of infectious agents, as in infants born to women living with HIV [1-6]. Before the availability of effective interventions, about 15% of HIV-exposed infants acquired HIV infection through breastfeeding [7-9]. However, effective antiretroviral therapy (ART) in mothers lowers postnatal transmission rates in breastfed infants to 0.3% and 0.58% at 6 months and 24 months, respectively [10, 11].

In low-resource settings, the World Health Organization (WHO) recommends lifelong ART therapy for women living with HIV, and exclusive breastfeeding for 6 months for HIV-exposed infants [12]. With this recommendation, the infant receives only mother's own milk without any other liquids or solids, not even water, except for oral rehydration solution, vitamins, minerals or medicines, and breastfeeding continued thereafter, along with complementary feeds until 24 months [12]. In contrast, replacement feeding is recommended for their counterparts in high-income countries [13]. However,

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evidence suggests that healthcare workers in low-resource settings struggle to keep up with the rapidly evolving infant feeding policies and fail to convey current best practice recommendations to mothers [14-16]. This practice deficit increases the risk of vertical HIV transmission [15, 17-20].

Nigeria is a high burden country with a HIV prevalence of 1.5% and 0.2% among adults and children (<15 years), respectively, [21, 22] and a large gap in the uptake of services for prevention of mother-to-child HIV transmission (PMTCT) [23-27]. The Nigeria national HIV policy advises healthcare workers to counsel mothers to exclusively breastfeed HIV-exposed infants for the first 6 months and continue breastfeeding with complementary feeds for 12 months [28]. Healthcare workers constitute a trusted source of information [29, 30] and serve as important role models for mothers [31]. The personal biases, knowledge of guidelines, and counseling skills of healthcare workers could, therefore, influence infant feeding practices [32]. A recent study found suboptimal exclusive breastfeeding rates among HIV-positive mothers attending a tertiary health center in northern Nigeria [33], and little is known about healthcare workers' counseling practices [34].

The objective of the study is to identify predictors of knowledge and HIV exposed infant feeding counseling practice among healthcare workers in a tertiary facility in Kano, Nigeria. Our findings could inform the development of targeted training interventions for HCW that would impact initiatives for eliminating mother-to-child transmission of HIV.

2. MATERIALS AND METHODS

2.1. Study Area and Population

The study was conducted in Aminu Kano Teaching Hospital, Nigeria (AKTH), a tertiary referral center for more than 13 million people located in Kano, the most populous city in northern Nigeria [35]. With 750 bed capacity and 2,188 healthcare workers, AKTH provides prevention, treatment, and care to over 6,000 people living with HIV. Mothers are counseled on infant and young child feeding based on national guidelines [28]. In addition to antiretroviral treatment for mothers and infant nevirapine prophylaxis, caregivers are counseled to exclusively breastfeed for the first six months. Complementary feeds are then introduced with continued breastfeeding during infancy. Proper attachment and nipple care are demonstrated to mothers and risks associated with nipple cracks, mastitis and infant mouth ulcers [36-40] communicated. The safety of expressed pasteurized human milk and HIV-negative wet-nursing (*i.e.* the breastfeeding of an infant by someone other than the infant's biological mother) are also explained.

The study population included health care professionals providing clinical care, namely physicians, nurses/midwives, pharmacists, and laboratory scientists. Other participants were social workers, counselors and community health extension workers. Only eligible healthcare workers employed at AKTH who provided informed consent were included. Workers providing non-clinical, administrative and support services were excluded. Further, staff on study leave, sick leave and those who withheld consent were excluded. The study protocol was reviewed and approved by the AKTH research ethics committee.

2.2. Study Design and Sampling

The study was cross-sectional in design. A target sample size of 286 was estimated from Fisher's formula for a single proportion [41], using the proportion of healthcare workers that counseled mothers on feeding options in a previous study (79.0%) [34], 95% confidence level and tolerable error of 5%. This number was increased by 10% to account for anticipated non-response.

A two-stage sampling method was employed. In the first stage, healthcare workers were stratified by professional categories as physicians, nurses/midwives, pharmacists, laboratory scientists and others (community health extension workers, social workers, counselors and community health officers). Probability proportionate to size was used to assign numbers to the strata. In stage two, eligibility was first determined and using a systematic sampling process, sampling intervals were obtained for each stratum. The first respondent in each stratum was randomly selected using a serial number between 1 and the sampling interval. Subsequent respondents were obtained by adding the sampling interval to the previous respondent's serial number. Sampled healthcare workers were then recruited into the study after providing informed consent.

2.3. Questionnaire and Measures

A 24-item structured self-administered questionnaire was derived from WHO recommendations [12] and previous studies [33, 42]. The questionnaire was pretested to enhance clarity and validated among 30 healthcare workers in Mohammed Abdullahi Wase Specialist Hospital, Kano, Nigeria. Content validity was confirmed by two specialist pediatricians, who agreed that the questions are valid measures of knowledge and infant feeding counseling practice among healthcare workers. Reliability was obtained for the knowledge and infant feeding counseling practice sections (Cronbach's alpha values of 0.87 and 0.85, respectively). The questionnaire had 3 sections. In the first section, 11 items elicited socio-demographic characteristics, including age, sex, marital status, ethnicity, education, religion, marital status, professional category, work experience, number of children, and hospital unit. The second section included 12 items that assessed knowledge of HIV transmission risks and options for feeding HIV-exposed infants (yes, no, or don't know responses). Correct responses were awarded 1 mark, while incorrect and 'don't know' responses were scored 0. Total scores of ≤4, 5-8 and 9-12 were graded as poor, fair and good knowledge, respectively [19]. Section 3 assessed self-reported HIV-exposed infant feeding counseling practice. Respondents who answered 'Yes' to the question 'Have you ever counseled a woman living with HIV on how to feed her infant?' were considered to have practiced infant counseling.

2.4. Study Procedures

After securing the permission of hospital management and the cooperation of the various professional unions, for-

mal communications were sent to department heads to inform their staff about the study. Sampled eligible respondents were individually contacted by trained research assistants and provided detailed information on the study objectives and what participation entails. Respondents were informed that participation was voluntary, and that there are no consequences for withholding or withdrawing consent. Healthcare workers were approached individually in their workplaces. Sampled respondents who signed an informed consent form were provided a paper questionnaire in an envelope and were requested to fill the questionnaires independently. A research staff returned at an agreed time on the same day to collect the completed questionnaire. Two data entry clerks checked and independently double-entered the data in a password-protected database at the Centre for Infectious Disease Research. To ensure confidentiality, serial numbers were assigned and no identifiers were collected. Research assistants were trained in human research participant protection and the consent process.

2.5. Statistical Analyses

Data were analyzed using SPSS Version 22.0 [43]. Means and standard deviation or medians and range/ interquartile range were used to summarize numeric data, as appropriate. Frequencies and percentages were obtained for categorical variables. Pearson's Chi-square [44] or Fisher's exact test [45] was used to assess significant associations between socio-demographic and training variables and the outcomes. Type I error was fixed at 5% for all tests. Binary logistic regression models were developed for knowledge and HIV-exposed infant feeding counseling. Independent variables included socio-demographic, work experience and training variables with $p<0.10$ at the bivariate level and those considered conceptually important [46]. For the infant feeding counseling practice model, knowledge was included. The outcome measure were predictors of knowledge and HIV-exposed infant feeding counseling practice among healthcare workers at AKTH, Nigeria. Adjusted odds ratios (AORs) and the 95% CIs were used to measure the strength and direction of effect of the independent variables on the outcomes.

3. RESULTS

3.1. Participant Demographics

Of the 286 healthcare workers contacted, 262 completed the questionnaires (response rate of 91.6%). The mean age of participants was 35.4±8.14 years. Most participants were female (55%, *n*=144), of Hausa/Fulani ethnic group (72.5%, *n*=190), Muslim (83.6%, *n*=219), and married (68.7%, *n*=180). Over half (60.7%, *n*=159) of respondents had at least 5 years of work experience and (42.0%, *n*=110) had been trained on infant and young child feeding counseling. The participants included physicians (37.4%, *n*=98) nurses/midwives (35.2%, *n*=92), pharmacists (7.6%, *n*=20), laboratory scientists (7.6%, *n*=20) and other healthcare workers (12.2%, *n*=32). Approximately 44% of the participants (*n*=115) had two to four children (Table **1**).

Table 1. Characteristics of health care workers, Aminu Kano Teaching Hospital, Kano, Nigeria.

Characteristics	Frequency No. (%) N=262
Sex	-
Male	118 (45.0)
Female	144 (55.0)
Age group	-
<30	71 (27.1)
30-39	114 (43.5)
≥40	77 (29.4)
Ethnicity	-
Hausa	136 (51.9)
Fulani	54 (20.6)
Others*	72 (27.5)
Religion	-
Islam	219 (83.6)
Christianity	43 (16.4)
Marital status	-
Single	75 (28.6)
Married	180 (68.7)
Divorced/Widowed	7 (2.7)
Professional category	-
Physician	98 (37.4)
Nurse/Midwife	92 (35.2)
Pharmacist	20 (7.6)
Laboratory Scientist	20 (7.6)
Others**	32 (12.2)
Years of experience	-
<5	102 (38.9)
5-9	72 (27.5)
≥10	87 (33.2)
No. of children	-
0	80 (30.5)
1	28 (10.7)
2-4	115 (43.9)
≥5	39 (14.9)
Hospital Unit	-
Obstetrics & Gynecology	58 (22.1)
Pediatrics	58 (22.1)
S S Wali ART center	24 (9.2)
GOPD	12 (4.6)
Others***	110 (42.0)

Others* include Yoruba, Igbo, Kanuri, Egbira, Igala
Others** include social workers, community health officers, and community health extension workers
Others*** include specialty clinics, pediatric outpatient and special care baby unit

Table 2. Knowledge of HIV transmission and feeding options among health care workers, Kano, Nigeria.

-	-	Frequency No. (%)		
S. No.	-	Yes	No	Don't know
-	**HIV transmission**	-	-	-
1.	HIV transmissible during pregnancy	183 (69.8)	79 (30.2)	-
2.	HIV transmissible during delivery	231 (88.2)	31 (11.8)	-
3.	HIV transmissible during breastfeeding	227 (86.6)	35 (13.4)	-
4.	Possible for an HIV-positive mother to breastfeed without infecting her baby	209 (79.8)	53 (20.2)	-
-	**Recommended feeding options**	-	-	-
5.	Exclusive breastfeeding	151 (57.6)	111 (42.4)	-
6.	Human milk substitutes	119 (45.4)	143 (54.6)	-
7.	HIV-negative wet nursing	97 (37.0)	165 (63.0)	-
8.	Heated expressed human milk	54 (20.6)	208 (79.4)	-
9.	Mixed feeding (human milk and infant formula or other feeds)	35 (13.4)	227 (86.6)	-
10.	Recommended duration of exclusive breastfeeding for exposed infants	-	-	-
-	(i). 6 months	195 (74.4)	-	-
-	(ii). 4 months	12 (4.6)	-	-
-	(iii). One year	19 (7.3)	-	-
-	(iv). As long as is convenient for the mother	11 (4.2)	-	-
-	(v). Others	5 (1.9)	-	-
-	(vi). Don't know	20 (7.6)	-	-
11.	Continued breastfeeding (with complementary feeding) for HIV exposed infants after 6 months?	109 (41.6)	119 (45.4)	34 (13.0)
12.	Recommended weaning age for HIV exposed infants	-	-	-
-	(i). 9 months	14 (5.3)	-	-
-	(ii). 12 months	70 (26.7)	-	-
-	(iii). 18 months	11 (4.2)	-	-
-	(iv). 24 months	14 (5.3)	-	-
-	(v). Don't know	153 (58.4)	-	-
13.	Breastfeeding is encouraged for mothers with unknown HIV status?	159 (60.7)	65 (24.8)	38 (14.5)
14.	Avoidance of breastfeeding increases the chance of HIV transmission	50 (19.1)	185 (70.6)	27 (10.3)
15.	Mastitis increases chance of HIV transmission	159 (60.7)	53 (20.2)	50 (19.1)
16.	Mouth ulcer in infant increases risk of HIV acquisition	207 (79.0)	23 (8.8)	32 (12.2)
17.	HIV-positive mothers should breastfeed exclusively for 6 months like all other mothers	210 (80.2)	27 (10.3)	25 (9.5)
18.	ART in mothers reduce the risk of HIV transmission to the baby	236 (90.1)	4 (1.5)	22 (8.4)
19.	All babies breastfed by HIV positive mothers will become HIV-positive	28 (10.7)	209 (79.8)	25 (9.5)
20.	The breast milk of all HIV-positive mothers contain the virus	191 (72.9)	40 (15.3)	31 (11.8)

3.2. Knowledge of HIV Transmission Risk and Feeding Options

Most (86.6%, *n*=227) of the respondents were aware of the risk of HIV transmission through breastfeeding. The proportions of respondents with good, fair and poor knowledge of recommended feeding options for HIV-exposed infants were 58.0%, (*n*=152), 36.0% (*n*=94) and 6.0% (*n*=16), respectively. The feeding options mentioned by respondents included exclusive breastfeeding (57.6%, *n*=151), human milk substitutes (45.4%, *n*=119), HIV-negative wet-nursing (37.0%, *n*=97), heated expressed human milk (20.6%, *n*=54) and mixed feeding with human milk and infant formula or

other feeds (13.4%, *n*=35). Similarly, three-fourths of the participants stated that HIV-exposed infants should be exclusively breastfed for 6 months, with less than half (41.6%, *n*=109) recommending continued breastfeeding thereafter. Whereas more than a quarter of respondents felt that HIV-exposed infants should be weaned at 12 months, more than one-half of them (58.4%, *n*=153) did not know (Table **2**).

3.3. Infant Feeding Counseling Practice

Over half (57.3%, *n*=150) of the respondents have ever counseled a HIV-positive mother on infant feeding options. Although most participants (77.9%, *n*=204) opined that counseling should be provided during prenatal visits, less than half of them counselled mothers during that period, while more than half (57.3%, *n*=150) did so after delivery.

3.4. Predictors of Knowledge and Infant Feeding Counseling Practice

At the bivariate level, knowledge of feeding options was associated with respondents' sex, age, marital status, professional category, years of experience, training in infant feeding, and the number of children ($p<0.05$) (Table **3**).

At the multivariate level, knowledge of feeding options was predicted by sex (female versus male, Adjusted Odds ratio (AOR) =2.47, 95% Confidence Interval (CI): 1.35-4.52), profession (physician versus laboratory scientist, AOR=4.00, 95%CI: 1.25-12.87), (nurse/midwife versus laboratory scientist, AOR=2.75, 95%CI: 1.17-9.28), number of children (1 versus 0, AOR=1.20, 95%CI: 1.11-6.12; 2-4 versus 0, AOR=1.75, 95%CI: 1.23-3.92) and training on infant and young child feeding counseling (AOR=3.27, 95%CI: 1.87-5.71) (Table **4**).

At the bivariate level, infant feeding counseling was associated with respondents' sex, age group, knowledge of infant feeding options, marital status, professional category, years of experience, training on infant feeding, number of children and hospital unit ($p<0.05$). At the multivariate level, infant feeding counseling practice was independently predicted by participants' sex (female versus male, AOR=2.85, 95%CI (1.39-5.85), age (30-39 versus <30 years, AOR=1.58 95% CI: 1.15-4.85; >40 versus <30 years, AOR=3.87, 95%CI: 1.27-15.65), knowledge of infant feeding options (good versus fair/poor, AOR=3.96, 95%CI: 2.07-7.59), profession (physician versus laboratory scientist, AOR=10.7, 95%CI: 2.85-40.54; nurse/midwife versus laboratory scientist, AOR=4.8, 95%CI: 1.26-18.02) (Table **5**). All models were of a good fit, as demonstrated by Hosmer-Lemeshow test results of $\chi2=14.6$, p=0.067 and $\chi2=13.6$, p=0.093 for the knowledge and HIV-exposed infant feeding counseling practice models, respectively.

4. DISCUSSION

In this study, the predictors of HIV-exposed infant feeding knowledge and counseling practices among healthcare workers in Kano, Nigeria were assessed. Inadequate knowledge and sub-optimal infant feeding counseling practices among study participants were found. Knowledge was predicted by respondents' sex, the number of children, previous training, and profession, whereas counseling practice was independently predicted by sex, age, knowledge, previous training, and profession.

Our findings are consistent with reports from other parts of Nigeria [47], Kenya [48], and South Africa [49]. For instance, the proportion of respondents with good knowledge of HIV-exposed infant feeding options was similar to the figure (61.1%) from Benin City, Nigeria [47]. Similarly, the proportion of the respondents who were aware of the transmission risk through breastfeeding and of preventive measures was consistent with figures of 86.6% and 92% from Kenya, respectively [48]. The proportion of participants recommending exclusive breastfeeding for HIV exposed infants also concurred with reports from Uganda [18] and Tanzania [14], but not South Africa (97%) [42].

Consistent with our findings, discrepancies between healthcare worker recommendations and national guidelines were reported in South Africa, [50] Kenya [48] and Papua New Guinea [51]. In South Africa, these incongruities were related to breastfeeding initiation, feeding frequency, giving water and the duration of breastfeeding [50]. Up to 93% of the respondents correctly indicated that breastfeeding should be initiated within the first hour. However, contrary to the guidelines, 71% and 50% would allow water and solid feeds before age six months [50]. Further, relative to our respondents, higher proportions of healthcare workers (45%-49.7%) in other African studies considered pasteurized human milk to be safe for HIV-exposed infants [42, 48]. Compared to other studies, a lower proportion of our respondents were aware of the transmission risk associated with mastitis and infant mouth ulcers [36]. These differences could be related to the opportunities and intensity of training, access to current guidelines and confusing infant feeding guidelines for low and high-income countries [52]. Consistent with our findings, two-thirds of participants in Kenya recommended exclusive breastfeeding to mothers of unknown HIV status [48].

In keeping with our findings, less than half of healthcare workers in Papua New Guinea encouraged the continuation of breastfeeding during infancy, with the introduction of complementary feeds at 6 months [51]. The proportion was even lower (26%) in South Africa [42]. This finding suggests that a substantial proportion of healthcare workers doubt the safety of breastfeeding beyond six months, hence their reluctance to recommend it to mothers, despite evidence to the contrary [53]. This finding could also be a carry-over effect from the previous recommendation of a shorter duration of exclusive breastfeeding and abrupt cessation [54]. Healthcare workers could misconstrue breastfeeding of HIV exposed infants beyond six months as a form of mixed feeding. Evidence, however, suggests that, unlike in younger infants, by the age of 6 months, the gut mucosa is mature and able to process complementary feeds [55]. Future qualitative interviews could reveal the reasons why substantial proportions of healthcare workers still recommend cessation of breastfeeding at 6 months for HIV-exposed infants. Variations in the pre-service curriculum, learning opportunities and prioritization of infant and young child feeding could explain the differences.

Compared to previous studies, a sizeable proportion of our respondents recommended human milk substitutes [42].

Table 3. Factors associated with health care worker knowledge of HIV exposed infant feeding options and counseling practice (*n*=262), Kano, Nigeria.

-	Knowledge of HIV Exposed Infant Feeding Options		HIV Exposed Infant Feeding Counseling Practices	
Characteristics	**Good Knowledge[a] No. (%)**	**Fair/Poor Knowledge No. (%) p Value**	**Ever Counseled HIV+ Mother on Infant Feeding Options[b] No. (%)**	**Have Never Counseled HIV+ Mother on Infant Feeding Options No. (%) p Value**
Sex	-	<0.001*	-	0.004*
Male	54 (45.8)	64 (54.2)	56 (47.5)	62 (52.5)
Female	98 (68.1)	46 (31.9)	94 (65.3)	50 (34.7)
Age group	-	0.004*	-	0.001*
<30	30 (42.2)	41 (57.8)	29 (40.9)	42 (59.2)
30-39	69 (60.5)	45 (39.5)	67 (58.8)	47 (41.2)
≥40	53 (68.8)	24 (31.2)	54 (70.1)	23 (29.9)
Ethnic group	-	0.69	-	0.97
Hausa	58 (42.7)	78 (57.3)	77 (56.6)	59 (43.4)
Fulani	20 (37.0)	34 (63.0)	31 (57.4)	23 (42.6)
Others*	32 (44.4)	40 (55.6)	42 (58.3)	30 (41.7)
Religion	-	0.095	-	0.59
Islam	132 (60.3)	87 (39.7)	127 (58.0)	92 (42.0)
Christianity	20 (46.5)	23 (53.5)	23 (53.5)	20 (46.5)
Marital status	-	<0.001*	-	<0.001*
Single	30 (40.0)	45 (60.0)	31 (41.3)	44 (58.7)
Ever Married	122 (65.2)	65 (34.8)	119 (63.6)	68 (36.4)
Professional category	-	0.007*	-	<0.001*
Physician	60 (61.2)	38 (38.8)	73 (74.5)	25 (25.5)
Nurse/Midwife	60 (65.2)	32 (34.8)	63 (68.5)	29 (31.5)
Others**	27 (51.9)	25 (48.1)	10 (19.2)	42 (80.8)
Laboratory Scientist	5 (25.0)	15 (75.0)	4 (20.0)	16 (80.0)
Years of experience	-	0.008*	-	0.04*
<5	51 (49.5)	52 (50.5)	50 (48.5)	53 (51.5)
5-9	39 (54.2)	33 (48.3)	42 (58.3)	30 (41.7)
≥10	62 (71.3)	25 (28.7)	58 (66.7)	29 (33.3)
Trained in infant feeding counseling	-	<0.001*	-	<0.001*
Yes	82 (74.6)	28 (25.4)	99 (90.0)	11 (10.0)
No	70 (46.1)	82 (53.9)	51 (33.6)	101 (66.4)
Number of Children	-	0.002*	-	0.006*
0	33 (41.2)	47 (58.8)	33 (41.3)	47 (58.8)
1	20 (71.4)	8 (28.6)	17 (60.7)	11 (39.3)
2-4	71 (61.7)	44 (38.3)	74 (64.4)	41 (35.7)
≥5	28 (71.8)	11 (28.2)	26 (66.7)	13 (33.3)

(Table 3) contd….

-	Knowledge of HIV Exposed Infant Feeding Options		HIV Exposed Infant Feeding Counseling Practices	
Characteristics	**Good Knowledge[a] No. (%)**	**Fair/Poor Knowledge No. (%) p Value**	**Ever Counseled HIV+ Mother on Infant Feeding Options[b] No. (%)**	**Have Never Counseled HIV+ Mother on Infant Feeding Options No. (%) p Value**
Hospital Unit	-	0.61	-	<0.001*
Obstetrics & Gynecology	24 (42.4)	34 (56.6)	41 (70.7)	17 (29.3)
Pediatrics	21 (36.2)	37 (63.8)	45 (77.6)	13 (22.4)
S S Wali ART Center	8 (33.3)	16 (66.7)	14 (58.3)	10 (41.7)
GOPD	6 (50.0)	6 (50.0)	6 (50.0)	6 (50.0)
Others***	51 (46.4)	59 (53.6)	44 (40.0)	66 (60.0)
Knowledge of HIV exposed infant feeding options	-	-	-	<0.001*
Good	NA	NA	41 (37.3)	69 (62.7)
Fair/poor	NA	NA	109 (71.7)	43 (28.3)

[a]Good knowledge of HIV exposed infant feeding options.
[b]Health care workers that have ever counseled HIV+ mothers on infant feeding options.
Others* include Yoruba, Igbo, Kanuri, Egbira, Igala.
Others** include social workers and community health extension workers.
Others*** include specialty clinics, pediatric outpatient and special care baby unit.

Table 4. Logistic regression model for predictors of knowledge of HIV exposed infant feeding options among health care workers, Kano, Nigeria, 2018 (*n*=262).

Characteristics	Crude Odds Ratio (95% CI)	Adjusted Odds Ratio (95% CI)[a]	*P*-value
Sex	-	-	-
Male	Ref	-	-
Female	2.53 (1.53-4.18)	2.47 (1.35-4.52)	0.03[b]
Age group	-	-	-
<30	Ref	-	-
30-39	2.10 (1.15-3.83)	1.86 (0.69-5.01)	0.36
≥40	3.02 (1.54-5.92)	1.95 (0.54-6.99)	0.22
Marital status	-	-	-
Single	Ref	-	-
Ever Married	2.82 (1.62-4.89)	1.15 (0.42-3.16)	0.21
Professional category	-	-	-
Physician	4.74 (1.59-14.1)	4.00 (1.25-12.87)	0.016[b]
Nurse/Midwife	5.63 (1.87-16.90)	2.75 (1.17-9.28)	0.032[b]
Others*	3.24 (1.03-10.22)	2.79 (1.24-9.11)	0.027[b]
Laboratory Scientist	Ref	-	-
Years of experience	-	-	-
<5	Ref	-	-
5-9	1.21 (0.66-2.20)	0.75 (0.32-1.75)	0.76
≥10	2.53 (1.38-4.63)	1.34 (0.87-3.61)	0.44

(Table 4) contd….

Characteristics	Crude Odds Ratio (95% CI)	Adjusted Odds Ratio (95% CI)[a]	*P*-value
Trained in infant feeding counseling	-	-	-
Yes	3.43 (2.10-5.86)	3.27 (1.87-5.71)	0.013[b]
No	Ref	-	-
Number of Children	-	-	-
0	Ref	-	-
1	3.56 (1.40-9.05)	1.20 (1.11-6.12)	0.012[b]
2-4	2.30 (1.28-4.12)	1.75 (1.23-3.92)	0.034[b]
≥5	3.63 (1.59-8.29)	1.21 (0.31-4.73)	0.47

[a]Logistic model includes the following variables: sex, age group, marital status, professional category, years of experience, training in infant counseling and number of children.
[b] Significant at $p<0.05$; OR: Odds Ratio, CI: confidence interval; Ref: reference group *Others include social workers and community health extension workers.

The persistence of this advice in low resource settings could be attributed to previous guidelines that supported human milk substitutes when acceptable, feasible, affordable, sustainable and safe [54], and the current recommendations for HIV-exposed infants in high-income countries [13]. The differences in guidelines for low-resource and high-income countries should be emphasized during in-service and continuing professional development courses [52]. More troubling was the mention of mixed feeding (breast milk and infant formula or other feeds) as a safe option for HIV-exposed infants in low resource settings by a proportion of our respondents (13.4%), despite the recognized dangers. Similar findings were observed among their contemporaries in South Africa [56]. Mixed feeding in early infancy has been reported to increase the HIV transmission risk 3-4 fold as a result of gut mucosal damage and to impact HIV-free infant survival [57-64].

Healthcare workers often serve as experts and are frequently consulted for breastfeeding advice by mothers, especially in complex situations, such as the feeding of HIV-exposed infants. It is, therefore, worrisome that, as is the case with their colleagues in other parts of Nigeria (34.1%), a low proportion of our respondents had been trained on HIV-exposed infant feeding [47]. Similarly, a low proportion of respondents had ever counseled HIV-positive mothers on infant feeding, as reported elsewhere in Africa [48, 50]. Although most of our participants knew that infant feeding counseling should commence during prenatal visits, most of them counseled mothers only during postnatal care, by which time some of the infants would have received inappropriate feeds, thereby increasing the risk of HIV transmission. The importance of counseling women early in their pregnancy should be stressed during the training of healthcare workers.

In most cultural settings, gender roles often influence infant feeding behavior [65-67], and infant feeding is frequently considered the responsibility of the mother [68, 69]. The predictive role of female sex on the knowledge of infant feeding, therefore, came as no surprise. Apart from formal training, female healthcare workers acquire experience breastfeeding their infants. Variations in curricula content and clinical roles could explain the advantage of some professions [47]. As expected, training predicted knowledge of healthcare workers [47], although that was not the case elsewhere [49]. Further, healthcare workers' parity predicted knowledge in some studies [70], but not others [47]. Unlike in our sample, other researchers reported a positive influence of years of experience on breastfeeding knowledge [51]. This finding could be due to the frequent updates in guidelines and limited training opportunities [12, 54]. Recently qualified health care professionals are more likely to have been trained on the current guidelines than those who graduated before the release of the new guidelines.

The perception in traditional cultures that mothers are responsible for infant feeding [32] concurs with the beliefs in other parts of Nigeria [71] sub-Saharan Africa [70] and elsewhere [72], and could explain the predictive role of sex on infant feeding counseling. In addition, the preponderance of females in the health care professions in developing countries, especially, in nursing and midwifery and the likely preference of mothers for female counselors confer practice opportunities on females [73]. Similarly, the increasing trend in counseling with age could reflect the advantages conferred by clinical and personal experience, as observed elsewhere [74]. Expectedly, respondent knowledge of breastfeeding options was predictive of counseling practice, as reported elsewhere [70]. The dominance of infant feeding counseling among physicians and nurses/midwives compared to other healthcare workers has been reported earlier [75]. This could be due to the varied clinical roles of the health care professions, with prenatal and postnatal care handled mostly by nurses and midwives and the complicated cases referred to physicians.

This study was conducted in a large HIV treatment center in northern Nigeria, and our findings could differ if respondents were drawn from the primary and secondary treatment centers. Hence, the need for caution when extrapolating our findings. Future research should focus on providers at these lower levels. Other limitations include the risk of social desirability bias, as our respondents might want to answer questions in a manner that will be favorably viewed by investigators, rather than actual practice. In contrast, attendance at previous training on infant feeding could be underreported in anticipation of being selected for future training. Our use of anonymous self-completed questionnaires and detailed explanations of the study objectives could have reduced these biases.

Table 5. Logistic regression model for predictors of HIV-exposed infant feeding counseling practices among health care workers, Kano, Nigeria, 2018 (*n*=262).

Characteristics	Crude Odds Ratio (95% CI)	Adjusted Odds Ratio (95% CI)[a]	*P*-value
Sex	-	-	-
Male	Ref	-	-
Female	2.1 (1.26-3.43)	2.85 (1.39-5.85)	0.024[b]
Age group	-	-	-
<30	Ref	-	-
30-39	2.1 (1.13-3.77)	1.58 (1.15-4.85)	0.017[b]
≥40	3.4 (1.72-6.71)	3.87 (1.27-15.65)	0.025[b]
Knowledge of HIV exposed infant feeding options	-	-	-
Good	4.3 (2.53-7.20)	3.96 (2.07-7.59)	0.010[b]
Fair/poor	Ref	-	-
Marital status	-	-	-
Single	Ref	-	-
Ever Married	2.5 (1.44-4.30)	0.71 (0.20-2.48)	0.29
Professional category	-	-	-
Physician	11.7 (3.57-38.24)	10.7 (2.85-40.54)	0.013[b]
Nurse/Midwife	8.7 (2.67-28.30)	4.8 (1.26-18.02)	0.026[b]
Others*	0.95 (0.26-3.48)	0.45 (0.10-1.93)	0.56
Laboratory Scientist	Ref	-	-
Years of experience	-	-	-
<5	Ref	-	-
5-9	1.48 (0.81-2.72)	1.06 (0.39-2.85)	0.37
≥10	2.12 (1.18-3.82)	0.55 (0.19-1.65)	0.34
Trained in infant feeding counseling	-	-	-
Yes	2.88 (1.32-6.33)	2.60 (1.42-5.32)	0.014[b]
No	Ref	-	-
Number of Children	-	-	-
0	Ref	-	-
1	2.20 (0.91-5.30)	0.68 (0.17-2.78)	0.57
2-4	2.57 (1.43-4.62)	1.15 (0.33-4.00)	0.19
≥5	2.85 (1.28-6.34)	0.86 (0.20-3.78)	0.84
Hospital Unit	-	-	-
Obstetrics & Gynecology	Ref	-	-
Pediatrics	1.44 (0.62-3.31)	1.47 (0.51-4.21)	0.67
S.S Wali ART Center	0.58 (0.22-1.56)	0.46 (0.12-1.82)	0.34
GOPD	0.41 (0.12-1.47)	0.33 (0.05-2.19)	0.25
Others**	0.28 (0.14-0.55)	0.53 (0.19-1.48)	0.16

[a]Logistic model includes the following variables: sex, age group, knowledge of HIV exposed infant feeding options, marital status, professional category, years of experience, training in infant counseling, number of children and hospital unit.
[b]Significant at $p<0.05$; OR: Odds Ratio, CI: confidence interval; Ref: reference group
*Others include social workers and community health extension workers
**Others include specialty clinics, pediatric outpatient and special baby care unit

CONCLUSION

Knowledge gaps and misconceptions and sub-optimal infant feeding counseling practice among healthcare workers at a major tertiary center in northern Nigeria were identified. Although these HCW were actively involved in the care of women living with HIV, the knowledge and practices of some respondents did not conform to current national guidelines. To accelerate the elimination of mother-to-child transmission of HIV, it is important to provide regular in-service training to enable healthcare workers to stay abreast of current best practices regarding infant feeding. Nutrition counseling training can improve caregiver feeding practices, and enhance the nutritional status and general health of HIV-positive children [76, 77]. Pre-service curricula and continuing professional courses should be reviewed regularly to build the capacity of health care providers to counsel mothers on HIV-exposed infant feeding choices. Messages regarding appropriate feeding options for HIV-exposed infants should be communicated in a clear and consistent fashion to mothers during individual and group counseling sessions.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

Ethical clearance for this study was obtained from the Aminu Kano Teaching Hospital Ethics Review Board, Nigeria, (Approval no. NHREC/21/08/2008/AKTH/EC/2269).

HUMAN AND ANIMAL RIGHTS

No animals were used in this research. All human research procedures were in accordance with the articles set forth in the Declaration of Helsinki of 1975, as revised in 2013.

CONSENT FOR PUBLICATION

Aminu Kano Teaching Hospital Ethics Review Board approved the use of the data. Patient consent was obtained as described. Data were entered in a password-protected database at the Centre for Infectious Disease Research, Bayero University, Nigeria. To ensure confidentiality, serial numbers were assigned and no identifiers were collected.

AVAILABILITY OF DATA AND MATERIALS

The dataset that supports the results and findings of this research is available from [ZI] as the corresponding author upon request.

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CONFLICT OF INTEREST

The authors declare no conflict of interest, financial or otherwise.

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