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Comparative Study on Drivers and Barriers of Vaccine Stock Management Practices Among Healthcare Workers in Northwestern State, Nigeria

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Abstract

The growing concerns regarding stock out of vaccines at the health facility level during immunization sessions have resulted in missed opportunity and caregivers losing confidence in the health system. This study assessed the drivers and barriers to effective vaccine stock management amongst healthcare workers in equipped and non-equipped health facilities in Jigawa state, Nigeria. A cross sectional comparative study was conducted to assess barriers of vaccine stock management amongst healthcare workers rendering routine immunization. A multistage sampling technique was used for the selection of respondents. A semi-structured questionnaire was used to obtain information from respondents. Level of significance set at $p<0.05$. Majority of the respondents from equipped health facilities 142 (71.7%) and non-equipped health facilities 56 (28.3%) had between 1-9 years of practice. Use of target population data for vaccine forecasting had the highest responses with 60% of healthcare workers in equipped health facilities as compared to 22% from non-equipped health facilities. Reserved stock as a parameter for vaccine restocking had the least responses with 15% of healthcare workers in equipped health facilities as compared to 6% from non-equipped health facilities. Respondents from equipped health facilities had good practices of vaccines and cold chain management as compared to those from non-equipped health facilities. Poor electricity supply was statistically significant ($p=0.029$) with more responses from healthcare workers from equipped health facilities as compared to those from non-equipped health facilities. The findings from this study could be used to improve effective vaccine stock management at the state, LGA, and health facility levels.

Keywords*: Barriers, Comparative study, Healthcare workers, Nigeria, Vaccine management, practices.*

Introduction

Immunization is a cost-effective public health intervention to reduce morbidity and mortality associated with infectious diseases [1], it is one of the key elements of primary health care. Immunization against vaccine-preventable diseases is one of the most cost-effective interventions of all time, improving child survival in developing countries [2, 3]. It is reputed to save about 2.5 million lives per year and it can save more if better deployed [4].

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Immunization programs depend greatly on efficient and effective supply chain systems to store, transport, and distribute these vaccines and health commodities, which ensures that the right products are available at the right place, at the right time and in the right condition to provide efficient health services to the communities. Evidence has shown that an effective vaccine supply chain system is one of the most vital elements of any immunization program, which ensures that vaccines reach recipients in their potent form. The availability of vaccines in their right quantities is necessary to achieve targeted health goals. Understanding the challenges and constraints of supply chain systems is essential for developing interventions to improve the performance of this system [5]. One of the most critical areas in the vaccine supply chain is ensuring consistent and continuous availability of quality vaccines. When health facilities lack sufficient quantities of quality vaccines required for scheduled immunization services, these sessions are cancelled leading to missed opportunities for vaccination, which will eventually reduce immunization coverage [6].

Immunization is also a critical component in the global drive towards a significant reduction in childhood mortality. However, there are several challenges hindering wide and complete childhood immunization, especially in low- and middle-income countries like Nigeria [7]. Although there has been a steady decline in communicable diseases in Nigeria, they remain a major cause of death in childhood as over 40% of under-5 mortalities are due to vaccine-preventable communicable diseases [8].

The growing concerns regarding the stock of vaccines at the health facility level at the fixed and outreach posts during immunization sessions have resulted in missed opportunities and caregivers losing confidence in the health system due to suboptimal service delivery. Exploring drivers and barriers to effective vaccine stock management will help in the documentation of best practices and lessons learned for health system strengthening and improvement in immunization coverage in the country. The study was conducted to assess drivers and barriers of vaccine stock management practices among healthcare workers in equipped and non-equipped health facilities in Jigawa State, Northwest Nigeria.

Materials and Methods

Study Area

The study was conducted in Jigawa state, northwest geopolitical zone of Nigeria with 27 Local Government Areas (LGAs) and 284 political wards. There are 765 functional HFs rendering routine immunization services in Jigawa state of which 752 are public HFs, 7 private HFs and 6 HFs with no identified organization (public or private) respectively[9]. The facilities conduct at least one fixed session in a week, and one outreach session, with a maximum of four fixed and outreach sessions monthly. The state has 388 Solar Drive Devices (SDD) sites across the political wards with improved access to vaccines and vaccine accountability.

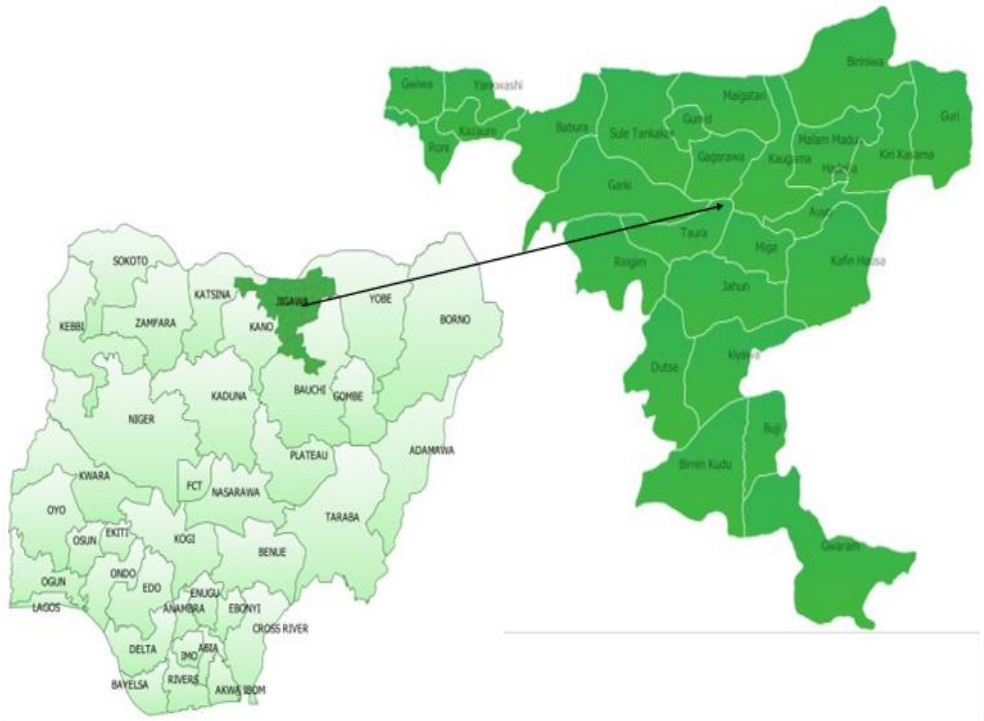

Figure 1. Map of Nigeria Highlighting Jigawa State

Study Design

A cross-sectional comparative study design was conducted in Jigawa state to assess vaccine management knowledge and practices amongst HCWs across equipped and non-equipped HFs rendering routine immunization (RI) from 1st-31st December 2022. The equipped HFs have functional cold chain equipment and the capacity to store vaccines while non-equipped HFs collect vaccines on the day of the RI session and return unused vaccines after the session by storing them in equipped HFs.

Study Population

The target population are HCWs in Jigawa state providing routine immunization services across public HFs in the state. The study population included HCWs at equipped and non-equipped HFs providing routine immunization services.

Inclusion Criteria

All consenting HCWs across equipped and non-equipped HFs, LGA and state levels who have been in public service for at least one year.

Exclusion Criteria

HCWs across equipped and non-equipped HFs that met the inclusion criteria but couldn't participate in the study due to reasons like being on leave, working experience in clinical practice, and declining to participate in the study.

Sample Size/Sampling Technique

This was calculated using the formula for comparing two groups[10] with a total sample size of 400 respondents. A 6-stage multistage sampling technique was used in selecting the study respondents.

Data Collection

A self-administered semi-structured field-tested questionnaire was deployed electronically on an open data kit (ODK) to obtain information on:

1. Socio-demographic characteristics of respondents.
2. Practices of healthcare workers on vaccine stock management.

3. Barriers to effective vaccine handling among healthcare workers in equipped and non-equipped health facilities.

Data Analysis

Data was analyzed using both descriptive (frequency distribution tables and charts generated from variables) and inferential statistics (cross-tabulation and test statistics done where applicable) using the Statistical Package for Social Sciences (SPSS) software. The chi-square test was used to test significance of association between two categorical variables. Level of significance was set at p-value <0.05.

Practice Scoring and Grading

For questions whose responses were either yes or no (or correct and incorrect), a correct answer was scored 1 and a wrong answer was scored 0. An overall assessment of health workers' practices on vaccine stock management was reviewed across 15 questions however only 9 questions were graded with a score for each correct response with a maximum obtainable score of 9, and a minimum score of 0 points. The mean practice score was calculated, with respondents who scored below the mean being regarded as having poor practice while those who scored up to or above the mean were regarded as having good practice respectively.

Ethical Considerations

Ethical clearance was obtained from the Jigawa State Ethics Review Committee and permission to carry out the study was obtained from the head of each primary healthcare centre. Participation was voluntary and written informed consent was obtained from the respondents who consented to be part of the study. Information about the participants was kept confidential and their names were not indicated to ensure the anonymity of participants. There was no potential risk attached to study participation. Findings will be used by authorities to develop plans to improve the immunization system with feedback shared with all stakeholders at the national, state, LGA and health facilities.

Limitations

The research, however, had some limitations which were addressed. The possibility of healthcare workers not disclosing sensitive information during the quantitative interview. This was however addressed using electronic questionnaire administration with the confidentiality of respondents preserved. The questionnaire was self-administered and as such some of the responses could have been biased, to address limitations associated with the research work such as fear of divulging sensitive information and incomplete entry, an electronic questionnaire administration was used to ensure the privacy and confidentiality of respondents. The objective of the study was clearly stated in the consent information section of the questionnaire, this also provided the detailed information needed to guide respondents in the filling of the questionnaire. Confidentiality was also assured with no unique identifier required by respondents. This made them respond in an objective manner.

Results

Socio-demographic Characteristics of Respondents

Overall, a total of 386 respondents out of the expected 400 respondents across 23 LGAs in the state participated in the study, with a response rate of 97 per cent (%). The majority of the respondents from equipped 121 (69.9%) and non-equipped 52 (30.1%) health facilities were between 30-39 years of age, with a mean age of 36.8 years ± 8.7 standard deviation (SD) for healthcare workers from equipped health facilities, and 35.8 years ± 7.1 standard deviation (SD) for their counterparts from non-equipped health facilities respectively. There was a significant difference ($p<0.05$) between the level of education of respondents from equipped health facilities as compared to

counterparts from non-equipped health facilities with more respondents from equipped health facilities 240 (71.2%) having diploma degrees as compared to those from non-equipped health facilities 97 (28.8%). The majority of the respondents from equipped health facilities 142 (71.7%) and non-equipped health facilities 56 (28.3%) had between 1-9 years of practice. Years of immunization experience were found to be more than five years among respondents from equipped health facilities 137 (70.6%) and 57 (29.4%) from non-equipped health facilities (Table 1).

Table 1. Respondents' Socio-demographic Characteristics across Selected Health Facilities in Jigawa State, Nigeria, 2022 (N=386)

Variable	Health Facility Status		χ2	df	p value
	Equipped n (%)	Non-equipped n (%)			
Age (in years)					
< 20	1 (100.0)	0 (0.0)	6.18	4	0.19
20-29	58 (76.3)	18 (23.7)			
30-39	121 (69.9)	52 (30.1)			
40-49	71 (69.6)	31 (30.4)			
≥ 50	30 (88.2)	4 (11.8)			
Mean (+ SD) age	36.77±8.69	35.82±7.06			
Sex					
Male	235 (73.0)	87 (27.0)	0.03	1	0.86
Female	46 (71.9)	18 (28.1)			
Level of Education					
Primary	3 (75.0)	1 (25.0)	10.19	4	0.04*
Secondary	6 (54.5)	5 (45.5)			
Degree	27 (93.1)	2 (6.9)			
Diploma	240 (71.2)	97 (28.8)			
Postgraduate degree	5 (100.0)	0 (0.0)			
Length of years in practice					
< 1	3 (100.0)	0 (0.0)	3.54	4	0.47
1 – 9	142 (71.7)	56 (28.3)			
10 – 19	84 (71.2)	34 (28.8)			
20 – 29	47 (75.8)	15 (24.2)			
≥ 30	5 (100.0)	0 (0.0)			
Mean (+ SD) length of years	10.87±7.52	10.36±6.51			
Years of working experience in HF					
< 1	7 (87.5)	1 (12.5)	2.58	3	0.46
1 – 9	217 (71.4)	87 (28.6)			
10 – 19	49 (75.4)	16 (24.6)			
20 – 29	8 (88.9)	1 (11.1)			
Mean (+ SD) years of working experience	5.93±5.13	5.73±4.09			
Years of immunization experience					
< 1	44 (80.0)	11 (20.0)	1.91	2	0.39
1 – 5	100 (73.0)	37 (27.0)			
> 5	137 (70.6)	57 (29.4)			

*Statistically significant

Two hundred and seventy-nine (72.8%) and 2 (66.7%) of respondents with equipped health facilities worked at public and private health facilities respectively as compared to 104 (27.2) and 1 (33.3%) respondent with non-equipped health facilities who worked at public and private health facilities. (Figure 2).

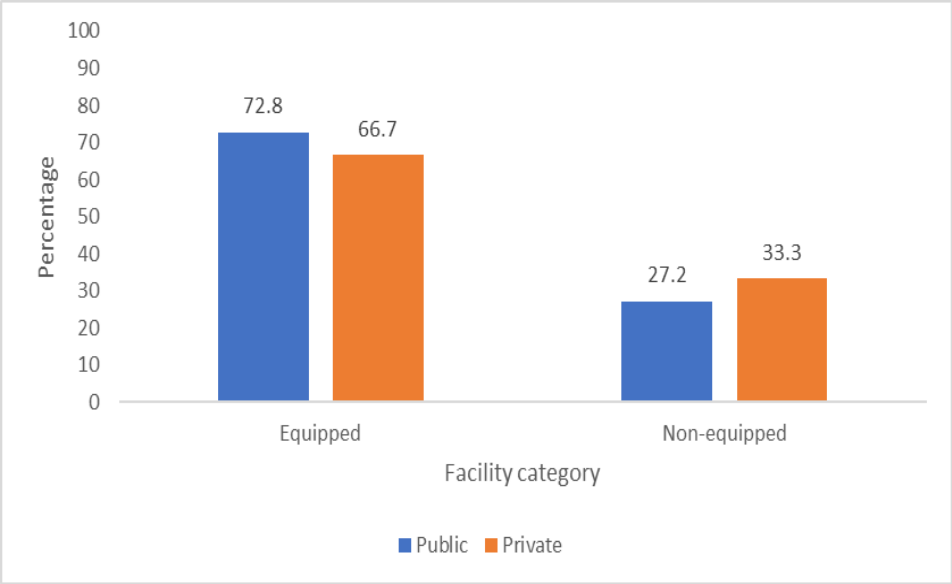

Figure 2. Distribution of Respondents based on Facility Category in Jigawa State, Nigeria, 2022 (N=386)

Practices of Healthcare Workers on Vaccine Stock Management

Vaccine forecasting parameters among healthcare workers in equipped and non-equipped health facilities.

Use of target population data as a parameter for vaccine forecasting had the highest responses with 60% of healthcare workers in equipped health facilities as compared to 22% from non-equipped health facilities. Distribution data as a parameter for vaccine forecasting had the least responses with 19% of healthcare workers in equipped health facilities as compared to 7% from non-equipped health facilities (Figure 3).

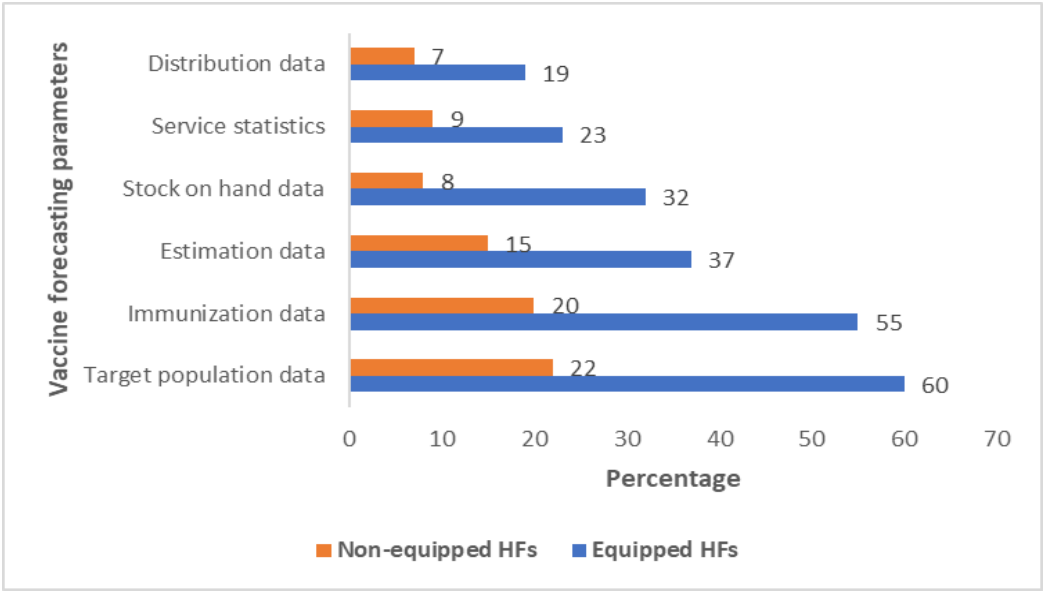

Figure 3. Respondents Vaccine Forecasting Parameters in Jigawa State, Nigeria, 2022 (N=386)

Vaccine restock consideration among healthcare workers in equipped and non-equipped health facilities.

Use of consumption record as a parameter for vaccine restock had the highest responses with 59% of healthcare workers in equipped health facilities as compared to 22% from non-equipped health facilities. Reserved stock as a parameter for vaccine restock had the least responses with 15% of healthcare workers in equipped health facilities as compared to 6% from non-equipped health facilities (Figure 4).

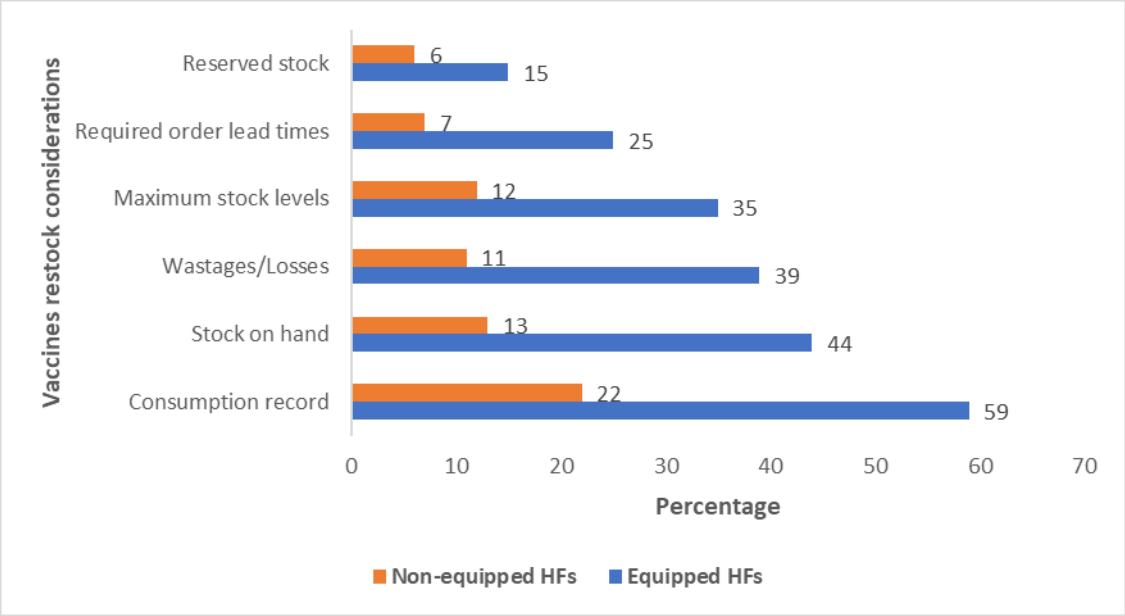

Figure 4. Respondents Vaccine Restock Considerations in Jigawa State, Nigeria, 2022 (N=386)

Practices of Healthcare Workers on Vaccines and Cold Chain Management

There was a significant difference ($p<0.05$) for responses on availability of functional thermometer in health facility with 249 (100%) for healthcare workers in equipped health facilities. The practice of First Expiry, First out (FEFO) principle, 267 (74.4%) of healthcare workers in equipped health facilities as compared to those 92 (25.6%) in non-equipped health facilities. Availability of adequate vaccine stock 3 months prior to the conduct of the study, 180 (79.3%) of healthcare workers in equipped health facilities as compared to those 47 (20.7%) in non-equipped health facilities (Table 3).

Table 3. Practices of Healthcare Workers on Vaccines and Cold Chain Management in Jigawa State, Nigeria, 2022 (N=386)

Practice questions	Health facility status				χ2	df	p value
	Equipped n (%)		Non-equipped n (%)				
	Yes	No	Yes	No			
Ever received training on cold chain management	255 (73.7)	26 (65)	91 (26.3)	14 (35)	1.37	1	0.24
Ever read a vaccine handling and storage guideline	253 (72.9)	28 (71.8)	94 (27.1)	11 (28.2)	0.25	1	0.88
Availability of functional thermometer in health facility	249 (100)	32 (23.4)	0 (0.0)	105 (76.6)	386	1	<0.001*
Practice of FEFO	267 (74.4)	14 (51.9)	92 (25.6)	13 (48.1)	6.46	1	0.04*

principle in health facility							
Availability of sufficient vaccine storage capacity in health facility	238 (89.1)	43 (36.1)	29 (10.9)	76 (63.9)	126.76	1	<0.001*
Availability of requisition form for vaccine ordering and reporting	243 (77.6)	38 (52.1)	70 (22.4)	35 (47.9)	27.66	1	<0.001*
Availability of adequate vaccine stock in the past 3 months	180 (79.3)	101 (63.5)	47 (20.7)	58 (36.5)	12.01	1	0.002*
Availability of relevant RI data tools in health facility	258 (73.1)	23 (69.7)	95 (26.9)	10 (30.3)	0.30	1	0.86
Vaccine vial monitor status of vaccine recorded for each vaccine	260 (72.8)	21 (75)	97 (27.2)	7 (25)	0.91	1	0.64

*Statistically significant

Respondents from equipped health facilities had good practices of vaccines and cold chain management as compared to those from non-equipped health facilities. There was a statistical difference ($p<0.05$) in practices of vaccines and cold chain management between both groups (Table 4).

Table 4. Association of Respondents' Practices across Health Facilities in Jigawa State, Nigeria

Practice score	**Health Facility Status**		**χ2**	**df**	**p value**	**OR (95% C.I)**
	Equipped n (%)	**Non-equipped n (%)**				
Good practice	210 (84.0)	40 (16.0)	44.96	1	<0.001*	4.81 (2.98 – 7.74)
Poor practice	71 (52.2)	65 (47.8)				

*Statistically significant

Determinants of Vaccine Management Practices

Association between healthcare worker's practices with other variables revealed statistical differences ($p<0.05$) for respondents' gender and years of working experience in health facility respectively. Male respondents had good vaccine management practices 217 (67.4%) as compared to their female counterparts 33 (51.6%) with a significant difference of $p=0.02$. They are also 0.5 times more likely to have good vaccine management practices as compared to their female counterparts (95% CI: 0.30-0.89). Respondents with 1-9 years of working experience in health facilities had good vaccine management practices 185 (60.9%) as compared to their counterparts with less than 1 year working experience 5 (62.5%) with a significant difference of $p=0.01$ (Table 5).

Table 5. Association of Respondents' Vaccine Management Practices with Other Variables in Jigawa State, Nigeria

Characteristics	Vaccine and cold chain management practices		X^2	df	p-value	OR (95% CI)
	Good practice	Poor practice				
Gender						
Male	217 (67.4)	105 (32.6)	5.86	1	0.02*	0.52 (0.30 – 0.89)
Female	33 (51.6)	31 (48.4)				
Age (Years)						
< 20	1 (100.0)	0 (0.0)	4.56	4	0.34	-
20 – 29	44 (57.9)	32 (42.1)				
30 – 39	115 (66.5)	58 (33.5)				
40 – 49	64 (62.7)	38 (37.3)				
≥ 50	26 (76.5)	8 (23.5)				
Educational level						
Primary	2 (50.0)	2 (50.0)	0.45	4	0.98	-
Secondary	7 (63.6)	4 (36.4)				
Degree	19 (65.5)	10 (34.5)				
Diploma	219 (65.0)	118 (35.0)				
Postgraduate degree	3 (60.0)	2 (40.0)				
Years of working experience in HF						
< 1	5 (62.5)	3 (37.5)	10.74	3	0.01*	-
1 – 9	185 (60.9)	119 (39.1)				
10 – 19	53 (81.5)	12 (18.5)				
20 – 29	7 (77.8)	2 (22.2)				
Type of health facility						
Public	248 (64.8)	135 (35.2)	0.01	1	0.95	1.09 (0.10 – 12.12)
Private	2 (66.7)	1 (33.3)				

*Statistically significant

Barriers to effective vaccine handling among healthcare workers in equipped and non-equipped health facilities.

Barriers to effective vaccine handling include insufficient ice packs with 34% of healthcare workers at equipped health facilities and 10% from healthcare workers at non-equipped health facilities. Cost of transporting vaccines to the health facility for the conduct of routine immunization sessions with 30% from healthcare workers at equipped health facilities and 11% from healthcare workers at non-equipped health facilities. Other barriers to effective vaccine handling included – Faulty SDD, Unavailability of solar refrigerators/generators, Insufficient/unavailability of style, unavailability of the functional refrigerator, insufficient ice packs, poor state of VVM when received, and unavailability of support for transporting vaccine.

Barriers to effective vaccine management such as insufficient backup refrigerators were statistically significant (p=0.009) with more responses from healthcare workers from equipped health facilities as compared to those from non-equipped health facilities. Poor electricity supply was statistically significant (p=0.029) with more responses from healthcare workers from equipped health facilities as

compared to those from non-equipped health facilities. Cost of transporting vaccines was not statistically significant (p=0.82) with more responses from healthcare workers from equipped health facilities as compared to those from non-equipped health facilities. (Figure 5).

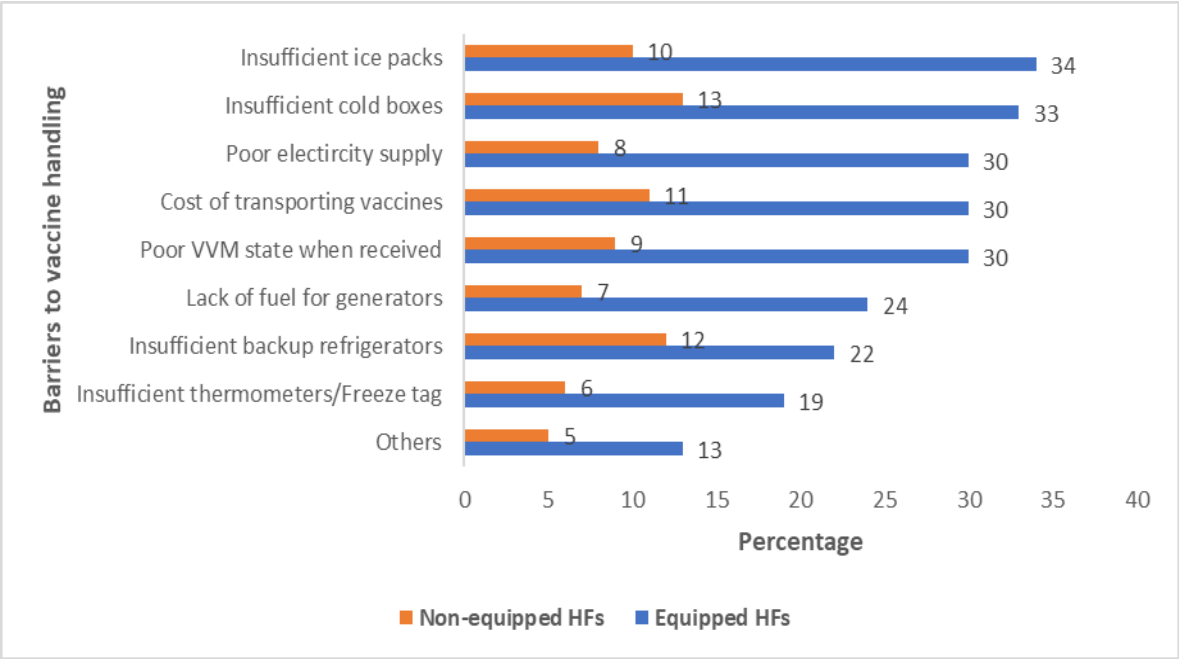

Figure 5. Respondents Barriers to Effective Vaccine Handing in Jigawa State, Nigeria, 2022 (N=386)

Discussion

Effective vaccine stock management is pivotal to a successful routine immunization service delivery. The research work highlighted determinants of effective vaccine stock management practices in relation to working experience, vaccine forecasting parameters, restock considerations and barriers to effective vaccine handling. Diploma degree was the most frequent level of education from the study with CHEWs and JCHEWs constituted the highest proportion of respondents, accounting for over 67% of all respondents in the study area. This is essential because, aside from doctors, they are the cadre of health work force required for effective PHC service delivery in Nigeria [11, 12].

Majority of the public health facilities in the state are equipped with functional cold chain system, which could be attributed to government efforts at the national level of ensuring the provision of at least one functional SDD in each ward with apex health facilities having enough storage capacity with uninterrupted power supply for vaccine storage. Strong political support of the state government in terms of ownership and sustainability have also contributed to improvement in the provision of routine immunization service delivery across LGAs in the state. Private health facilities usually have high client flow with provision of basic and specialized services usually at a cost [13, 14], with opportunities for reaching eligible children for routine immunization and other PHC services. More than two-thirds of the private health facilities in the state providing routine immunization services have functional cold chain system with provision of routine immunization services.

Years of working experience most importantly immunization experience showed more than five years' experience for respondents from equipped and non-equipped health facilities, with similar findings in a study conducted in the North Central Nigeria [15].

Safe vaccine storage practices entail refrigeration of vaccines in optimal temperature range within the refrigerator; and ensuring that

other items aside from vaccines are not kept in the vaccine refrigerators [16]. Training health care providers is often identified as a first step to revitalizing health services, majority of the respondents from equipped and non-equipped health facilities received training on cold chain management, with training done within a year ago. This could have been attributed to overall good vaccine management practices from the study.

According to the vaccine cold chain management system [17], a stock recording system is a valuable tool in the management of vaccines, their storage movement, and use. The availability of reliable and quality stock is vital in availing of lifesaving vaccines and for informed decision-making processes at all levels of the supply chain system. Findings from the study revealed availability of requisition form for vaccine ordering and reporting more among the healthcare workers working at equipped health facilities as compared to those of non-equipped health facilities.

Overall practices on vaccine stock management were found to be high among healthcare workers from equipped health facilities as compared to their counterparts from non-equipped health facilities. Findings from the equipped health facilities were like previous studies with appropriate vaccine management practices [18-20].

Barriers identified for vaccine stock management from the study were in tandem with findings from other studies on cold chain management [21-23]. The poor electricity supply as highlighted by study respondents will inhibit attaining recommended vaccine storage temperatures in the face of a lack of fuel for generators and insufficient backup refrigerators. The lack of fuel for standby refrigerators greatly accelerates vaccine thawing which in turn accelerates the loss of vaccine potency. Insufficient cold boxes and ice packs mostly at the health facility level are characterized by a considerable decrease in vaccine potency resulting in poor vaccine handling and storage. Lack of provision for vaccine delivery to the last mile is one of the barriers to effective vaccine handling with increase responses from healthcare workers from equipped health facilities.

Conclusion

The study revealed that healthcare workers from equipped health facilities in Jigawa state had good vaccine stock management was also observed among healthcare workers from equipped health facilities as compared to their counterparts at non-equipped health facilities. Drivers of effective vaccine stock management are length of years working in health facilities and practices on vaccine stock management as evident among healthcare workers from equipped health facilities. Barriers to effective vaccine stock management include insufficient cold boxes, ice packs, and cost of transporting vaccines to health facility for the conduct of routine immunization sessions, erratic power supply, insufficient backup refrigerators and lack of fuel for generators among others with increased observations from healthcare workers working at equipped health facilities in the state. The findings from this study should be used to improve effective vaccine stock management at the state, LGA, and health facility levels.

Conflict of Interest

There is no conflict of interest in the study.

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