

## Vaccine Management Practices Among Healthcare Workers in Northwestern State, Nigeria: A Comparative Study

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### Abstract

*Effective vaccine stock management is one of the criteria for a functional vaccine supply chain. The study evaluated vaccine management practices among healthcare workers in equipped and non-equipped public health facilities in Jigawa State, Northwest Nigeria. A cross sectional comparative study was conducted to assess vaccine management knowledge and practices 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  $p < 0.05$ . There was a significant difference for response on vaccine vial monitors are the only temperature monitoring devices that routinely accompany vaccines throughout the entire supply chain among healthcare workers from equipped health facilities 213 (77.2%) as compared to those from non-equipped health facilities 63 (22.8%). There was a statistical difference in attitude of vaccines and cold chain management between both groups. Respondents from equipped health facilities had good practices of vaccines and cold chain management as compared to those from non-equipped health facilities. The study revealed that healthcare workers from equipped health facilities had good knowledge and positive attitude on vaccines and cold chain management as compared to their counterparts from non-equipped health facilities. Drivers of effective vaccine stock management are length of years working in health facilities, good knowledge, and practices on vaccine stock management as evident among healthcare workers from equipped health facilities. Findings from this study could be used to improve effective vaccine stock management at the state, LGA, and health facility levels.*

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

### 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]. A functional vaccine supply chain is a critical element of an immunization program [4, 5]. Improving immunization coverage requires a reliable supply of vaccines and immunization

supplies, trained and incentivized health workers, good program management, and strategies to improve the demand for immunization. Evidence have shown that 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 [6]. 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 [7].

The health facilities receive their vaccine supplies through two types of systems, the push and pull system. The push system involves the higher-level store such as the national store, district-level store or regional store deciding the number of products to be delivered to a health facility. This decision is made based on the target population, the incidence of disease and other factors. The push system may be used when the lower level in the supply chain cannot or is not able to or adequately manage its vaccine stock and place orders. On the other hand, the pull system operates from the level of the health facility, whereby requisitions are made by the health facility based on their consumption, stock level and other factors [6]. The growing concerns regarding stock out of vaccines at the health facility level at the fixed and outreach posts during immunization sessions have resulted in missed opportunity 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 evaluate vaccine management practices among healthcare workers (HCWs) in equipped and non-equipped public health facilities (HFs) in Jigawa State, Northwest Nigeria.

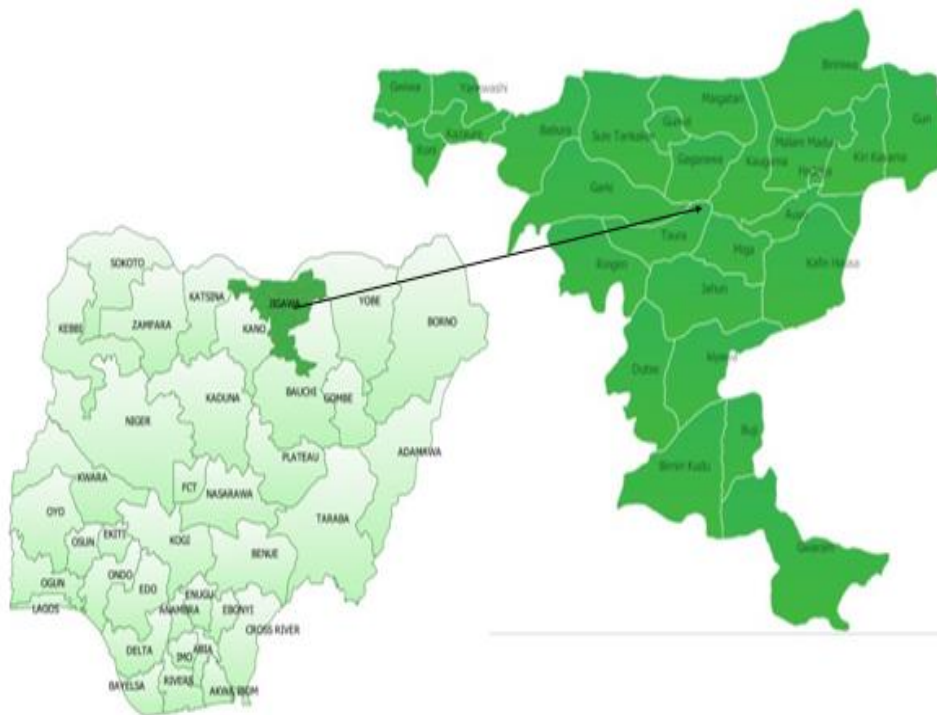
## **Materials and Methods**

### **Study Area**

The study was conducted in Jigawa state, northwest geopolitical zone of Nigeria with 27 Local Government Areas (LGAs) and 284 political wards (Figure 1). 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 [8]. 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.

### **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 capacity to store vaccines while non-equipped HFs collect vaccine the day of RI session and return unused vaccines after session by storing in equipped HFs.



**Figure 1.** Map of Nigeria highlighting Jigawa State

### **Study Population**

The target population were 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[9] 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. Knowledge of healthcare workers on vaccine and cold chain management.
3. Attitude of healthcare workers on vaccine and cold chain management.
4. Practices of healthcare workers on vaccine stock management.

### **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 the significance of the association between two

categorical variables. Binary logistic regression was done to identify predictors of vaccine stock management practices. The level of significance was set at p-value <0.05. The reliability of data and validity of test data were done using Cronbach's equation.

**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. For questions with three responses, (yes, no, and not sure) the correct response was scored 1, the wrong response was scored 0, and not sure was scored 0. For questions about attitude that had strongly agree, agree, indifferent, disagree and strongly disagree options, the responses were scored 5,4,3,2 and 1 in that order for a positive attitude response and 1,2,3,4 and 5 for a negative attitude response respectively.

**Knowledge scoring and grading:** Knowledge was assessed with 13 questions and an obtainable maximum score of 13 points. The mean knowledge score was calculated, with respondents who scored below the mean regarded as having poor knowledge while those who scored up to or above the mean were regarded as having good knowledge respectively.

**Attitude scoring and rating:** Attitude was assessed with 7 questions with an obtainable maximum score of 35 points. These were rated using a 5-point Likert scale. Mean attitude score was calculated, with respondents who scored below the mean being regarded as having negative attitude while those who scored up to or above the mean were regarded as having positive attitude respectively.

**Practice scoring and grading:** 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 point. Mean practice score was calculated, with respondents who scored below the mean was regarded as having poor

practice while those who scored up to or above the mean were regarded as having good practice.

## **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 however addressed. The possibility of healthcare workers not disclosing sensitive information during the quantitative interview. This was however addressed using electronic questionnaire administration with confidentiality of respondents preserved. 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

### Sociodemographic 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 97%

response rate. 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 (Table 1).

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

Variable	Health Facility Status		$\chi^2$	df	p-value
	Equipped n (%)	Non-equipped n (%)			
<b>Age (in years)</b>					
< 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)			
$\geq 50$	30 (88.2)	4 (11.8)			
Mean (+ SD) age	36.77 $\pm$ 8.69	35.82 $\pm$ 7.06			
<b>Sex</b>					
Male	235 (73.0)	87 (27.0)	0.03	1	0.86
Female	46 (71.9)	18 (28.1)			
<b>Level of education</b>					
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)			
<b>Cadre</b>					
JCHEW	48 (65.8)	25 (34.2)	8.94	6	0.18
CHEW	155 (71.4)	62 (28.6)			
CHO	7 (87.5)	1 (12.5)			
Medical Doctor	3 (100.0)	0 (0.0)			
Midwife	11 (100.0)	0 (0.0)			
Registered Nurse	5 (83.3)	1 (16.7)			
Others	52 (76.5)	16 (23.5)			

\*Statistical significance

### Knowledge of Healthcare Workers on Vaccines and Cold Chain Management

There was a significant difference ( $p < 0.05$ ) for responses on VVMs are the only temperature monitoring devices that routinely

accompany vaccines throughout the entire supply chain among healthcare workers from equipped health facilities 213 (77.2%) as compared to those from non-equipped health facilities 63 (22.8%) (Table 2).

**Table 2.** Knowledge of Healthcare Workers on Vaccines and Cold Chain Management in Jigawa state, Nigeria, 2022 (N=386)

Knowledge questions	Health facility status				$\chi^2$	df	p value
	Equipped n (%)		Non-equipped n (%)				
	Correct	Incorrect	Correct	Incorrect			
Where in the ice-lined refrigerator should the thermometer be placed?	190 (72.0)	91 (74.6)	74 (28.0)	31 (25.4)	0.29	1	0.59
Ice-lined refrigerators can expose vaccines to freezing temperatures if vaccines are not arranged properly in baskets provided in the ice-lined refrigerators	239 (73.1)	42 (71.2)	88 (26.9)	17 (28.8)	0.09	1	0.76
Heat sensitive vaccine is also known as heat damaged vaccine	258 (72.7)	23 (74.2)	97 (27.3)	8 (25.8)	0.03	1	0.86
Vaccine Vial Monitors (VVMs) are the only temperature monitoring devices that routinely accompany vaccines throughout the entire supply chain	213 (77.2)	68 (61.8)	63 (22.8)	42 (38.2)	9.37	1	0.002*
VVMs do not measure exposure to freezing temperatures	211 (73.0)	70 (72.2)	78 (27.0)	27 (27.8)	0.03	1	0.87

\*Statistically significant

### Attitude of Healthcare Workers on Vaccines and Cold Chain Management

There was a significant difference ( $p < 0.05$ ) for responses on the number of times vaccine refrigerators should be opened in a day 228 (72.8%) for healthcare workers in equipped health facilities as compared to those 85 (27.2%) in non-equipped health facilities. The use of vaccines before expiration, 260 (73%) of healthcare workers in equipped health facilities as compared to 96 (27%) in non-equipped health facilities (Table 3).

### Practices of healthcare workers on vaccines and cold chain management

There was a significant difference ( $p < 0.05$ ) for responses on the availability of functional thermometers in health facilities with 249 (100%) for healthcare workers in equipped health facilities. In the practice of the First Expiry, First Out (FEFO) principle, 267 (74.4%) of healthcare workers in equipped health facilities as compared to 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 4).

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

Attitude questions	Health Facility Status				χ <sup>2</sup>	df	p value		
	Equipped n (%)		Non-equipped n (%)						
	A	I	D	A					
Vaccine refrigerators should be opened less than 2 times a day	228 (72.8)	10 (83.3)	43 (70.5)	85 (27.2)	2 (16.7)	18 (29.5)	13.96	4	0.01*
Vaccines should be used before expiration	260 (73)	8 (80.0)	13 (65)	96 (27)	2 (20.0)	7 (35)	15.38	4	0.004*
Drugs can be stored with vaccines in the same refrigerator	170 (68.3)	23 (85.2)	88 (80)	79 (31.7)	4 (14.8)	22 (20)	12.91	4	0.01*
Child health card can be pre-filled before commencement of routine immunization session to save time	128 (67.7)	10 (76.9)	143 (77.7)	61 (32.3)	3 (23.1)	41 (22.3)	9.53	4	0.05

A: Agree, I: Indifferent, D: Disagree \*Statistically significant

**Table 4.** Practices of Healthcare Workers on Vaccines and Cold Chain Management in Jigawa state, Nigeria, 2022 (N=386)

Practice questions	Health facility status				χ <sup>2</sup>	df	p value
	Equipped n (%)		Non-equipped n (%)				
	Yes	No	Yes	No			
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 principle in health facility	267 (74.4)	14 (51.9)	92 (25.6)	13 (48.1)	6.46	1	0.04*
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

The alpha coefficient using the Cronbach's equation was 0.515 for knowledge questions, 0.539 for attitude questions, and 0.573 for practice questions 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 working experience in health facility 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 <sup>2</sup>	df	p-value	OR (95% CI)
	Good practice	Poor practice				
<b>Gender</b>						
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)				
<b>Age (Years)</b>						
< 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)				
<b>Educational level</b>						
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)				
<b>Years of working experience in HF</b>						
< 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)				
<b>Knowledge on vaccine management</b>						
Good	161 (69.4)	71 (30.6)	5.46	1	0.02*	1.66 (1.08 – 2.53)
Poor	89 (57.8)	65 (42.2)				
<b>Attitude on vaccine management</b>						
Positive	122 (62.6)	73 (37.4)	0.84	1	0.36	0.82 (0.54 – 1.26)
Negative	128 (67.0)	63 (33.0)				

**\*Statistically significant**

Predictors of vaccine management practices among healthcare workers in Jigawa state based on gender, religion, knowledge on vaccine and

cold chain management, and years of working experience in health facility was found not to be statistically significant ( $p>0.05$ ) (Table 6).



**Table 6.** Predictors of Vaccine Management Practices among Healthcare Workers in Jigawa State, Nigeria

Variable	p-value	AOR	95% CI
Gender (reference: Female)	0.07	0.60	0.34-1.05
Religion (reference: Christianity)	0.10	0.35	0.10-1.22
Knowledge (reference: Good)	0.07	1.49	0.96-2.30
Years of working experience in health facility (reference: $\geq 1$ year)	0.99	1.01	0.22-4.56

## Discussion

Effective vaccine stock management is pivotal to a successful routine immunization service delivery. The research work highlighted the association between healthcare workers vaccine management practices in relation to duration of work experience at the health facility level and knowledge acquired over the years on effective vaccine stock management. Healthcare workers from equipped health facilities were found to have good vaccine stock management practices as compared to their counterparts from non-equipped health facilities in the state.

Respondents from equipped health facilities had increased knowledge of vaccines and cold chain management as compared to those from non-equipped health facilities. This might not be unconnected with the fact that vaccine management topics, such as vaccine storage and handling, cold chain management, VVM interpretation and use of Multidose Vial (MDV) policy were taught during routine immunization training in the state, on-the-job training, and mentorship of healthcare workers during health facility supervisory visits by LGA level officials. Findings from the study were similar to studies conducted in health facilities in Ethiopia and Nigeria respectively [10, 11].

Overall knowledge of vaccines and cold chain management was found to be high among healthcare workers in equipped health facilities. This finding was however at variance with another study on vaccine cold chain management [12].

Health professionals' attitude in their workplace has been found to directly affect their job performance, decisions, and turn-over

[13]. Positive attitude to vaccines and cold chain management was observed more with healthcare workers at equipped health facilities as compared with those from non-equipped health facilities. This is like findings from previous studies carried out in other regions of Nigeria [12, 14, 15]. However, the study findings contrasted findings from a study in Malaysia in which over three-quarters of respondents had a negative attitude toward cold chain management [16]. There was overall good knowledge and a positive attitude towards vaccine stock management.

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 [17]. According to the vaccine cold chain management system [18], 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 the availability of requisition forms 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 [15, 19, 20].

## Conclusion

The study revealed that healthcare workers from equipped health facilities in Jigawa state had good knowledge and positive attitudes on vaccines and cold chain management as compared to their counterparts from non-equipped health facilities. 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 the length of years working in health facilities, good knowledge, and practices on vaccine stock management as evident among healthcare workers from equipped health facilities. Effective vaccine stock management was found to be dependent on knowledge and attitude of vaccine and cold chain management with practices of vaccine stock management. The findings from this study should be used to improve effective vaccine stock management at the state, LGA, and health facility levels. It is recommended that the Jigawa State Primary Health Care Development Agency should help address identified barriers to effective vaccine stock management across all health facilities in the state. The conduct of the qualitative study to further explore determinants of vaccine

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management practices amongst healthcare workers is recommended.

## Conflict of Interest

There is no conflict of interest in the study.

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