

Vaccine Management in North Central Nigeria: A Review of the Impact of Optimized Integrated Routine Immunization System, Kaduna State, Nigeria

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Abstract:

Background: The unintentional wastage of vaccines associated with Immunization programmes worldwide is an obvious pointer to the huge losses in form of shortages, expiry dates, breakages etc. in many nations. This was a retrospective descriptive study based on information retrieval from relevant statutory records. There is lack of comprehensive study done in Kaduna State to validate the wastage rate recommended by WHO and the National Primary Health Care Development Agency (NPHCDA), thus aim for this assessment was to assess the profile of vaccine wastage in the Routine immunization program of Kaduna state from 1st January 2019 to December 2019.

Materials and Methods: Monthly vaccine allocation, usage, storage and retirement data were collected from the Local Government Health Authorities (LGHAs) of the 23 LGAs of Kaduna State, while information on vaccine vials used at Immunization Clinic (IC) and children vaccinated were retrieved from immunization reports for the reference period 1st January 2019 to 31st December 2019.

Results: Our study revealed that Kaduna State recorded an average of 3.5%, 20.8% and 19% wastage rate of Lyophilized, Liquid and Oral vaccines between the period under review across all vaccines in use, with BCG having the highest wastage rate of 63% with 2.72 wastage factor.

Conclusion: Documentation in terms of specific causes of vaccine wastage, capturing breakages, mal-handling of packages, remnants from the used vials and other factors involved in the distribution chain were not considered in the vaccine wastage records in Kaduna state. These findings also validate the wastage rate recommended by WHO and NPHCDA. Further still, proper documentation in terms of specific causes of vaccine wastage, capturing breakages, mal-handling of packages, and other factors involved in the distribution chain and remnants from the used vials as well as stakeholders training revolving round vaccine wastage and management should be a priority in all immunization programme are recommended.

Key Word: Distribution Chain; Priority; Management; Vaccine Use; Data quality; Documentation.

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I. Introduction

Nigeria is one of the countries enjoying support from various agencies both internationally and locally. Huge allocation and donations in relation to immunization programs globally calls for monitoring, accountability and prudence. Aaron *et al.*, (2017) ¹reported that inadequate implementation of vaccine

management guidelines, missed opportunities to vaccinate, and reduce the lyophilized vaccine wastage to their barest minimum. The ongoing optimized routine immunization services' data quality spot checks provided a better sense of vaccine utilization and wastage rate can lead to better planning and management of vaccine stocks. This assessment is designed to unveil the district level vaccine wastage to influence the management and policy regarding vaccine use².

Investing in a more rational approach to estimate wastage rates will enable countries to adjust their budgets based on accurate vaccine supply forecasting. In addition, it would help procuring agents such as United Nations Children's Fund (UNICEF) and Pan American Health Organization (PAHO) to improve predictability of the global demand for vaccines and share this information with manufacturers. It will also enable donors to maximize value for money of their investments to support enhanced vaccine coverage and equity³. Vaccine wastage is often defined as "loss by use, decay, erosion, or leakage or through wastefulness"⁴, in other words, it is the proportion of vaccine doses supplied and actually used in the immunization program⁵. There are many factors that contribute to vaccine wastage. The losses could arise from inventory, in unopened vials, for different reasons: expiry, damage from cold chain breakdowns, breaking, freezing, failure of multi-dose vial policy, discarding opened vials of vaccines eligible for reuse because of misuse or ignorance of the multiple-dose vial policy (MDVP). TT, pentavalent and Hip, are examples of vaccines in which MDVP is applicable⁶. Vaccine wastage is an expected component of any immunization program. In order to ensure that no child is missed during an immunization session, extra vaccine must be supplied but should be balanced with excessive wastage, safety concerns, and timely use of vaccines. Immunization programmes worldwide now have an abundance of immunization service options including single-dose and multi-dose vials, pre-filled auto-disposable devices, and other vaccine presentation options that can influence vaccine wastage rates⁷. In recent years a number of new vaccines have been added to national vaccination programmes and consequently the cost per fully immunized child has increased considerably^{8,9}. These growing costs make the considerate use of vaccines pressing and interest to minimize vaccine wastage has risen¹⁰. Due to restricted cold storage capacity in many developing countries, multi-dose vials are commonly used. In 2014 World Health Organization (WHO) revised its multi-dose vial policy (MDVP) to advise countries on minimizing vaccine wastage while ensuring vaccine safety¹¹. Under the policy, multi-dose vials with preservatives may be kept for up to 28 days after opening in contrast to the lyophilised vaccines, which do not contain preservatives, and should be discarded 6 hours after reconstitution¹¹. Through a procurement services agreement with the Government of Nigeria, all vaccines used in the national immunization programme are supplied by UNICEF and imported from WHO prequalified sources. Vaccine distribution system starts from the national cold store in Abuja to the national zonal cold store in Kano to the state Cold store in Kaduna, the state has zonal cold stores in the three senatorial zones, 23 cold stores at the Local Government Area (LGA) headquarters. Health Clinics with Solar Direct Drive (SDD) refrigerators provide quality storage for all vaccines. The distribution of vaccines and supplies to health facilities providing routine immunization (RI) either at fixed sessions and or outreaches. It is usually at these operational levels that vaccine wastage happens during their operations. The dearth of information locally in north central Nigeria, particularly Kaduna State already having a memorandum of Understanding with bilateral and multilateral agencies will validate the wastage rate, thus reason for this assessment was to assess the profile of vaccine wastage in the Routine immunization program of Kaduna state from 1st January 2019 to December 2019.

II. Material And Methods

Study area

Kaduna state is located at the Northern part of Nigeria's High Plains. The vegetation cover is Sudan Savannah type, characterized by scattered short trees, shrubs and grasses. The soil is mostly loamy to sandy type. A substantial amount of clay is found also. Its northern half became Katsina state in 1987. The state is bordered by seven states¹². It is ranked 4th by land area and 3rd by population in Nigeria. The state capital was the former capital city of the British protectorate of Northern Nigeria region (1923-1966) after Zungeru (1903-1923) and Lokoja (1897-1903). Other major urban areas include Zaria, Kagoro, Kafanchan, Kachia, Nok, Makarfi, BirninGwari and Zonkwa¹³. The latitude of Kaduna, Nigeria is 10.609319, and the longitude is 7.429504. Kaduna, Nigeria is located at Nigeria country in the *Cities* place category with the global positioning system (gps) coordinates of 10° 36' 33.5484" N and 7° 25' 46.2144" E. ¹⁴. The Kaduna State economy was ranked 15th largest state in Nigerian economy from 2002 to 2008, and it made up 3.3% of Nigerian GDP. Agriculture contributed 30% of SGDP in Kaduna¹⁵. Kaduna state cultivates cotton and peanuts (groundnuts) for exporting and domestic extraction of Peanut oil. In the state there is National Institute of Leather and Technology, to improve modern technology and traditional method^{16, 17, 18, 19, 20}. Kaduna State has over 1,000 primary healthcare facilities to cater to every resident - even in the most remote village or ward of the state. To further improve on healthcare delivery, in 2016, the Kaduna State Government partnered with the UK Department For International Development (DFID) to install over 1.3 Mega Watts of Solar Systems in primary

healthcare facilities across the state²¹. At the time of writing this article the SDD saturation in the State has since increased to every political ward, all secondary health facilities and most tertiary hospitals, with the aid of the Bill and Melinda Gate Foundation/AlikoDangote Foundation.

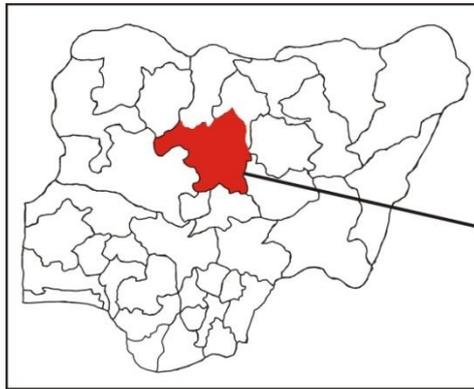


Figure 1: Map of Nigeria showing Kaduna State
Source: http://commons.wikimedia.org/file:Kaduna_state_nigeria.png [22]



Figure 2: Map of Kaduna State showing the 23 LGAs
Source: 2019 festivalclaca.cat [23]

III. Methods

This was a retrospective descriptive study from the Kaduna State Primary Health Care Delivery Agency’s database and retrieved for review and use of data for action (January–December, 2019) immunization reports. Kaduna state like most other eighteen northern states have made remarkable progress in the routine immunizations and other related health indicators. At the thus moving away from the emergency mode as influenced by the routine immunization strengthening programme with the MOU to implement the primary health care under one roof (PHCUOR). This also includes monthly vaccine allocation, usage, storage and retirement data from the 23 LGAs (Local Government Area) of Kaduna State.

Data collection

The 23 LGAs in the state routinely collect their supplies including vaccine monthly, the usage equally monitored monthly and feedback sessions held quarterly. This informs the basis of our review of the data collated for 2019 in Kaduna state from the Local Government Health Authorities (LGHAs) of the 23 LGAs of Kaduna State, while information on vaccine vials used at Immunization Clinic (IC) and children vaccinated were retrieved from immunization reports for the reference period January 2019 to December 2019.

Ethical approval

Ethical approval with Reference Number NHERC/17/03/2018 and MOH/ADM/774/Vol.1/919 was obtained from the Kaduna State Ministry of Health, Nigeria.

Statistical analysis

The data collected was entered into Microsoft Excel 2003-2007 and exported into SPSS version 20 (SPSS Inc., Chicago, IL) for analysis, while the wastage rate at store level and session site levels were estimated using the WHO recommended formula for calculating vaccine wastage³¹:

$$\text{Vaccine of} \left\{ \begin{array}{l} \text{Number of usable} \\ \text{doses at beginning} \\ \text{period} \end{array} \right\} + \left\{ \begin{array}{l} \text{Number of doses} \\ \text{received during} \\ \text{period} \end{array} \right\} - \left\{ \begin{array}{l} \text{Number of usable} \\ \text{doses in stock at} \\ \text{end period} \end{array} \right\} = \left\{ \begin{array}{l} \text{Number} \\ \text{of doses} \\ \text{administered} \end{array} \right\} \quad \times 100$$

$$\text{Wastage rate (\%)} = \frac{\left\{ \begin{array}{l} \text{Number of usable} \\ \text{doses at beginning} \\ \text{of period} \end{array} \right\} + \left\{ \begin{array}{l} \text{Number of doses} \\ \text{received during} \\ \text{period} \end{array} \right\} - \left\{ \begin{array}{l} \text{Number of usable} \\ \text{doses in stock at} \\ \text{end of period} \end{array} \right\}}{\left\{ \begin{array}{l} \text{Number of usable} \\ \text{doses at beginning} \\ \text{of period} \end{array} \right\} + \left\{ \begin{array}{l} \text{Number of doses} \\ \text{received during} \\ \text{period} \end{array} \right\}} \times 100$$

The LGA level sub-stores have their records from which the wastages are summed and estimated as required using the opening stock balance, new doses received, closing stock, and the children vaccinated. The vaccines used rely on all doses administrated at the sessions held at facility and outreach sites under the respective store were considered. For the outreach sessions, all doses administrated at the outreach session were considered. Wastage for each vaccine for every month for each facility, session site and store and for each different dose type (IPV and fIPV), vial size (5, 10, 20 and 50 doses), vaccine type (lyophilized and liquid), and applicability of open vial policy (open vial or single use) were calculated according to²⁴.

IV. Result

Table1:Summary of the wastage rate of lyophilized vaccines from the 23 Local Government Areas of Kaduna State Jan-Dec 2019

Antigen	Children immunized	Doses used	Doses received	Discarded doses	Doses returned	Recommended wastage rate	Wastage rates (Administrative)	Wastage rate (Systemic)	Wastage rate Global	Wastage factor
BCG	350277	953919	1175283	20	16590	70%	63%	0.002%	69%	2.72
Yellow fever	329637	598886	617239	0	11226	30%	45%	0.000%	45%	1.82
Measles	336473	604394	624728	0	11198	30%	44%	0.000%	44%	1.80
MenA	72162	189600	192848	0	4920	30%	62%	0.000%	60%	2.63

Key: BCG= *Bacillus Calmette-Guerin vaccine*, MenA= *Meningococcal group Apolysaccharide vaccine*

During the study period under review, table1 showed the wastage rate of lyophilized vaccines and wastage factor of the different vaccines in Kaduna state. The highest wastage rates were found in BCG (63%), and MenA (62%) with wastage factor of 2.72 and 2.63; the least wastage rate for Yellow fever (45%), and Measles (44%) with 1.82 and 1.80 wastage factors respectively.

Table2: Summary of the wastage rate of liquid vaccines from the 23 Local Government Areas of Kaduna StateJan-Dec 2019

Antigen	Children Immunized	Doses used	Doses received	Discarded Doses	Doses returned	Recommended wastage rate	Wastage rates (Administrative)	Wastage rates (systemic)	Wastage rate Global	Wastage Factor
Penta	1060655	1193888	1215597	22	12530	25%	11%	0.002%	12%	1.13
PCV	1061073	1182112	1197193	12	12864	10%	10%	0.001%	10%	1.11
HBV	217982	324840	332188	0	8511	25%	33%	0.000%	32%	1.49
IPV	344625	466553	486560	0	9239	25%	26%	0.000%	27%	1.35
TT	658481	862645	777971	0	4920	25%	24%	0.000%	15%	1.31

Key: Penta = Pentavalent vaccine, PCV=Pneumococcal conjugate vaccine, HBV = Hepatitis B, IPV = Inactivated polio vaccine, TT= Tetanus toxoid

Table2 showed the wastage rate for the liquid vaccines alongside their wastage factor. Higher wastage rates were found in HBV (33%) IPV (26%), TT (24%) with corresponding wastage factorof 1.49, 1.35, 1.31, respectively. The low wastage rate recorded in Penta (11%), PCV (10%) with 1.13 and 1.11 wastage factor vaccine is quite revealing.

Table 3: Summary of the wastage rate of the Oral vaccines in the 23 Local Government Areas of Kaduna state Jan-Dec 2019

Antigen	Children Immunized	Doses used	Doses received	Discarded Doses	Doses returned	Recom mended wastage rate	Wastage rates (Administrative)	Wastage rates (systemic)	Wastage rate Global	Wastage Factor
OPV	1350610	1675975	1685920	32	20526	25%	19%	0.002%	19%	1.24
Rota	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Key: OPV = Oral polio vaccine, NA = Not applicable

Table 3 showed wastage rate and factor for oral vaccine to be 19% and 1.24. Kaduna state recorded a 53.5%, 20.8% and 19% wastage rate of Lyophilized, Liquid and Oral vaccines between the period under review across all vaccines.

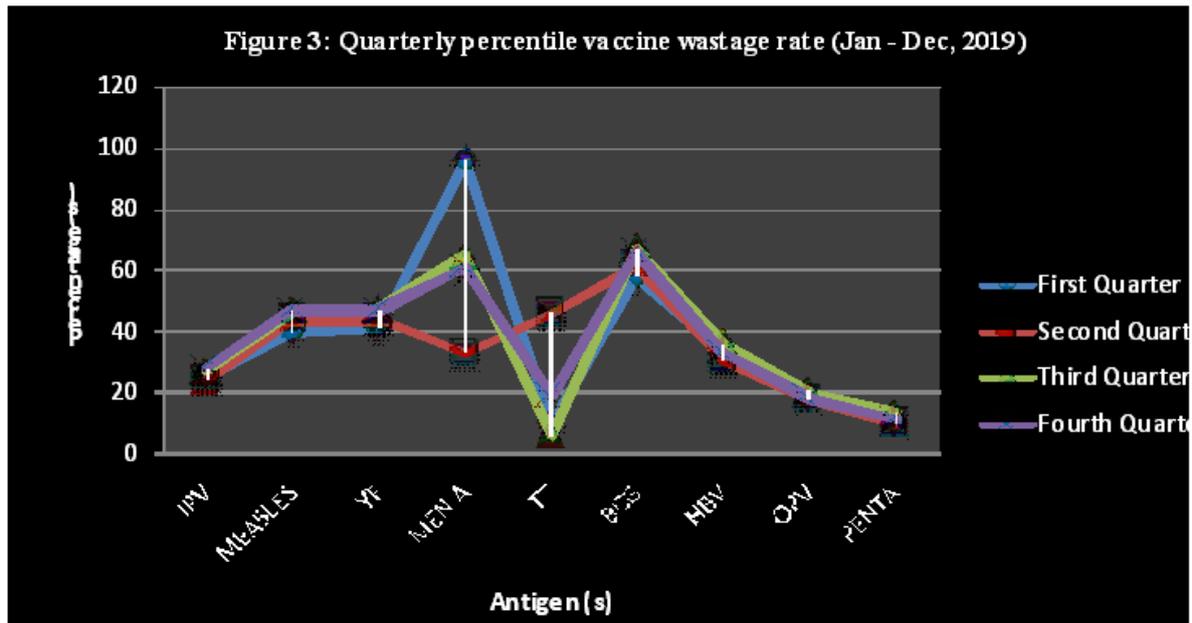
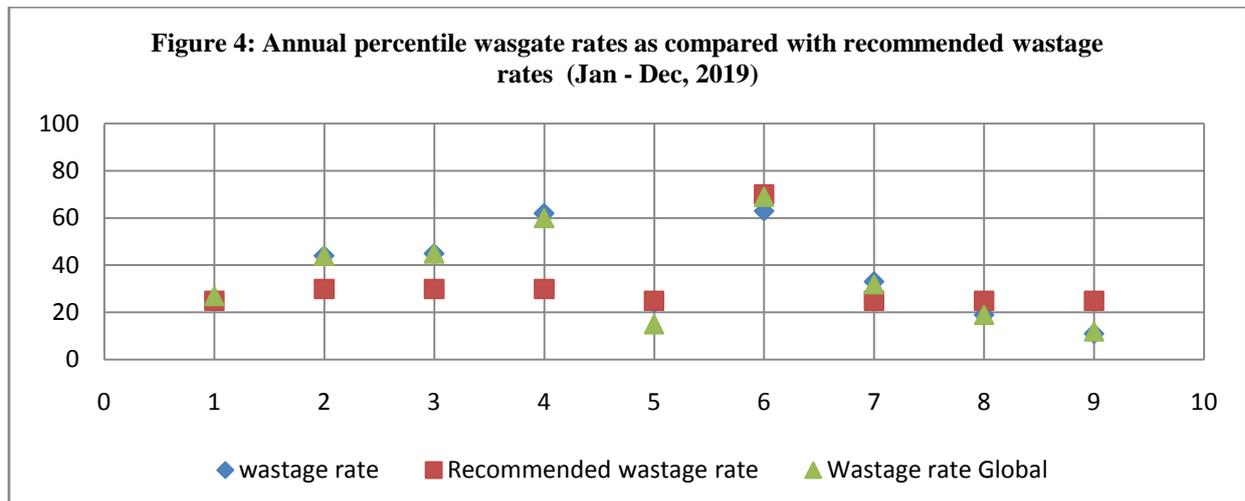


Figure 3: MenA vaccines recorded the highest (100%) rate of wastages during the first and third quarters of the year while BCG had a sustained high wastage in the four Quarters (59% - 76%) compared to other vaccines.



The recorded vaccine wastage for the four quarters fell within the recommended rate (Figure 4).

V. Discussion

In our study, BCG vaccine had the highest wastage rate of 63% with 2.72 wastage factor. Similarly Chakraborty *et al.*, (2019)²⁵ and UNICEF²⁶ recorded wastage rates of 68.9% and 61% with 3.21 wastage factor. Since BCG is a single dose vaccine given at birth or as soon as possible, and has to be reconstituted and used within the shortest possible time of at least 6 hours. When not administered, the remaining dose has to be discarded after 6 hours. This could lead to the high level of wastage rate of the vaccines. However, this falls within the global wastage rate (69%).

The wastage rate of OPV in our study was 19% with 1.24 wastage factors which was higher than studies conducted by Praveena *et al.*, (2015)²⁷ and Tiwari *et al.*, (2017)²⁸ with 2.4% and 14.5% wastage rates. This study recorded a lower wastage rate as compared to the study conducted by Chakraborty *et al.*,²⁵ who recorded a 27.7% wastage rate with 1.38 wastage factors.

In 2011, according to UNICEF, an estimated USD\$ 1.5 million worth of vaccines were lost in five months, often due to difficulties maintaining cold chain vaccine supply to their remote location²⁹. Our study

however revealed that the availability of SDD refrigerators had taken care of vaccine wastage due to power outage thus resulting in loss of vaccine potency in Kaduna state. It should be noted that power outage can break the cold chain i.e. a temperature-controlled supply chain that runs from the time the vaccine is produced until it's administered. WHO reports vaccine wastage to be over 50% all around the World³⁰.

Our study further revealed that most of the wastages were recorded in MenA at first quarter, then reduced in the second quarter and increased again at the third quarter, while BCG maintained same degree of wastage throughout the year. MenA (the most expensive of the vaccines) and BCG are the most wasted.

Despite the vaccine wastages recorded for the four quarters of the year 2019 in Kaduna state, they are within the acceptable range in Comparison with the global and recommended wastage rate.

The current wastage could be attributed to factors that with improved management of vaccine utilization at the operational levels (health Clinics and outreach sites). According to this study, the vaccine wastages point to the distribution chain, lack of all round documentation and inadequate supportive supervision at the service delivery points in the health clinics.

VI. Conclusion

Documentation in terms of specific causes of vaccine wastage, capturing breakages, package handling, of the used vials and other factors involved in the distribution chain were not considered in the vaccine wastage records in Kaduna state. The wastage rates recorded being 3.5%, 20.8% and 19% for the Lyophilized, Liquid and Oral vaccines between the period under review across the vaccines, including BCG having 63% and 2.72 wastage factor, validates the improved quality of delivery and management of scarce Vaccines supply to the Kaduna state.

The Primary Health Care Development Agency should craft a durable supportive supervisory mechanism and coaching at the operational levels to sustain the improvements and reduce wastages to the barest minimum.

Implementation of stakeholders training revolving round vaccine wastage and management should be a priority in all immunization programme.

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