Vaccination Rates Analysis for Preventable Childhood Diseases in Nigeria

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1. Business Understanding

1.1 Overview

Immunisation is one of the most cost-effective ways of preventing many under-five deaths. Therefore immunisation coverage is one of the indicators used to monitor progress toward the reduction of child morbidity and mortality. WHO considers a child to be entirely vaccinated if, during the first year of life, he or she has received tuberculosis vaccination; three doses of vaccine to prevent diphtheria, pertussis, and tetanus; at least three doses of polio vaccine; and one dose of measles vaccine. This is the reason why information on vaccination coverage typically concentrates on the 12- to 23-month age group (the average age by which infants should have received all fundamental vaccinations).
The real goal is to make sure that all children under one year old are fully immunised at a rate of 90 percent nationally and at least 80 percent in each state.

1.2 Problem Statement

The Nigerian Expanded Programme on Immunization (EPI) was initiated in 1979. There was progress in the 1980s and since then, the vaccination coverage has then stagnated. The real goal is to make sure that all children under one year old are fully immunised at a rate of 90 percent nationally and at least 80 percent in each state.

1.3 Objectives

The objective is to create client value by addressing the challenge of improving vaccination rates through data analysis and providing actionable recommendations.

Specific Objectives

- Conduct exploratory data analysis to gain a comprehensive understanding of the vaccination rates.
- Perform statistical analysis and identify patterns, trends and within the data and derive meaningful insights.
- Create informative visualisations and present the insights in an understandable manner.
- Give sensible recommendations based on findings discovered when analysing the data.

1.4 Project Plan

- I used Python on Jupyter Notebook and Tableau for my data analysis
- Reading material to understand the state of vaccination coverage in Nigeria in 2018
- Derivation of meaningful insights using visuals and statistics

2. Data Understanding

This section is broken down into tasks that included;

1. Collection of the Initial Data
2. Data Description
3. Data Cleaning
   Making the dataset understandable and easy for data analysis
4. Exploratory Data Analysis

2.1 Overview

This data was collected from the National Nutrition and Health Survey conducted in 37 domains, 36 states and Federal Capital Territory (FCT) between February 19 and June 2, 2018. The data will be extracted from the opendataAfrica website, an API was provided to extract the data for an analysis.
I then imported the necessary libraries for loading of the dataset using the API; *requests, json and pandas*

2.2 Data Description

Overall understanding of the dataset, how many instances and columns there are and doing descriptive statistics.
The data includes information about the states in Nigeria, the types of vaccine administered and the total percentage of children immunised.
The data had a total of 100 rows and 3 rows. There were two categorical columns; 'state' and 'vaccine' columns and one numerical column the 'total' columns.
I then carried a small descriptive statistical analysis; the maximum and minimum percentages of vaccination coverages was 36 and 98, respectively.

2.3 Data Preparation

This is the actual preparation of the data to allow data analysis, it involves data cleaning and formatting to ensure the Validity, Accuracy, Completeness, Consistency and Uniformity of the Data.

To ensure consistency and uniformity, this will include checking for missing and duplicated values and values. There were neither missing values nor duplicated instances.
I also went ahead to check for any outliers, to ensure there weren't any abnormalities and there were none.
I did not need to do any formatting of the column names because of the limited available data.

2.4. Data Analysis

I explored the data using both the Jupyter notebook and Tableau.
In Jupyter Notebook, I divided it into three sections;

1. Univariate Analysis
2. Bivariate Analysis
3. Multivariate Analysis

Univariate Analysis

The purpose of the univariate analysis is to understand the distribution of values for a single variable.
I started by checking the 'total' column, by plotting a histogram and found that there was more than 90% vaccination coverage that year in Nigeria, which is an improvement from the previous years.

Bivariate Analysis

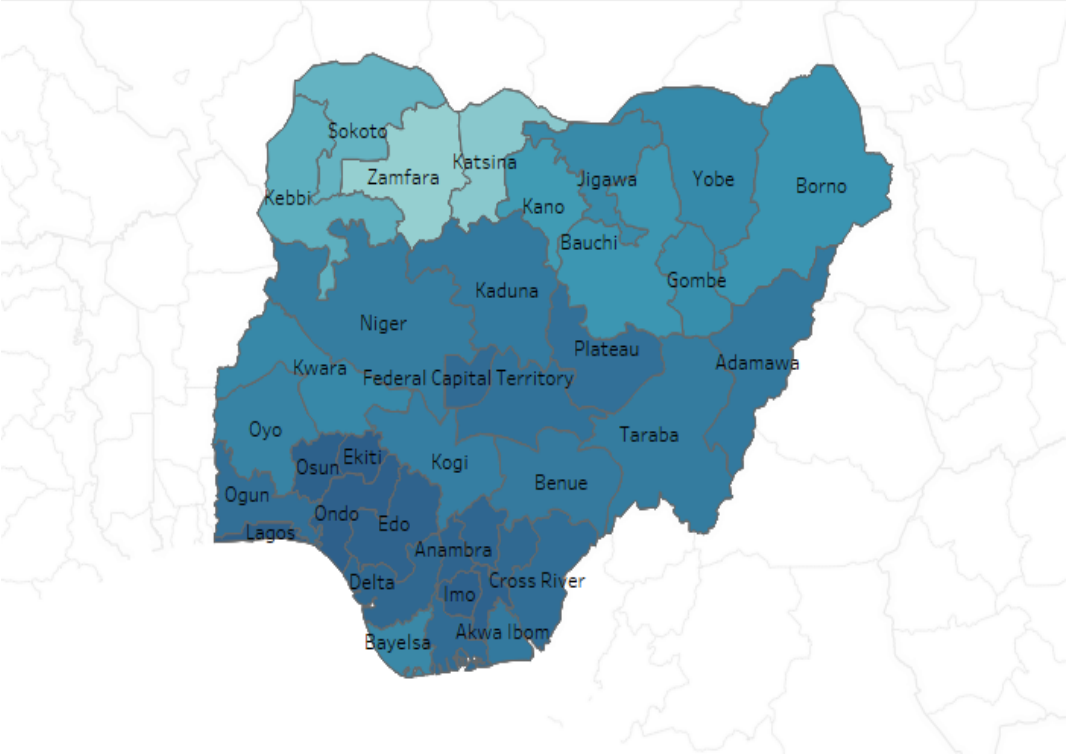
We use Bivariate analysis for the analysis of two variables.
We use a visualisation, to analyse the relationship of state and total vaccination coverage. From the bar plot, we observe that the state that received the highest vaccination rate was *'Ekiti', 'Imo',* and *'Anambra'* and the states with the least vaccination coverage was *'Kano', and 'Jigawa'*.
Next, we analyse the relationship between the 'vaccine' and the 'total', the vaccine 'Any' was the most frequent vaccine administered to the children in total and 'Penta 3' was the least administered. I then went ahead to check if it was the same case for each state and it was, the most common vaccine in each state was 'Any' and the least common vaccine was 'Penta3'

Multivariate Analysis

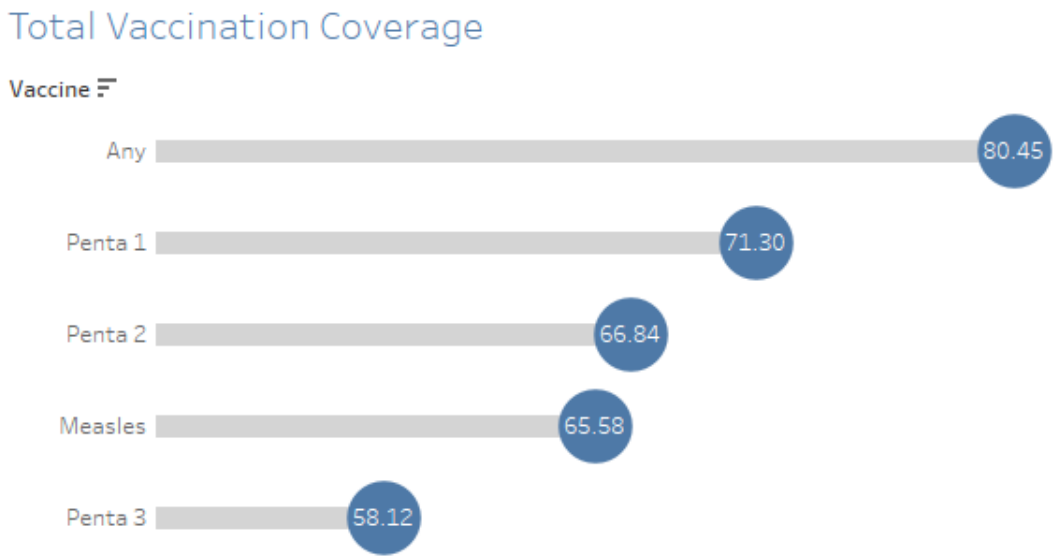
The analysis of more than two or all variables and checking how they are correlated.
To check the correlation of all the 3 columns, I used a grouped bar chart and it emphasised the above results of *'Kano'* having the highest vaccination rates.

Tableau Visualisations

I created a map visual to show me which areas of the country had low vaccination rates, and it indicated the Northern parts of Nigeria, specifically the "Zamfara" and "Katsina" states in the NorthEast followed by the NorthWest. More than 80% of the children in the North East did not receive all their routine immunisations.



Another visual of the delivery of each of the vaccines shows that there is high dropout rate and many children do not finish their immunisations.



Here's a summary of the vaccination coverage rates for children aged 12-23 months:
Children (12-23 months) who received **any** vaccine:
National coverage: 79.3%
Zone-wise coverage:
North Central (NC) Zone: 83.1%
North East (NE) Zone: 73.0%
North West (NW) Zone: 56.9%
South East (SE) Zone: 95.6%
South South (SS) Zone: 89.4%
South West (SW) Zone: 92.8%

Children (12-23 months) who received **Penta3** vaccine:
National coverage: 57.2%
Zone-wise coverage:
North Central (NC) Zone: 49.7%
North East (NE) Zone: 48.4%
North West (NW) Zone: 28.7%
South East (SE) Zone: 82.9%
South South (SS) Zone: 74.2%
South West (SW) Zone: 78.5%

Children (12-23 months) who received **measles** vaccine:
National coverage: 64.7%
Zone-wise coverage:
North Central (NC) Zone: 69.2%
North East (NE) Zone: 61.4%
North West (NW) Zone: 39.8%
South East (SE) Zone: 81.1%
South South (SS) Zone: 73.8%
South West (SW) Zone: 80.2%
These percentages indicate the proportion of children within each zone who received the specified vaccines. It is important to note that higher coverage rates indicate better vaccine uptake and protection against preventable diseases.

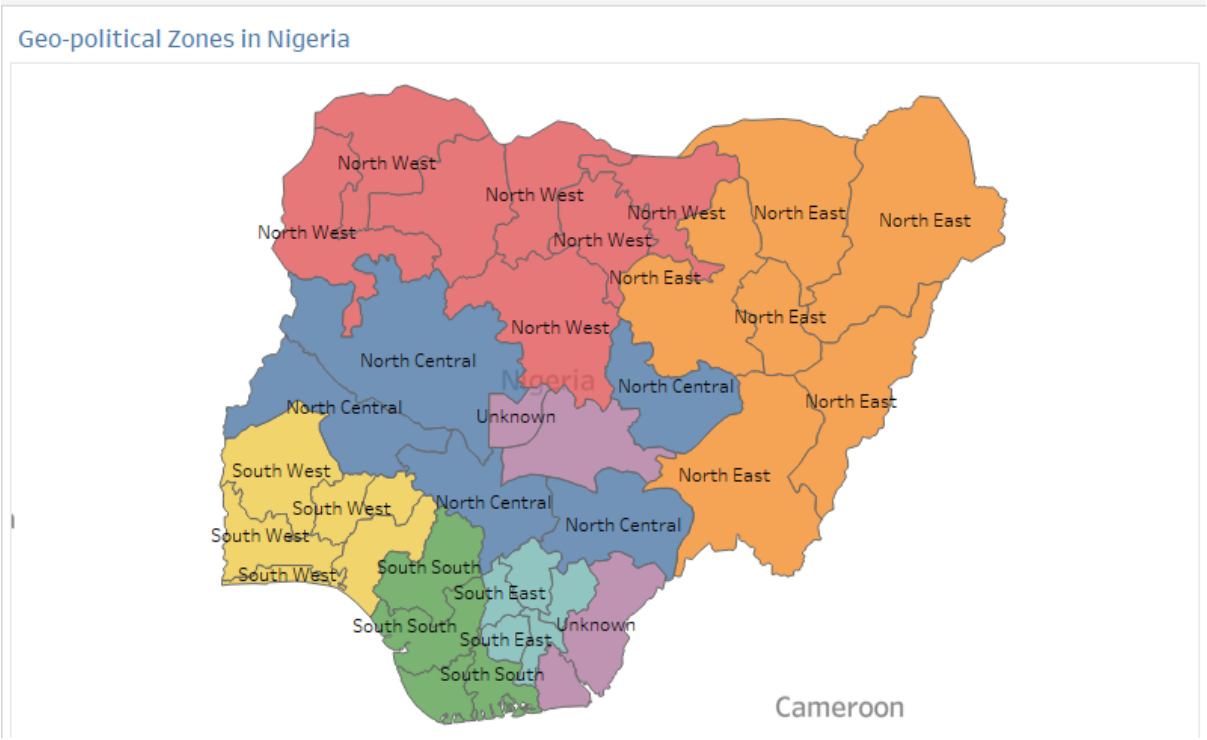
3. Visualisation and Insights

General Knowledge about Nigeria

The Federal Republic of Nigeria is in West Africa. It has a coastline on both the Gulf of Guinea and the Atlantic Ocean. It shares borders with Benin to the west, Cameroon to the east, Chad to the north-east, and Niger to the north.
From the Gulf of Guinea on the Atlantic Ocean, most of the country is made up of plateaus and plains. There are coastal swamps in the south, tropical woods, woodlands, and fields in the middle, and semi-desert in the north.
Nigeria has 36 states and one federal capital territory (FCT) that work together to run the country. About 186 million people live in the country, which has 37 governmental units. This makes it the most popular country in Africa. It is also one of the most racially varied places in the world, with more than 250 different groups. The Hausa and Fulani people live in the north, the Yoruba people live in the west, and the Igbo people live in the east. Along with English Creole (Pidgin English), these are also the most spoken languages in the country.

The 37 Nigerian states have been grouped into six geo-political zones

Geo-political zone	States
South East	Anambra, Enugu, Ebonyi, Imo and Abia
South South	Edo, Delta, Rivers, Bayelsa, Cross-River and Akwa-Ibom
South West	Lagos, Ogun, Oyo, Osun, Ondo and Ekiti
North Central	Kwara, Kogi, Plateau, Nassarawa, Benue, Niger and F.C.T
North East	Adamawa, Borno, Yobe, Bauchi and Gombe
North West	Zamfara, Kebbi, Kaduna, Katsina, Kano and Jigawa



Nigeria has introduced several child survival initiatives and expanded existing ones, with a particular focus on strengthening routine immunisation. In May 2012, for instance, Nigeria began the replacement of the diphtheria, pertussis, and tetanus (DPT) vaccine with the pentavalent vaccine, which contains more antigens – Haemophilus influenzae type B, and hepatitis B. The actual target is to ensure full immunisation of children less than one year at 90 percent nationally, with at least 80 percent coverage in each state

Immunisation coverage in Nigeria is far below national goals, putting a substantial number of children at risk of death and disability from vaccine preventable diseases. Immunisation coverage varies across Nigeria but improvements are needed in every state, especially the North.
Vaccination coverage was low particularly in the North East states like Zamfara. More than 80% of children there did not receive complete vaccination, this means that 4in 10 children do not receive any vaccines.
The mothers were asked to provide the vaccination cards, in the cases where they did not have any the ladies were asked to recall the vaccine given to the child and the number of doses of the Penta vaccines. The 3rd dose of pentavalent vaccine (penta3) is an indicator of the immunisation system's ability to reach and retain children with multiple vaccinations and 4 in 10 children never completed all the recommended vaccines.

- The North East of Nigeria has a lower rate of vaccine than the rest of the country. There are many reasons for this. Here are some reasons why that might be:

Socioeconomic Factors: The North East of Nigeria has a lot of social and economic problems, such as a high rate of poverty, limited access to health care, and low levels of schooling. These things can make it harder for people to find out about vaccines and get them, which can lead to lower coverage rates.

Concerns about security: The North East has a long history of security problems, such as insurgencies and wars. These security problems can interrupt healthcare services, making it harder for people to get immunisations and slowing the growth of healthcare facilities.

Cultural and Religious Factors: The acceptance and use of vaccinations can be affected by cultural and religious views. Some people in the North East may believe or think things that aren't true about vaccines, which can lead to lower coverage rates. Changing these views and encouraging people to get vaccinated can be very important for increasing coverage.

Infrastructure Problems: There are infrastructure problems in the North East, such as a lack of medical services, bad roads, and insufficient transportation systems. These problems can make it hard to get vaccines to people and places that are hard to reach, like rural areas and towns.

Humanitarian Crisis: There is a humanitarian crisis in the North East because of people moving and the effects of war. This situation could mess up health care services, force people to move, and make it harder to run vaccine programmes well.

Lack of Awareness: A large number of carers in the region (17%) said they didn't know how important and helpful children vaccinations are. This lack of knowledge can lead to misunderstandings and false information about vaccines, which can lower the number of people who get vaccinated.

Vaccine Scepticism: About 14% of carers in the North East said they didn't believe in vaccinations. Hesitancy about getting a vaccine can come from traditional views, religious misconceptions, or worries about the safety and effectiveness of the vaccine. To get more people to get vaccinated, it is important to use focused education and information efforts to deal with vaccine fears.

Accessibility Problems: About 13% of carers said that immunisation places were too far away from where they lived. Access to health care centres can be hard to get to, and long routes can make it hard to get vaccinated. More immunisation centres or mobile vaccination units should be set up in remote places to make sure that vaccines are easy for everyone to get.

Caregiver Limitations: About 9% of carers said that they were too busy to get their children fully vaccinated. This shows how important it is to think about the problems that carers face when setting up and going to vaccine sessions. Flexible immunisation plans, longer clinic hours, and programmes that reach out to the community can help carers with their busy schedules.

- When compared to other states in Nigeria, Ekiti and Lagos have a better vaccine rate. There are several reasons for this:

Strong Health Care Infrastructure: Compared to other states, Ekiti and Lagos have more developed health care infrastructure. They have more health care services, such as hospitals, clinics, and places to get vaccinated. This infrastructure makes it easier for people to get shots and helps them get to where they need to go.

Urbanisation and Population Density: Compared to other states, Ekiti and Lagos have more people living in cities and a higher population density. In general, people in cities have better access to health care, including places to get vaccinated. Because there are more people living in a smaller area, vaccine programmes can be more effective and reach more people.

Government Commitment: The governments of Ekiti and Lagos may have put health care, including vaccination programmes, at the top of their lists of priorities. They may have put in place successful policies, programmes, and funding to increase the number of people who get vaccinated and make sure that vaccines are available and easy to get.

Awareness and Education: Ekiti and Lagos have more people who can read and write and better schools, which helps people know and understand how important vaccines are. Education efforts, getting people involved in their communities, and public knowledge programmes may have played a big part in getting people to accept and use vaccines.

Socioeconomic Factors: Compared to other places, Ekiti and Lagos are more developed and have better socioeconomic conditions. Higher socioeconomic level can affect how people get health care and make it easier for them to get services like vaccines.

4. Recommendations

- ➢ Here are some suggestions to boost vaccination rates in certain areas or for certain vaccines:

Targeted Awareness Campaigns: Make and run focused awareness campaigns that focus on areas with low vaccine rates, like the North East of Nigeria, where people are less likely to get vaccinated. These ads should stress how important vaccines are, clear up common misunderstandings, and talk about how immunisations help people.

Strengthen the Healthcare System: Spend money to improve the healthcare system in areas with lower vaccine rates. This means adding more health care facilities, vaccination centres, and trained health care workers so that vaccines are easier to get and are more available.

Community Engagement: To get more people involved in the community, encourage partnerships between community leaders, church institutions, and neighbourhood groups. Talk with people in the community, answer their worries, and give them correct information to help them trust and accept vaccines.

Mobile vaccine Clinics: Set up mobile vaccine clinics in rural or impoverished areas to reach people who may not be able to get to healthcare services easily. This method can make it easier to get vaccines to places that are hard to get to.

Strengthen the Vaccine Supply Chain: Make sure that there is a strong and effective method for managing the vaccine supply chain to avoid stockouts and make sure that vaccines are available at all healthcare centres. This will help keep vaccine services running smoothly and consistently.

Strengthen Regular Immunisation Programmes: Stress how important regular vaccination programmes are and make sure they work. This includes keeping an eye on, evaluating, and improving the programmes that are already in place to make sure that all shots are covered.

Collaboration with Stakeholders: Encourage alliances with healthcare organisations, government bodies, non-profit organisations, and foreign partners to share resources, knowledge, and support. Working together can help get more people vaccinated and put in place tactics that work.

Data-Driven Decision Making: Keep collecting, analysing, and keeping an eye on data about vaccinations to find places to improve and keep track of progress. Using data

to make decisions will allow for tailored actions and make sure that vaccine programmes work.

- ➢ Some tactics and actions to increase the number of people who get vaccinated in certain areas or for certain vaccines:

Targeted marketing programmes: Make special marketing programmes for areas or groups with low vaccine rates. These efforts should use messages that are sensitive to different cultures and involve local influencers, community leaders, and healthcare workers to raise awareness and deal with people who don't want to get vaccinated.

Community Education Programmes: Set up community education programmes to teach people the truth about vaccines, their benefits, and how important it is to get vaccinated. These programmes can include engaging sessions, teaching tools, and Q&A workshops to address concerns and debunk myths or false information.

Mobile vaccine Units: Set up mobile vaccine units to reach poor or remote places with limited access to health care services. These units can go to schools, community centres, and other handy places to give vaccines on-site and get around the problem of distance.

Immunisation sites in Schools: Work with schools to set up sites where people can get immunisations. This method makes it easy for kids to get vaccines and encourages schools to make vaccinations a regular part of their health programmes.

Programmes to teach doctors and nurses about vaccines: Do training programmes and classes for health care workers to help them learn more about vaccines and how they work. This includes talking about common worries, giving up-to-date information on vaccine plans, and stressing how important it is to support vaccines.

Public-Private Partnerships: Help the government, private health care companies, and non-governmental organisations (NGOs) work together to increase the number of people who get vaccinated. Use the money, knowledge, and reach of private health care centres to make vaccines more available and easier to get.

Reminder and recall systems for vaccines: Set up systems to let people and their families know about upcoming or missed vaccination dates. To make sure vaccinations happen on time, these systems can send messages through different methods, such as SMS, email, or automatic phone calls.

Strengthening the Cold Chain Infrastructure: To keep the quality and effectiveness of vaccines, you should invest in making the cold chain infrastructure better. This includes having the right ways to store, move, and keep an eye on vaccines so they don't go bad or get wasted.

Efforts for public health: Work with public health agencies to run larger efforts that show how important vaccines are for avoiding diseases and keeping communities

safe. These campaigns can include ads in the mass media, campaigns on social media, and events in the community.

Research and monitoring: Do research and monitoring to find out what factors affect the number of people who get vaccinated and how to deal with unique obstacles in different parts of the world. This method, which is based on data, will help adapt programmes and tactics to meet the unique needs of different groups.

- ➢ Here are some possible partnerships to think about:

Healthcare organisations;
Work together with hospitals, clinics, and other health care workers to make sure that vaccines are easy to get and are delivered in a smooth way.
Work with professional medical groups to get healthcare workers to support vaccinations and learn more about them.
Set up relationships with shops and private healthcare facilities to increase the number of ways vaccines can be given out.

Community Leaders and Organisations:
Ask community leaders, church leaders, and other important people to act as vaccine champions and push vaccination in their areas.
Work with community-based organisations, non-profits, and local projects to reach people who are left out or who don't get enough help.
Use neighbourhood networks and community events to raise knowledge about vaccines and address issues that are important to the community.

Government Agencies:
Work closely with the Ministry of Health or other government offices to make sure that attempts to vaccinate are in line with national programmes and policies for immunisation.
Work with local health offices to organise the distribution of vaccines, community education programmes, and the sharing of information.
Join public health task groups or panels to share your knowledge and ideas about how to apply vaccine tactics.

Information Institutions:
Work with schools, colleges, and universities to help with vaccine information programmes, vaccination pushes, and keeping track of which students have been immunised.
Work with school nurses and officials to make sure that vaccination standards are met and to encourage kids to get vaccinated.

Agencies for the public health:
Work with national and local public health bodies to share information, ideas, and the best ways to improve vaccine coverage.
Help with public health efforts and projects that aim to get more people vaccinated and deal with people who don't want to get vaccinated.
Take part in joint study projects and monitoring activities to keep track of trends in vaccinations and find places where action is needed.

These partnerships can help use the knowledge, resources, and power of different groups to increase the number of people who get vaccinated. Healthcare organisations, community leaders, and government bodies can work together to improve immunisation rates and make sure the health of the society as a whole.

5. Conclusion

Recommendations based on data to improve vaccine rates are very valuable to clients and partners in a number of ways:
The analysis lets us figure out which areas or groups of people have low vaccine rates. By focusing on these areas, stakeholders can make sure that their efforts have the most effect and that resources go where they are most needed. With this method, vaccine programmes are more efficient and successful.
The recommendations will help people make smart decisions about how to use their resources. By figuring out which places or vaccines have low coverage, resources like vaccines, medical staff, and outreach initiatives can be sent there to boost vaccination rates. This makes sure that resources are used in the best way possible and that no places or people are left behind.
These recommendations will also help healthcare organisations, community leaders, and government bodies figure out how to work together. Based on the findings from the data, stakeholders can work together to put in place measures, raise knowledge, and remove hurdles to vaccine. Collaboration makes projects more effective and makes it more likely that gains in vaccine rates will last.
Also, the suggestions will help those involved keep track of and measure the impact of their actions. By keeping track of vaccine rates over time and comparing them to data from the beginning, stakeholders can figure out how well their plans are working. This makes it possible to keep getting better and to change treatments as needed to get the results you want.

In conclusion, the analysis of vaccine statistics in Nigeria has given important information about the current state of vaccination coverage. The figures showed that different states and geographic zones have different vaccine rates, with the North East having the lowest coverage. Vaccination rates are lower in some places because of things like lack of knowledge, scepticism, and problems with getting things done.

Based on the results, it is important to put focused treatments and partnerships at the top of the list to increase the number of people who get vaccinated. Strategies like getting the community involved to raise awareness, putting an end to vaccine scepticism through education programmes, and making it easier to get vaccinated can help fill in the gaps in coverage. It is important for healthcare organisations, community leaders, and government

bodies to work together to organise efforts, make the best use of resources, and come up with answers that will last.

By using suggestions that are based on data, stakeholders can make smart choices, distribute resources well, and measure the effects of actions. This data-driven method adds value by making it easier to make decisions, allow focused actions, better use of resources, encourage teamwork, and track progress.

In the end, Nigeria can work towards a higher vaccine rate by solving the problems that have been found and putting evidence-based plans into place. This will protect the health and well-being of its people.