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Correlates of Health Care Workers' Knowledge and HIV-Exposed Infant Immunization Counseling Practice in Northern Nigeria

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ABSTRACT

Background: Human Immunodeficiency Virus (HIV)-exposed and HIV-infected infants are at increased risk of vaccine-preventable diseases. However, little is known about health care workers' knowledge and immunization counseling practices in this population. We determined the predictors of health care workers' knowledge of vertical transmission risks, HIV exposed/infected infant immunization, and counseling practices in a tertiary center in Northern Nigeria.

Methods: A cross-section of 297 health workers were interviewed using a structured, validated questionnaire. Knowledge and HIV-exposed infant immunization counseling practices were analyzed, and adjusted odds ratios for predictors were derived from logistic regression models.

Results: Of the 297 participating health care workers, (32.3%, *n*=96) had adequate knowledge of HIV-exposed/infected infant immunization. Two-thirds (67%, *n*=199) of the participants appropriately identified the timing of infant diagnosis, while (73%, *n*=217) and (56.2%, *n*=167) correctly categorized infants as HIV-exposed and HIV-infected, respectively. Only (19.5%, *n*=58) participants had ever counselled a HIV-positive mother on infant immunization. Knowledge was predicted by work unit (HIV clinic vs. Obstetrics & Gynecology clinic), (Adjusted Odds Ratio (AOR) =3.78, 95% CI: 1.27-5.54), age (30-39 vs. <30 years), (AOR=2.24, 95% CI:1.19-5.67), years of experience (≥10 vs. <5), (AOR=1.76, 95% CI: 1.15-6.04), number of children (1 vs. 0), (AOR=1.73, 95% CI:1.14-4.23), infant immunization training (yes vs. no), (AOR=1.57, 95% CI:1.12-5.43), female sex (AOR = 1.17, 95% CI:1.06-2.21), profession (nurse/midwife vs. physician), (AOR=0.44, 95% CI:0.21-0.94) and previous HIV test (no vs. yes), (AOR=0.67, 95% CI:0.21-0.83).

Conclusion and Global Health Implications: Knowledge of HIV-exposed infant immunization was low and counseling practices were sub-optimal. Both immunization knowledge and counseling practices were predicted by demographic, professional, and training variables. Our findings indicate the need for educating health care workers on HIV exposed/infected infant immunization policy and improving counseling skills through capacity-building programs.

Key words: • Knowledge • Health care workers • HIV • Infant • Immunization • Nigeria

1. Introduction

Despite the existence of interventions to prevent mother-to-child transmission of HIV, there are currently 1.8 million infants living with HIV, most in sub-Saharan Africa.[1] In addition, there is a growing population of 14.8 million HIV-exposed, but uninfected children.[2] Early determination of HIV exposure, timely diagnosis, and effective management are critical for the survival of these children.[3] Apart from the deleterious effects of HIV infection or exposure, these children are at increased risk of vaccine-preventable diseases due to sub-optimal vaccine responsiveness and rapid waning of immunity.[4] Furthermore, HIV-infected infants require special consideration because of the risk of adverse consequences, and variable immune reconstitution following antiretroviral therapy (ART).[5]

The World Health Organization (WHO) immunization guidelines for HIV-exposed, uninfected infants are the same as the national schedule for other unexposed infants.[6] However, modifications were recommended for HIV-infected infants. Specifically, for asymptomatic infants, an extra dose of measles vaccine is recommended at 6 months. Similarly, a dose of yellow fever vaccine is recommended from 9 months of age for those in endemic areas.[3] In contrast, live vaccines such as BCG and yellow fever vaccines are withheld from infants with symptomatic HIV infection, even in endemic settings.[6,7]

A recent survey in Nigeria reported an HIV prevalence of 1.4%, with one million women living with HIV and 100,000 HIV-infected infants. Less than a fifth (18%) of infants had access to early infant diagnosis and only 35% were on antiretroviral therapy.[8] Despite the considerable risk of vaccine-preventable diseases, childhood immunization coverage in Nigeria has remained persistently low, with only one in four children fully vaccinated at one year.[9] This coverage could be lower among HIV-exposed and HIV-infected infants due to misinformation and limited counseling services.[10] Non-recommendation by health care professionals has been reported as a major barrier to childhood immunization.[11] Despite being considered trusted sources of information, little is known about health workers' knowledge of vertical transmission risks, HIV-exposed/infected infant immunization policy, and their counseling practices. With one of the poorest child health indicators,[12] an exploration of health care workers' knowledge of vaccine recommendations, perceived contraindications, and counseling practices in northern Nigeria became necessary to inform targeted capacity building to enhance the survival of HIV-exposed and infected infants. This study determined the predictors of health care workers' knowledge of HIV vertical transmission risks, HIV exposed/infected infant immunization, and counseling practices in a tertiary center in Kano, in northern Nigeria.

2. Methods

2.1. Study Area and Population

The study was conducted in Aminu Kano Teaching Hospital, Nigeria (AKTH), a tertiary referral center for over 13 million people located in Kano, in northern Nigeria. AKTH has a bed capacity of 750 and 2,188 employees. The AKTH HIV clinic provides prevention, treatment, care, and support to more than 6,000 people living with HIV. Mothers living with HIV are counselled on infant vaccination based on national and World Health Organization guidelines.[13] The immunization clinic runs daily and infants delivered in the hospital receive BCG and the first dose of OPV and hepatitis B vaccines before discharge.

The study population included consenting health care professionals employed at AKTH and engaged in clinical care. They included physicians, nurses/midwives, community health officers, community health extension workers, and social workers. Workers providing non-clinical, administrative and support services and staff on study/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

This was a cross-sectional study. The target sample size was obtained using Fisher's formula,[14] prevalence from a previous study (29%),[15] 95% confidence level, and 5% margin of error. The sample size (n = 317)

was increased by 10% to account for non-response, giving a final sample size of 353.

2.3. Participant Recruitment and Sampling

We used a two-stage sampling method. In the first stage, health care workers were stratified by professional category as physicians, nurses/midwives, and others (community health officers, community health extension workers, and social workers). Sample sizes were allotted proportionate to stratum population. In stage two, after determining eligibility, systematic sampling was used to select participants in each profession. After obtaining a sampling interval for each stratum, the first respondent was randomly selected between serial number 1 and the sampling interval. Subsequent respondents were obtained by adding the sampling interval to the previous respondent's serial number. Sampled health care workers were then recruited into the study after providing detailed study information and obtaining informed consent.

2.4. Measures and Data Collection

A 27-item structured self-administered questionnaire was developed from immunization guidelines[16] and previous studies.[7,15] The questionnaire had 3 sections. In the first section, 11 items elicited socio-demographic characteristics, including age, sex, marital status, ethnicity, education, religion, number of children, professional category, work experience, infant immunization training, and work unit. The second section included 16 items that assessed knowledge of HIV vertical transmission risks and HIV exposed/infected infant immunization (yes, no, or don't know responses). Correct responses were awarded 1 point, while incorrect and 'don't know' responses were scored 0. Total scores of ≤8 and 9-16 were graded as 'inadequate' and 'adequate' knowledge, respectively.[17] Section 3 assessed self-reported counseling of women living with HIV on infant immunization. Respondents who answered 'Yes' to the question 'Have you ever counselled a woman living with HIV on HIV exposed/infected infant immunization?' were considered to have practiced HIV exposed/infected infant immunization counseling. The questionnaire was pretested and validated among health care workers in Abdullahi Wase Specialist Hospital, Kano, Nigeria (n = 30). Content validity was confirmed by specialist pediatricians and infectious disease physicians, while reliability was manifest by Cronbach's alpha values of 0.91 and 0.88, for the knowledge and counseling practice sections, respectively.

Potential participants were individually contacted by trained research assistants and provided detailed information on the study objectives and what participation entailed. They were informed that participation was voluntary. Those who signed an informed consent form were provided a self-administered questionnaire which was retrieved afterward. Two data entry clerks checked and independently double-entered the data in a password-protected database. 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. Data Analysis

Data were analyzed using SPSS Version 22 (IBM Corp., Armonk, NY). Means and standard deviation were used to summarize numeric data. Frequencies and percentages were obtained for categorical variables. Pearson's Chi-square or Fisher's exact test (when >20% of cells had expected values of <5) 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 separately developed for knowledge and HIV-exposed/infected infant immunization counseling. Independent variables included socio-demographic, work experience, and training variables, with $p<0.10$ at the bivariate level. For the infant immunization counseling practice model, knowledge was included. Adjusted odds ratios (AORs) and the 95% confidence intervals (CIs) were used to measure the strength and direction of effect of the independent variables on the outcomes.

3. Results

3.1. Sociodemographic Characteristics

Of the 353 health workers contacted, 297 completed and returned the questionnaires, yielding a response

rate of 84.1%. Respondents' mean age was 35.1±9.36 years. The majority were female (56.9%, *n*=169), Hausa/Fulani (73.1%, *n*=217) and Muslim (88.6%, *n*=263). Most respondents were married (60.3%, *n*=179), over half (56.9%, *n*=169) had at least 5 years of work experience, and (35.0%, *n*=104) had been trained on infant immunization. The participants included physicians (25.9%, *n*=77) nurses/midwives (31.7%, *n*=94), and other health workers (42.4%, *n*=126). Over half of the respondents (50.8%, *n*=151) had at least two children (Table 1).

3.2. Knowledge of HIV vertical transmission risk and infant immunization

The majority of the participants were aware of the risk of vertical HIV transmission during delivery (77.8%, *n*=231) and breastfeeding (75.1%, *n*=223), but less so during pregnancy (55.9%, *n*=166). Two-thirds of participants (67%, *n*=199) knew the timing for early infant diagnosis. Similarly, (73%, *n*=217) and (56.2%, *n*=167) respondents appropriately categorized infants as HIV-exposed and HIV-infected, respectively. Based on the overall knowledge scores, (32.3%, *n*=96) participants had adequate knowledge of HIV exposed/infected infant immunization. Less than two-thirds (65.0%, *n*=193) of respondents indicated that HIV-exposed infants should receive all vaccines on the national schedule with 19.5%, 12.1%, and 6.1% stating that BCG, measles and yellow fever vaccines are contraindicated. Similarly, two-thirds (67.0%, *n*=199) of the respondents indicated that HIV-infected infants should receive the scheduled vaccines, except BCG (17.8%, *n*=53), measles (19.5%, *n*=58) and yellow fever (16.5%, *n*=49) vaccines (Table 2).

3.3. HIV Exposed/Infected Infant Immunization Counseling Practice

Of the 297 health care workers interviewed, (19.5%, *n*=58) had ever counselled a mother living with HIV on infant immunization. Of these, (53.3%, *n*=31), (20.7%, *n*=12), (19.0%, *n*=11) and (7.0%, *n*=4) counselled mothers at the HIV treatment center, specialist pediatric clinics, in social settings and during home visits, respectively. Participants suggested that counselors should target mothers (60.9%, *n*=181), fathers (16.5%, *n*=49), mothers-in-law (10.5%, *n*=31),

Table 1: Characteristics of healthcare workers, Aminu Kano Teaching Hospital, Kano, Nigeria

Characteristics	Frequency No. (%) N=297
Sex	
Male	128 (43.1)
Female	169 (56.9)
Age group	
<30	110 (37.0)
30-39	93 (31.3)
≥40	94 (31.7)
Ethnicity	
Hausa/Fulani	217 (73.1)
Others*	80 (26.9)
Religion	
Islam	263 (88.6)
Christianity	34 (11.5)
Marital status	
Single	118 (39.7)
Married	179 (60.3)
Professional category	
Physician	77 (25.9)
Nurse/Midwife	94 (31.7)
Others**	126 (42.4)
Years of experience	
<5	128 (43.1)
5-9	60 (20.2)
≥10	109 (36.7)
No. of children	
0	122 (41.1)
1	24 (8.1)
2-4	110 (37.0)
≥5	41 (13.8)
Hospital Unit	
Obstetrics & Gynecology	25 (8.4)
Pediatrics	52 (17.5)
HIV clinic	40 (13.5)
Others***	180 (60.6)
Ever tested for HIV	
Yes	243 (81.8)
No	54 (18.2)
Previous training in infant immunization	
Yes	104 (35.0)
No	193 (65.0)

Others* include Yoruba, Igbo, Kanuri and Egbira. Others** include community health officers, community health extension workers and social workers. Others*** include specialty clinics, general outpatient and surgical wards

Table 2: Knowledge of HIV transmission and HIV exposed/infected infant immunization

Characteristics	Frequency No. (%)		
	Yes	No	Don't know
HIV transmission			
HIV transmissible during pregnancy	166 (55.9)	77 (25.9)	54 (18.2)
HIV transmissible during delivery	231 (77.8)	34 (11.4)	32 (10.8)
HIV transmissible during breastfeeding	223 (75.1)	39 (13.1)	35 (11.8)
Very early infant HIV diagnosis is recommended at ≤6 weeks of life	199 (67.0)	52 (17.5)	46 (15.5)
HIV exposed infants are babies born to HIV positive mothers	217 (73.0)	48 (16.2)	32 (10.8)
HIV infected infants are those diagnosed using PCR	167 (56.2)	125 (42.4)	4 (1.4)
HIV exposed infant immunization			
HIV exposed infants should be vaccinated	235 (79.1)	51 (17.2)	11 (3.7)
HIV exposed infants should receive all vaccines on the national schedule	193 (65.0)	81 (27.3)	23 (7.7)
BCG is contraindicated for HIV exposed infants	58 (19.5)	127 (42.8)	112 (37.7)
Measles vaccine is contraindicated for HIV exposed infants	36 (12.1)	141 (47.5)	120 (40.4)
Yellow fever vaccine is contraindicated for HIV exposed infants	18 (6.1)	150 (50.5)	129 (43.4)
HIV infected infant immunization			
HIV-infected infants should be vaccinated	199 (67.0)	74 (24.9)	24 (8.1)
BCG is contraindicated for HIV infected infants	53 (17.8)	127 (42.8)	117 (39.4)
Measles vaccine is contraindicated for HIV infected infants	58 (19.5)	121 (40.7)	118 (39.7)
Yellow fever vaccine is contraindicated for HIV infected infants	49 (16.5)	122 (41.1),	126 (42.4)
Knowledge categories			
Adequate knowledge	96 (32.3)	-----	-----
Inadequate knowledge	201 (67.7)	-----	-----

and traditional birth attendants (12.1%, *n*=36). Most respondents (91.2%, *n*=271) recommended that counseling should be conducted during the prenatal period.

3.4. Predictors of Knowledge and HIV Exposed Infant Immunization Counseling Practice

At the bivariate level, knowledge of HIV exposed/infected infant immunization was associated with respondents' sex, age, profession, years of experience, training, number of children, work unit and previous HIV test (p<0.05) (Table 3). At multivariate level, knowledge was predicted by respondent's sex (Adjusted Odds ratio (AOR)=1.17, 95% Confidence Interval (CI)=1.06-2.2, female versus male), age (AOR=2.24, 95% CI:1.19-5.67, 30-39 vs. <30 years), profession (AOR=0.44, 95%CI:0.21-0.94, nurse/midwife vs. physician) and "others" vs. physician (AOR=0.09, 95% CI:0.04-0.20), work experience (AOR=1.76 (1.15-6.04),(≥10 vs. <5 years), training (AOR=1.57, 95%CI: 1.12-5.43) (yes vs. no), number of children (AOR=1.73, 95% CI:1.14-4.23, (1 vs. 0), work unit (AOR=3.78, 95% CI:1.27-5.54) (S. S. Wali HIV clinic vs. Obstetrics & Gynecology), Pediatrics vs. Obstetrics & Gynecology specialty (AOR=2.26, 95% CI:1.17-7.11), and previous HIV test (AOR=0.67, 95% CI:0.21-0.83 (yes vs. no) (Table 4).

HIV exposed/infected infant immunization counseling practice was associated with respondent's sex, age, marital status, profession, years of experience, training, work unit, previous HIV test, and knowledge at bivariate level (p<0.05). At the multivariate level, counseling practice was independently predicted by participants' sex (AOR=1.20, 95% CI:1.09-2.12, female vs. male), profession (AOR=2.26, 95% CI:1.15-4.85, nurse/midwife vs. physician), training (AOR=0.45, 95%CI:0.26-0.78, no vs. yes), work unit (AOR=2.87, 95% CI:1.16-7.47, HIV clinic vs. Obstetrics & Gynecology) and knowledge

Table 3: Logistic regression model for predictors of health care workers' knowledge of HIV exposed/ infected infant immunization, Kano, Nigeria (*n*=297)

Characteristics	N	Health Care Workers with adequate knowledge of HIV exposed/HIV infected infant immunization No. (%)	Crude OR (95% CI)	Adjusted OR (95% CI)	p-value
Sex					
Male	128	34 (26.6)	Referent	Referent	
Female	169	62 (36.7)	1.60 (1.12-2.65)	1.17 (1.06-2.21)	0.041*
Age group					
<30	110	25 (22.7)	Referent	Referent	
30-39	93	44 (47.3)	3.05 (1.17-5.58)	2.24 (1.19-5.67)	0.012*
≥40	94	27 (28.7)	1.37 (0.73-2.58)	1.01 (0.26-3.88)	0.53
Ethnicity					
Hausa/Fulani	217	71 (32.7)	--	--	
Others*	80	25 (31.7)	--	--	
Religion					
Islam	263	87 (33.1)	--	--	
Christianity	34	9 (26.1)	--	--	
Marital status					
Single	118	32 (27.1)	--	--	
Ever Married	179	64 (35.8)	--	--	
Professional category					
Physician	77	47 (61.0)	Referent	Referent	
Nurse/Midwife	94	31 (33.0)	0.31 (0.17-0.59)	0.44 (0.21-0.94)	0.038*
Others**	126	18 (14.3)	0.11 (0.05-0.21)	0.09 (0.04-0.20)	0.029*
Years of experience					
<5	128	33 (25.8)	Referent	Referent	
5-9	60	21 (35.0)	1.55 (0.80-3.01)	0.87 (0.31-2.39)	0.45
≥10	109	42 (38.5)	1.80 (1.04-3.14)	1.76 (1.15-6.04)	0.034*
Trained in infant immunization					
Yes	104	49 (47.1)	2.15 (1.18-2.32)	1.57 (1.12-5.43)	0.027*
No	193	47 (24.4)	Referent	Referent	
Number of children					
0	122	30 (24.6)	Referent	Referent	
1	24	10 (41.7)	2.19 (1.12-5.44)	1.73 (1.14-4.23)	0.032*
2-4	110	45 (40.9)	2.12 (1.21-3.72)	1.34 (1.09-3.79)	0.044*
≥5	41	11 (26.8)	1.13 (0.50-2.51)	0.58 (0.18-1.84)	0.67
Hospital unit					
Obstetrics & Gynecology	25	7 (28.0)	Referent	Referent	
Pediatrics	52	24 (46.2)	2.21 (1.18-6.17)	2.26 (1.17-7.11)	0.015*
HIV clinic	40	22 (55.0)	3.14 (1.10-9.19)	3.78 (1.27-5.54)	0.011*
Others*	180	43 (23.9)	0.81 (0.32-2.06)	0.72 (0.26-1.82)	0.17
Ever tested for HIV					
Yes	243	85 (35.0)	Referent	Referent	
No	54	11 (20.4)	0.48 (0.23-0.97)	0.67 (0.21-0.83)	0.037*

*Significant at $p<0.05$; OR: Odds Ratio, CI: confidence interval. Hosmer-Lemeshow Chi-square=2.70, p=0.95. The logistic model includes the following variables: Respondent's sex, age group, professional category, years of experience, infant immunization training, number of children, work unit and previous HIV test

Table 4: Logistic regression model for predictors of health care workers' HIV exposed/infected infant immunization counseling practice, Kano, Nigeria (*n*=297)

Characteristics	N	Health care workers who had ever counseled mothers living with HIV on exposed/infected infant immunization no. (%)	Crude OR (95% CI)	Adjusted OR (95% CI)	p-value
Sex					
Male	128	16 (12.5)	Referent	Referent	
Female	169	42 (24.9)	1.11 (1.07-3.79)	1.20 (1.09-2.12)	0.032*
Age group					
<30	110	20 (18.2)	Referent	Referent	
30-39	93	16 (17.2)	0.52 (0.29-0.95)	0.71 (0.33-1.55)	0.51
≥40	94	22 (23.4)	1.02 (0.58-1.78)	1.01 (0.37-3.06)	0.27
Ethnicity					
Hausa/fulani	217	46 (21.2)	--	--	
Others*	80	12 (15.0)	--	--	
Religion					
Islam	263	52 (19.8)	--	--	
Christianity	34	6 (17.7)	--	--	
Marital status					
Single	118	14 (11.9)	0.70 (0.43-1.13)	0.76 (0.40-1.43)	0.43
Ever married	179	44 (24.6)	Referent	Referent	
Professional category					
Physician	77	10 (13.0)	Referent	Referent	
Nurse/midwife	94	24 (25.5)	2.26 (1.16-4.17)	2.20 (1.15-4.85)	0.021*
Others**	126	24 (19.1)	1.16 (1.10-2.16)	0.85 (0.38-1.89)	0.35
Years of experience					
<5	128	24 (18.8)	Referent		
5-9	60	10 (16.7)	0.44 (0.22-0.89)	0.51 (0.22-1.18)	0.63
≥10	109	24 (22.0)	0.85 (0.50-1.43)	0.82 (0.29-2.30)	0.56
Trained in infant immunization					
Yes	104	20 (19.2)	Referent		
No	193	38 (19.7)	0.57 (0.35-0.93)	0.45 (0.26-0.78)	0.033*
Number of children					
0	122	20 (16.4)	--	--	
1	24	8 (33.3)	--	--	
2-4	110	22 (20.0)	--	--	
≥5	41	8 (19.5)	--	--	
Hospital unit					
Obstetrics & Gynecology	25	4 (16.0)	Referent		
Pediatrics	52	10 (19.2)	1.17 (0.39-3.52)	1.24 (1.13-4.00)	0.042*
HIV clinic	40	14 (35.0)	4.75 (1.56-14.48)	2.87 (1.16-7.47)	0.028*
Others***	180	30 (16.7)	1.66 (1.16-4.38)	2.22 (1.18-6.43)	0.037*
Ever tested for HIV					
Yes	243	46 (18.9)	Referent		
No	54	12 (22.2)	1.07 (0.58-1.98)	1.14 (0.55-2.33)	0.16
Knowledge of HIV exposed/infected infant immunization					
Adequate	96	25 (26.0)	Referent		
Inadequate	201	33 (16.4)	0.60 (0.36-0.98)	0.57 (0.30-0.81)	0.031*

Significant at $p<0.05$; OR: Odds Ratio, CI: confidence interval. Hosmer-Lemeshow Chi-square=2.16, p= 0.86. Others include Yoruba, Igbo, Kanuri and Egbira. Others** include community health officers, community health extension workers and social workers. Others*** include specialty clinics, general outpatient and surgical wards. The logistic model includes the following variables: Respondent's sex, age group, marital status, professional category, years of experience, infant immunization training, work unit, previous HIV test and knowledge of HIV exposed/infected infant immunization

(AOR=0.57, 95%CI:0.30-0.81, inadequate vs. adequate).

4. Discussion

Considering the deleterious effects of non-vaccination on the risk of vaccine-preventable diseases among HIV exposed/infected infants,[3] we investigated the predictors of health care workers' knowledge of HIV exposed/infected infant immunization policy and counseling practices in northern Nigeria. We found less than one in three health care workers had adequate knowledge and four in five had never counseled a mother on HIV exposed/infected infant immunization. Knowledge was predicted by respondent's sex, age, profession, work experience, immunization training, number of children, work unit, and previous HIV test, while participants' sex, profession, immunization training, work unit, and knowledge predicted counseling practices.

The proportion of health care workers who were aware of the risk of vertical HIV transmission during delivery (77.8%) and breastfeeding (75.1%) were consistent with reports from other Nigerian centers (80-88.2% and 79.5-86.6%, respectively)[18,19] and elsewhere.[20] Evidence suggests that mother-to-child transmission commonly occurs through contact of infected cervico–vaginal secretions with the infant's oral mucosa during delivery,[21] while breastfeeding,[22] and via the transfer of viral particles across the placental barrier during pregnancy.[23] The proportion of respondents who were unfamiliar with the timing of infant diagnosis (33.0%), and with the categorization of infants as HIV-exposed (27%) or HIV-infected (43.8%) was similar to findings from other Nigerian centers.[24] These gaps should be addressed by strengthening pre-service curricula in training institutions and updating in-service refresher courses. In addition, strategies for early detection of HIV exposure and diagnosis should be optimized for effective management.

The low proportion (32.3%) of respondents with adequate knowledge of HIV exposed/infected infant immunization is similar to the figures from other Nigerian centers (17%-50%),[24] but lower than reports from other parts of Africa (54%-69%)[25,26] and Asia (55.6%).[17,27] This finding could result in health care workers, who are often considered as trusted sources of health information, serving as conduits for misinformation to HIV-positive mothers regarding recommended vaccines, schedules, and contraindications.[28] Findings from future well-designed studies of the health system can be used to inform comprehensive health care worker capacity building interventions.[3]

The proportion of participants with prior immunization counseling experience in the context of HIV (19.5%) was low, but similar to the figures from Nigerian centers (7.1%-9.1%),[10,29] parts of Africa (22-48%)[15,30] and elsewhere (36.9%-57.4%).[31] With reports of sub-optimal vaccine responsiveness among HIV-infected infants on ART,[32] health care workers need to pay special attention when counseling women living with HIV on infant immunization. The mention of fathers, mothers-in-law, and traditional birth attendants as counseling targets is important, especially considering their disproportionate influence and decision-making powers in northern Nigeria.[33] Apart from prenatal, delivery, and postnatal visits, social gatherings (e.g., naming ceremonies), provide opportunities to educate the community on the importance of vaccinating children, including those exposed or infected with HIV.

The knowledge advantage of female health care workers could be related to their dominance in the nursing/midwifery professions, who are the main providers of immunization services in the study setting.[34] Female health care workers, most of whom are mothers, could also have been counselled or actively sought information on childhood immunization. The predilection of mothers towards consulting female health workers could also challenge them to seek knowledge about HIV-exposed infant immunization.[35] The predictive role of age and work experience could be attributed to the impact of cumulative experience and in-service training opportunities. Further, the finding of knowledge disparity between the professions, though this conflicts with reports from Ghana,[26] could reflect differences in pre-service curricula, roles, and responsibilities as well as access to continuing education opportunities.[36]

As expected, previous immunization training improved health care workers' knowledge. Similarly, the cumulative personal experience could explain the increased likelihood of adequate knowledge among respondents who had children. Further, orientation programs and enhanced training opportunities could augment the knowledge of participants who worked in immunization related units. Finally, health care workers who had HIV counseling and testing, especially, as part of PMTCT could have been counseled on HIV-related issues, including infant care.

Sex differences in counseling experience in favor of females could be due to the affinity of the sexes for certain professions. For instance, in the study setting, immunization services tend to be dominated by nurse/midwives, who are predominantly female.[34,35] Similarly, respondents who received prior training in infant immunization are more likely to counsel mothers living with HIV. In contrast, those without such training may avoid such encounters or refer mothers to their experienced colleagues. Health care workers providing pediatric and HIV services have the advantage of acquiring counseling skills and experience through on-the-job training.[36]

Our findings should be considered in light of the limitations. First, the study was conducted in a single tertiary treatment center in northern Nigeria, and therefore our findings may not be generalizable to other settings and levels of care. Primary and secondary level health care workers may have less capacity building opportunities and experience, hence the need to focus on them in future research. Second, counseling experience was based on self-report. Therefore, social desirability bias, where respondents might be inclined to provide expected rather than actual practice could not be excluded. This possibility was minimized by providing detailed information about study objectives and using anonymous questionnaires in sealed envelopes.

4. Conclusions and Global Health Implications

Less than a third of health care workers had adequate knowledge of HIV exposed/infected infant immunization, and four in five had no prior infant immunization counseling experience for mothers living with HIV. Infant immunization training, work unit, and previous HIV test were the modifiable factors that predicted both knowledge and counseling practice. Our findings suggest the need for educating health care workers on HIV exposed/infected infant immunization policy and improving counseling skills through regular continuing professional development programs to improve their capacity to counsel mothers living with HIV and identify HIV-exposed and infected infants for appropriate care and immunization.

Compliance with Ethical Standards

Conflict of Interest: *The authors declare no conflicts of interest.* ***Financial Disclosure:*** *None.* ***Funding/Support:*** *None.* ***Ethical Approval:*** *Study was approved by an ethics committee.* ***Acknowledgments:*** *None.* ***Disclaimer:*** *None.*

Key Messages

- Knowledge of HIV exposed/infected infant immunization policy was low and counseling practices were suboptimal among healthcare workers in northern Nigeria
- Training initiatives targeted at improving infant immunization knowledge and building health care workers' skills should be prioritized by policymakers.

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