# Chapter One

## Introduction

### 1.1 Background to the study

One of the most effective public health campaigns available for lowering under-five death is immunisation. Vaccine-preventable illnesses (VPDs) remain the predominant contributors to childhood mortality, accounting for around 3 million deaths annually, primarily in Africa and Asia.Nigeria launched the Reach Every Ward project in 2005 in order to improve immunisation rates for children between the ages of 0 and 23 months. Although Ogun State had complete immunisation coverage in 12 of its 20 local government areas by 2015, eight areas showed notable numbers of unimmunised children, with the highest rate (37%) in Remo-North. The study sought to pinpoint traits in Remo-North influencing immunisation service use to direct action plans removing obstacles to immunisation acceptance[2].

The National Immunisation Schedule in Nigeria, which parents and mothers need to adhere to in order to protect their children, requires completing all routine immunisations before the age of one. Vaccines are free, safe, and save lives. The vaccines given according to the immunisation schedule in Nigeria are BCG, Oral Polio Vaccine (OPV), Pentavalent, Hepatitis B, Measles, Yellow Fever, Vitamin A, Inactivated Polio Vaccine (IPV), Pneumococcal Conjugate Vaccine (PCV), and Rota Vaccine[3].The aforementioned vaccines are to prevent different types of diseases, BCG is to prevent against Tuberculosis, Pentavalent prevent against Diphtheria, Tetanus, Pertussis, Hepatitis B and Hemophilus influenza type B, Hepatitis B prevent against Hepatitis. Measles Vaccine prevent against measles, Yellow Fever vaccine prevent against

Yellow Fever, Vitamin A is for improvement of sight, inactivated Polio Vaccine (IPV) prevent against Poliomyelitis. Pneumococcal Conjugate Vaccine (PCV) prevent against pneumonia, Rota Vaccine prevent against Diarrhea diseases[4].

Despite initiatives to raise childhood immunisation rates in Nigeria, they have stayed below the recommended level. An assessment conducted in December 2019 on missed opportunities for vaccination in Ondo State, in South West Nigeria, revealed low immunisation coverage rates overall. The subsequent impediments were adversely correlated: the necessity of obtaining permission, inadequate financial circumstances, and significant distance to the clinic. These findings necessitated prompt intervention to rectify inequitable access to routine immunisation in Nigeria[5]. By eradicating all the six fatal diseases—which are measles, Diphtheria, Whooping cough, Tuberculosis, Yellow Fever and Polio—the Expanded Program on Immunisation (EPI) aims to enhance the health of Nigerian children[6].

About two to three million fatalities among children less than five are averted every year due to immunisation. Despite this, only 25% of Nigerian children aged 12 to 23 months received all recommended vaccines. The milieu in which families live and seek health care is a major factor in the considerable differences in the uptake of vaccines. Overall, the results show that vaccination rates are low. Permission requirements, financial constraints, and travel time to the clinic were all deemed as negative hurdles. These results highlight the urgent need for action to rectify the unequal distribution of route immunisation in Nigeria[7].

There are other programs introduced to reduce morbidity and mortality among children under five, such as the national program on immunisation for vaccine-preventable diseases, which constitute 20% of morbidity and mortality in paediatric populations. Lagos State Ministry of Health has adopted strategies including the development and dissemination of Information Education and Communication (IEC) materials, provision of cold chain equipment, procurement of generators, refresher training, and revitalisation of outreaches to strengthen routine immunisation[8].

### 1.2 Statement of the Problem

Vaccination is a powerful tool in the fight against preventable diseases and their associated health problems. Many diseases that can be prevented through vaccination can infect children who do not receive all of the recommended vaccines, including diphtheria, whooping cough, hepatitis, and tuberculosis. Adverse effects such as diarrhea, pneumonia, blindness, and starvation are prevalent in children who contract measles. Anyone taking responsibility for a child's care should be aware of the reasons for and consequences of not completing a child's immunisations on time.

Children and other family members are at increased risk for developing serious illnesses. Contributing to a community-wide disease outbreak and then having to pay for treatment and any problems that arise is a real possibility. The quality of life will decline, life expectancy will likely fall, travel restrictions will be imposed, and school attendance will be affected. In 2021, worldwide coverage fell to 83% from 86% in 2019[9]. Basic immunisations were not given to almost 25 million youngsters younger than one year. Five million more youngsters are totally unvaccinated as of 2019 compared to the previous year[10].

### 1.3 Justification of the Study

Given immunisation to children under-five is to prevent diseases and equally to reduce morbidity and mortality. Modern medicine has made great strides in protecting children from a wide range of diseases, making this an increasingly vital component of children's health care. As an example, the polio virus is on the verge of extinction, while other infections that used to damage or kill thousands of children are now uncommon. Vaccination is subjected to extensive scrutiny by scientists and other medical experts before to administration to children, ensuring its safety and efficacy. Ensuring that children and other family members who are able to receive the vaccine are properly vaccinated is crucial for the protection of those you care about. In addition to keeping everyone in the family safe, this will also help stop the transmission of disease. Some diseases that are preventable by vaccines can cause long-term disabilities, which can have a significant financial impact on families due to missed work days, high hospital expenditures, and ongoing disability care[11].

Immunisation with vaccines begins at birth and continues through infancy, adolescence, and old age. Illnesses such as polio, measles, pneumonia, tetanus, and meningitis can cause severe damage if we do not have immunisations. A number of these illnesses pose serious risks to human life[1]. The findings of this study can augment parents and knowledge, by providing sound knowledge on immunisation with the ultimate aim of improvement of living well into adulthood.

Even with the negative attitude, unfriendly and harsh behaviours exhibited by some health workers and staff of the Clinic, this will also educate clinic staff on the best way to conduct themselves during clinic days, so that mothers will find it interesting to attend for their wards' immunisation[12]. And also, today the attention of stakeholders in the health sector to make good policies that will be to the improvement and acceptance of immunisation by others through

adequate mass awareness. With the aforementioned problems identified, there is need to carry out research work on factors that is associated with the uptake of childhood immunisation of under five in Ajeromi-Ifelodun Local Government Area, Lagos State. In other to improve immunisation courage so as to reduces disease incidence.

### 1.4 Conceptual/Theoretical Framework

#### Theory of Reasoned Action

The theory of reasoned action was established in the year 1980 by Alzen and Fishbine**.** It examines the complex set of explanation that address individual behavioral pattern. This theory proposes the behavioral pattern of people when they heard about immunisation[13]

The theory is a complex model that is fundamental to the study of attitude and behaviors of people whenever immunisation is given, this is because of the believe they have about immunisation. This theory is related to immunisation is an efficacy preventing childhood diseases among children (from birth – 5 years) in the sense that a lot of people react almost the same whenever they hear about immunisation especially as a dominant role in the health of children, of course this can be effective only when you act positively on the information. The theory prompted health professionals to think about how a client's behavior relates to their perception, beliefs, and expected outcomes, and how these attitude components influence health, particularly in regards to immunisation[14].

## 1.5 Aim and Objectives of the Study

In the Ajeromi-Ifelodun Local Government Area of Lagos State, this study set out to determine what variables influence mothers' decisions to vaccinate their children under the age of five.

**Specific Objective**

1. To determine the proportion of under five children who were fully immunised by mothers.
2. To examine the barriers to the uptake of childhood immunisation by mothers.
3. To assess the perception of mothers towards childhood immunisation.
4. To determine the factors associated with the completion of childhood immunisation by mothers of under five children.

## 1.6 Research Question

1. What is the prevalence of the completion of childhood immunisation by mothers of under five in Ajeromi-Ifelodun L.G.A
2. What are the barriers to the uptake of childhood immunisation by mothers of under five in Ajeromi-Ifelodun L.G.A
3. What is the perception of mothers towards childhood immunisation of under five in Ajeromi-Ifelodun L.G.A
4. What are the predictors of completion of childhood immunisation by mothers of under five in Ajeromi-Ifelodun L.G.A

### 1.7 Significance of the Study

The study is significant as it aims to explain the factors responsible for incomplete childhood immunisation. It will also help educate the populace, especially mothers of children under five, on the importance of childhood immunisation. Furthermore, the findings will inform the government on effective approaches to address the challenges related to poor uptake of childhood immunisation.

The study can also draw the attention of stakeholders in the health sector to make good policies that will improve and increase the acceptance of childhood immunisation. Equally to change the mothers attitude towards immunisation in Ajeromi-Ifelodun Local Government Area, of Lagos State.

### 1.8 Scope of the Study

The mothers of children younger than five in the Ajeromi-Ifelodun Local Government Area of Lagos State were the focus of this study, which aimed to identify the variables that influence their decision to vaccinate their children. Ajeromi-Ifelodun Local Government Area's five wards were the focus of the research.

1. Alaba Oro Ward
2. Layeni Ward
3. Mosefejo Ward
4. Ojo Ward
5. Temidire Ward

### 1.9 Operational Definition of Terms

**Immunisation:** The procedure of protecting a child from a certain disease by injecting or otherwise introducing a vaccine into their body.

**Efficacy:** Ability to produce a desired or intended result. It can also be a power or capacity to produce a desire effect.

**Preventing**: This is the act of stopping a disease from occurring.

**Diseases**: This is a well-defined disease process with its own unique set of symptoms.

**Health**Is more than just being healthy; it encompasses a person's emotional, mental, and social well-being as a whole.

**Mortality**: A state of been liable to die from a certain disease condition.

## Endnotes


1. Abubakar Nasiru Galadima, Nor Afiab Mohd Zulkefli, Norlisa, Salmiah Md Said & Norisa Ahmad. *Factors Influencing Childhood Immunisation Uptake in Africa*: a systematic review. Published; 28 July, 2021. BMC Public Health 21, Article number: 1474 2021

2. Noni N. Akwataghibe, Elijah A, Ogunsola, Jacqueline E.W.Broeose, Oluwafemi A. Popoola, Adannah I. Agbo and Marjolein A. Dieleman., 20 Dec 2019 . *Exploring Factors Influencing Immunisation Utilisation in Nigeria* – As Mixed Method Study, Frontiers in public health.7, 392. Front, public health,20 Dec 2019 sec.pubic health policy volume 7-2019 https://doi.org/10.3389/fpubh.2019.00392

3. National Primary Health Care Development Agency, NPHCDA, 2019. *Immunisation, foundation of Primary Health Care system in Nigeria.* Immunisation, foundation of Primary Health Care system in Nigeria vanguardngr.com https://www.vanguardngr.com/2019/12/immunisation -foundation-of-primary-health-care system

4. Dr Gbemisola January 31, 2021. *Childhood Immunisation update. Current EPI schedule in Nigeria.* CHILDHOOD IMMUNISATION – UPDATE – Ask The Paediatricians Foundation https://ask the paediaticians.com/2021/01/childhood immunisation-update/31 Jan 2021

5. Akinola Ayoola Fatiregun; Laura NIC Lochlain Kaborie, Lessane; Dosumu, Modupeola; Isere, Elvis; Yetunde; Onyibe, Rosemary; Boatang, Kofi; Banda, Richard; Braka, Fioma. "*Missed Opportunities for Vaccination among Children, aged 0-23 months visiting Health Facilities in South West Nigeria,* December, 2019. Published Aug, 2021, Public Library of Science, e-ISSN1932 6203.

6. WHO, 2020 *Polio Eradication* - A Battle I Fought with Undiluted Passion, Professor Oyewale Tomori Published: 25 Aug, 2020 https://www.afro.who.int/news/polio eradication a battle fault with undiluted passion says professor oyewale tomori amjorlayer who made this feat possible

7. Comfort Z. Olorunsaiye & Hannah Degge - *Variation in the Uptake of Routine Immunisation in Nigeria:* Examining Determinant of Inequalities Access. https://doi.org/10.1080/2376200.2016.1206780 July, Page 19-29/published online: 22 July2016

8. Thomas Cherian, and Carsten Mantel 2020. *National Programme on Immunisation*. National immunisation programmes - PubMed nih.gov Bundesgesundheitsbatt Gesundheitsschutz.2020 Jan https://pubmed.ncbi.nim.nih.gov/31792552/

9. Mohammed Ruhul Amin and Sartini Saman 03 June 2021-*Reasons why it is important to complete all the vaccine on time.*

10. WHO ,14 July 2022 https://www.who.int *Therapeutics and COVID-19* :living guideline 14 July 2022 https://ins.who.int/handle/10665/359774

11. OIDP, May, 6 2022. *Five important Reasons to Vaccinate Your Child. Headquarters. Office of infectious Disease and HIV/AIDS Policy.U.S.* Department of Health and Human Services 330 C Street, SW. Suit L 100 Washington, D. C. 20024

12. *Healthcare* Base- 2019 March :71:23 Published Online 2019 February 1 Doi: 10.3390/healthcare 7010023 PMCID: PMC 6473815/PIMID: 3071313

13. Ajzen,T., & Fishbein, M .1980. *Understanding attitude and predicting social behaviour*. Englewood Cliffs,NJ: Prentic Hall

14. *The health belief model*-Sph.bu.edu-Boston university https://sphweb bumc.bu.edu.otit 3 Nov 2022

## Literature Review

### 2.1 Conceptual Review

#### 2.1.1 Concept of Immunisation

Among the most effective measures for warding against contagious illnesses, immunisation ranks high[1]. An individual can be "immunised" against infectious diseases by undergoing a series of steps that mostly include the injection of a vaccine[1]. When a person gets a vaccine, their immune system goes into overdrive, protecting them from any future illnesses. Making it available to even the most vulnerable and hard-to-reach people, based on established methods, it is among the health interventions that are most cost-effective[2].

Immunisation is a part of the well-defined target group child survival strategy. In addition to immunisations, various preventative treatments such as vitamin A supplements, deworming pills, and mosquito netting sprayed with pesticide can be distributed during vaccination campaigns[3]. Many consider the development of vaccines to be a crowning achievement of the twentieth century. Edward Jenner's smallpox experiments in 1796 demonstrated the effectiveness of vaccination, which paved the way for the eventual worldwide elimination of the disease. The Expanded Program on Immunisation (EPI) was established by the World Health Organisation (WHO) in 1974 to vaccinate children worldwide after smallpox was successfully eradicated. Vaccination against measles, diphtheria, tetanus, pertussis, and BCG (Bacillus Calmette-Guérin) was a joint effort between the WHO and UNICEF in the 1980s. Other vaccines that were administered included the oral polio vaccine, diphtheria, tetanus, and pertussis. The goal was to vaccinate 80% of the world's children by 1990[5].

After that, things kept moving forward: by 2011, 83% of the youngsters of the planet had gotten the diphtheria, tetanus, and pertussis (DTP3) vaccination, and 107 million children had received

all three doses. Hepatitis B (Hep B), yellow fever (in countries where it is endemic), meningitis, and the Haemophilus influenza (Hib) conjugate vaccine (in countries where the disease is common) are all vaccines that have recently been added to the EPI's list of recommended vaccines as a result of advances in our understanding of the immunologic factors of disease[2]. The number of vaccines developed has skyrocketed in the past two decades. These new vaccines have been funded in the poorest countries in large part by the GAVI Alliance (Global Alliance for Vaccines and Immunisation), other multilateral organisations, and state governments. There has been extensive distribution of vaccines that protect against Hepatitis B and Hib. Pneumococcal conjugate vaccine (PCV) and rotavirus vaccine (RV) are being included in the immunisation regimens of more and more nations. This provides protection against pneumonia and diarrhea, two of the main causes of child mortality. From 2000 to 2010, the number of deaths caused by measles decreased by 74%, while the prevalence of maternal and neonatal tetanus nearly disappeared from public health concerns. Additionally, poliomyelitis is on the brink of eradication[2].

The Nigerian government launched the Expanded Programme on Immunisation (EPI) in 1979 with the goal of improving children's health by eliminating six deadly diseases: yellow fever, TB, polio, whooping cough, measles, and diphtheria[6]. In the 1990s, we achieved an ideal vaccination coverage level of 81.5%; however, by 2003–2006, that success had faded to a pitiful 12.9%. Recent reports from the World Health Organisation and the United Nations Children's Fund (UNICEF) put Nigeria's vaccination rate at 57%[7]. By the time they are 12 months old, infants should have had a total of 10 vaccines, according to the National Primary Health Care Development Agency (NPHCDA). These include the following: a dose of BCG to prevent tuberculosis, four doses of polio, three doses of DPT (diphtheria, pertussis, tetanus), one dose of

measles, and one dose of yellow fever[8]. The pentavalent vaccine, which includes additional antigens for hepatitis B and Haemophilus influenza type B, began replacing the diphtheria, pertussis, and tetanus (DPT) vaccine in Nigeria in 2012. To combat the risk of circulating vaccine-derived poliovirus (cVDPV) and to enhance children's immunity against type 1 and type 3 wild poliovirus (WPV), the inactivated polio vaccine 3 (IPV) was developed in February 2015. It acts as a booster for the oral polio vaccination[8]. Table 2.1 provides a summary of these vaccinations together with their recommended immunisation regimen. An additional two vaccines against hepatitis B and Hemophilus influenza type B are included in the pentavalent DPT vaccine that is provided in these injections in Nigeria. In addition, the World Health Organisation states that in order for a kid to be considered fully vaccinated, they must have received the following vaccines: measles, polio, the single-dose BCG vaccination, the pentavalent DPT vaccine, or a combination of the two[9].

In Sub-Saharan Africa in particular, vaccine-preventable illnesses are a leading cause of child death and morbidity[10]. In terms of annual deaths among children under the age of five, it accounts for 17%10. Worldwide, routine vaccination treatments, such the DTP3 vaccine, failed to reach an estimated 18.7 million newborns in 2014. The following ten nations are home to over 60% of these kids: South Africa, Ethiopia, India, Indonesia, Iraq, Nigeria, and Pakistan, as well as the Philippines, Uganda, and Pakistan[11].

Approximately 22% of child mortality in Nigeria, or more than 200,000 lives annually, are attributed to vaccine-preventable diseases. Out of 23.2 million children globally in 2009, 3.5 million (or 14% of the total) did not receive the three doses of the diphtheria and pertussis vaccine in the first year of life[12]. It has come to light that several mothers-to-be have formed a poor vaccination routine for their newborns. Even though it's free for kids under five and there

has been a successful expanded program on immunisation (EPI), many vaccine-preventable diseases are still common, particularly in developing nations like Nigeria. This is because some parents choose not to vaccinate their children, which greatly raises the risk of infection for other vaccinated children. It is critical to find out what stops women with less than five children from getting their kids vaccinated and to improve our communication with parents about the risks of not immunizing their children and the benefits of vaccination.

### 2.1.2 The Immune System and Immunisation

Numerous pathogens, including bacteria, viruses, fungus, protozoa, and multicellular parasites, are present in the environment. When these microbes get into the body and start multiplying, they might trigger various diseases[13]. The body has defense mechanisms to physically prevent pathogens from entering or to eliminate them if they do. The immune system plays a crucial role in identifying and destroying invading organisms[14]. The immune system is an elaborate web of cells, tissues, and organs that work together to ward off dangerous infections. Innate immunity and adaptive immunity are its two primary subsystems. Physical barriers like skin and mucosal membranes, chemical barriers like stomach acid and saliva enzymes, and cellular defenses like phagocytes and natural killer cells make up innate immunity, which is the body's initial line of defense[15]. Additionally, the inflammatory response plays a critical role in recruiting immune cells to the site of infection.

Adaptive immunity, on the other hand, involves lymphocytes B cells and T cells which are crucial in targeting specific pathogens. B cells produce antibodies that neutralise these pathogens, while memory cells ensure a faster and more robust response upon re-exposure to the same pathogen[16]. This ability to remember pathogens is the foundation upon which immunisation is built.

Immunisation can be classified into active and passive types. Active immunisation occurs naturally when a sickness sets off the immune system to create antibodies, or artificially through vaccines that introduce antigens without causing the disease[17]. Passive immunisation involves the transference of pre-existing antibodies, either naturally transferred from mother to kid through the placenta or breast milk, or artificially via injections from another person or animal[17].

#### 2.1.2.1 How Immunisation Works

The capacity to differentiate between foreign and native cells and molecules is a key component of the immune system. The transmission of infectious diseases within the body is its primary function[15]. A sufficient number of competent cells and particular antibodies are synthesised by the immune system in reaction to the recognition of an infectious pathogen[18].

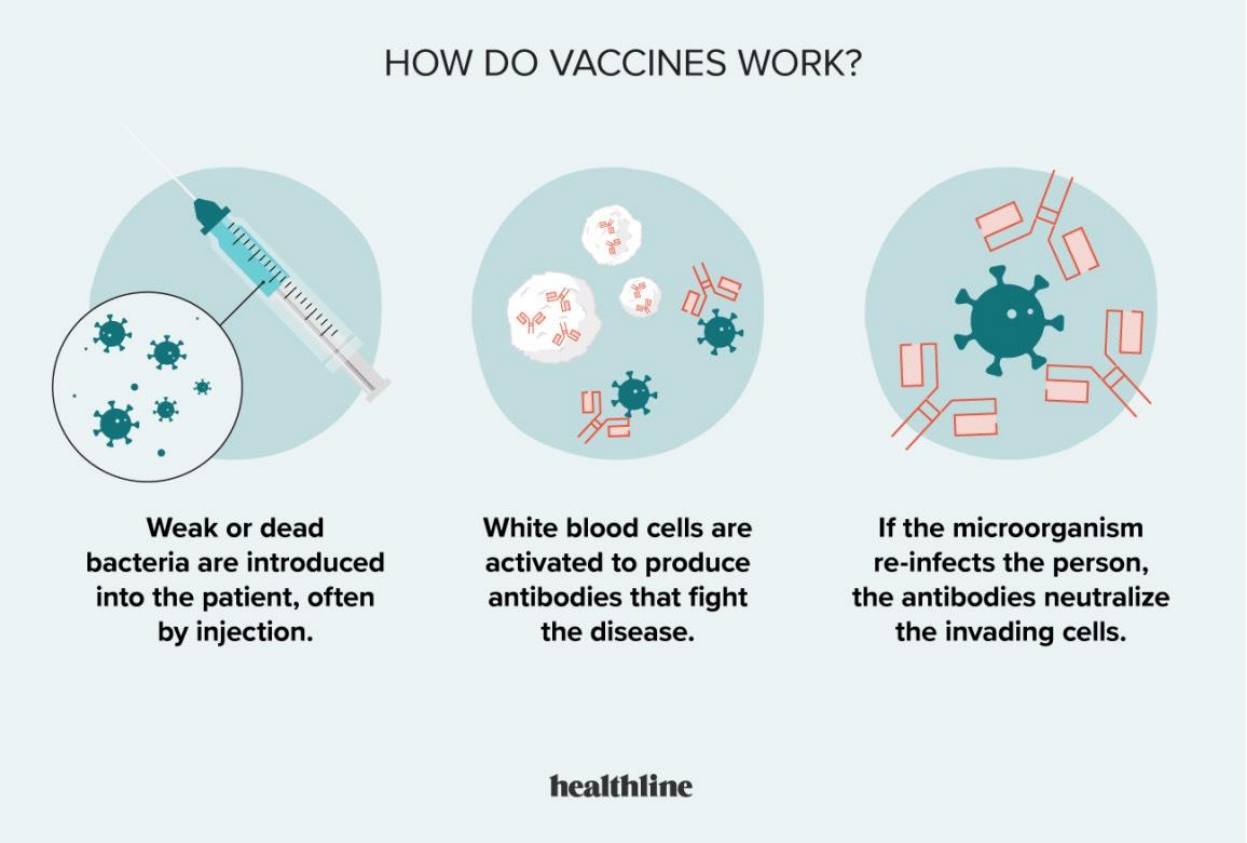


**Figure 2.1 How Immunisation Works**

Source: Boulanger[163]

Invasion of the body by pathogens like viruses or bacteria results in their assault and subsequent multiplication. Illness is caused by this invasion, which is known as an infection. Multiple mechanisms work together to ward off pathogens in the immune system. Red blood cells provide oxygen to the tissues and organs of the body, while white blood cells ward off infections[19]. Macrophages, B-lymphocytes, and T-lymphocytes make up the bulk of these white blood cells. One kind of white blood cell called a macrophage engulfs and digests pathogens and dead or dying cells. Macrophages retain antigens, which are remnants of the invading germs, after they digest them. When the immune system detects these antigens as potentially harmful, it launches an assault on them[19].

Another defensive white blood cell type are B-lymphocytes, it produce antibodies that target the antigens left behind by the macrophages. These antibodies specifically attack and neutralise the antigens. T-lymphocytes, also a sort of protective white blood cell, concentrate on targeting body cells already contaminated by the pathogens[19].

When the body first comes across a bacterium, it can take many days to create and arrange all the resources required to fight the infection. Once the virus passes, the immune system keeps a memory of how to defend against that particular disease in the future[20].

Immunisation leverages the adaptive immune system's ability to remember pathogens and mount a stronger, quicker response upon re-exposure. There are two main types of immunisation: active and passive[17]. Active immunisation is exposure to antigens stimulating the immune system to generate antibodies and memory cells. This can occur naturally for a person encountering a virus or artificially through vaccination[17]. The process of passive immunisation, which offers short-lived protection, entails the exchange of already-formed antibodies from one person to another. This can happen in two ways: naturally, when antibodies are passed from mother to child

through breast milk or the placenta, and artificially, when serum containing antibodies is administered[17].

Vaccines are the primary tools for active immunisation and come in various forms, each designed to induce a protective immune response without causing the disease. The main types of vaccines include live attenuated vaccines, inactivated vaccines, subunit vaccines, recombinant vaccines, polysaccharide vaccines, conjugate vaccines, toxoid vaccines, mRNA vaccines, and viral vector vaccines vaccines[21].

**Live Attenuated Vaccines:** Attenuated live vaccines contain pathogens that are less infectious but still able to replicate in the host. By mimicking a natural infection, these vaccines provoke a robust and enduring immune response[22]. Examples include the Measles, Mumps, and Rubella (MMR) vaccine, which shield against three highly contagious viral diseases, and the varicella (chickenpox) vaccine. While live attenuated vaccines are effective, they pose a risk to individuals with compromised immune systems, such as those undergoing chemotherapy or living with HIV/AIDS, may be unable to regulate the proliferation of the attenuated pathogen[23].

**Inactivated Vaccines:** Vaccines that include inactivated viruses have been rendered incapable of replicating because they have been destroyed or inactivated. This makes them more suitable for people whose immune systems are already weak[22]. Nevertheless, in contrast to live attenuated vaccines, inactivated vaccines usually trigger a less robust immune response, requiring booster shots or numerous doses to attain and sustain protection. A few examples are the hepatitis A vaccination and the inactivated polio vaccine (IPV)[24].

**Subunit, Recombinant, Polysaccharide, and Conjugate Vaccines:** Vaccines can be classified into four types: subunit, recombinant, polysaccharide, and conjugate. Subunit vaccines isolate the pathogen's most immunogenic components, such as proteins and carbohydrates[25]. These

components are sufficient to induce an immunological response without eliciting illness. Subunit vaccines, like the Hepatitis B vaccine, contain only the surface proteins of the pathogen[26]. Recombinant vaccines, such as the Human Papillomavirus (HPV) vaccine, are produced using genetic engineering techniques[27]. Polysaccharide vaccines, like the Pneumococcal vaccine, consist of polysaccharides from the pathogen's surface. Conjugate vaccines combine these polysaccharides with a carrier protein to enhance immune response. These vaccines are particularly useful for diseases where whole pathogen-based vaccines are impractical or ineffective[28].

**Toxoid Vaccines:** Toxoid vaccinations come from inactive poisons.

produced by the pathogen. Rather than targeting the bacteria itself, these vaccines protect against diseases caused by bacterial toxins[29]. The immune system learns to recognise and neutralise these toxins, preventing illness. Examples include the Tetanus and Diphtheria vaccines, which protect against potentially deadly bacterial infections[26].

**mRNA Vaccines** : mRNA vaccines are a revolutionary technology that employs a small portion of the pathogen's messenger. RNA (mRNA) to direct cells to generate a protein that triggers an immune response[30]. This innovative approach has been exemplified with the COVID-19 vaccinations developed by Pfizer-BioNTech and Moderna. mRNA vaccines offer advantages in rapid development and manufacturing compared to traditional vaccines, making them crucial tools in combating emerging infectious diseases[30,31].

**Viral Vector Vaccines:** Using a different virus as a vector, viral vector vaccines transfer the genetic material of the target disease into cells, therefore triggering an immune response without producing side effects disease[32]. Two examples are the Ebola and Johnson & Johnson COVID-

19 vaccines. These vaccines can induce a potent immune response and are particularly valuable for complex pathogens where traditional vaccine approaches may be less effective[26].

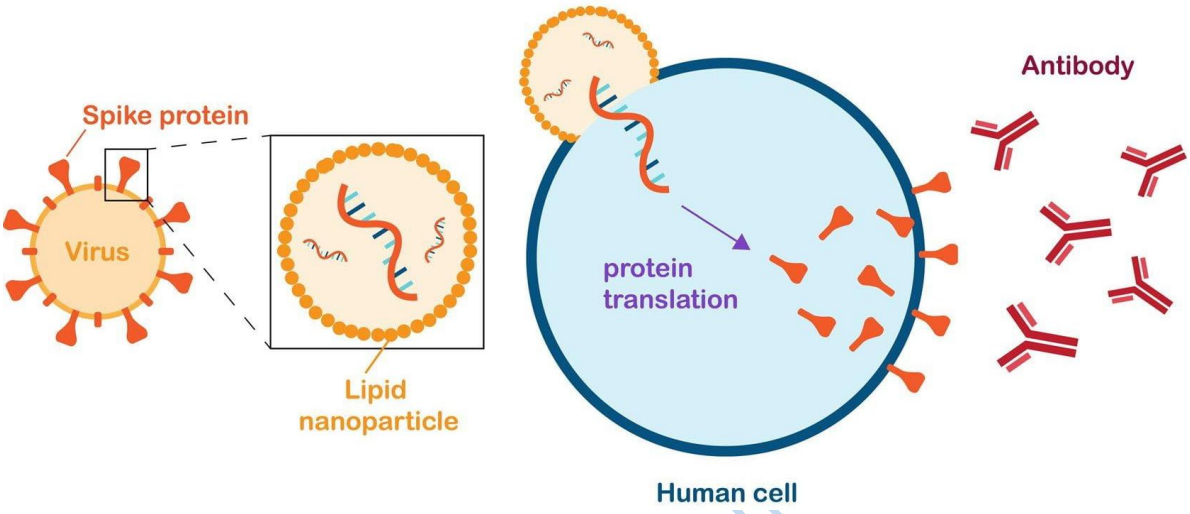


Figure 2.2 Mechanism of mRNA Vaccine

Source: Richter[164]

**2.1.2.2 Mechanism of Vaccine-Induced Immunity**

When a vaccine is administered, it delivers antigens the molecular components of organisms that cause an immunological response because they are identified as alien by the immune system. These antigens can be proteins, carbohydrates, or other molecules specific to the pathogen[33]. By introducing antigens into the body, vaccines simulate a natural infection without causing illness. Vaccine antigens provoke an immune response that fights off the infectious disease[26]. Dendritic cells and other antigen-presenting cells (APCs) are the first step in this process. APCs are immune cells tailored to capturing, processing, and presenting antigens to other cells in the immune system. After coming into contact with antigens, APCs travel to lymph nodes to introduce the antigens to T cells[34].

An essential function of helper T cells is to regulate the immunological response. When activated by APCs presenting antigens, helper T cells stimulate the proliferation and differentiation of other immune cells[35]. They release signaling molecules called cytokines, which act as messengers to activate B cells and cytotoxic T cells. Antibodies, which attach to and destroy infectious microbes, are made by B cells[7]. B cells differentiate into plasma cells when they are stimulated by helper T cells. These plasma cells are like little factories; they produce hundreds of antibodies each day, each one tailored to the vaccine's antigens[36].

Once released into the bloodstream, antibodies circulate throughout the body, clinging to alien molecules and identifying them for ultimate clearance by other immune cells. Antibodies can neutralise pathogens by preventing them from infecting host cells, agglutinating pathogens to facilitate their clearance by phagocytes, or activating the complement system to destroy pathogens directly[17]. In addition to antibody production, vaccines can also stimulate the activation of cytotoxic T cells. These specialised immune cells recognise and destroy cells that have been infected by the pathogen[17]. By eliminating infected cells, cytotoxic T cells help to prevent the spread of the infection and clear the pathogen from the body[17].

One of the most critical aspects of vaccine-induced immunity is the generation of memory cells. The immunological response to vaccination generates both memory T cells and memory B cells[26]. Long after the first shot has worn off, the immune system's memory cells are still there, ready to launch a powerful attack the next time the virus is encountered. The foundation for the long-term protection offered by immunisations is this immunological memory[26,37]. Upon subsequent exposure to the pathogen, memory B cells and memory T cells recognise the antigens and quickly mobilise to initiate an immune response. This rapid and enhanced response often prevents the pathogen from establishing an infection, thereby providing immunity[17]. By priming

immune system to recognise and combat specific pathogens, vaccines play a crucial role in preventing disease and promoting overall health[22].

Memory B cells and T cells formed during this process remain in the body long after the initial vaccination. These memory cells help the immune system to identify and react better to next pathogen encounter[26]. This rapid and enhanced response often prevents the pathogen from establishing an infection, thereby providing immunity[17,26].

### 2.1.3 Vaccine-Preventable Diseases among Infants

#### 1. Tuberculosis

Tuberculosis (TB), an infectious disease, is caused by Mycobacterium tuberculosis. Although the lungs are the most common organ affected, other organs like the kidneys, spine, brain, and lungs are not immune[38]. The infectious and potentially devastating nature of tuberculosis makes it an important public health issue, especially in underdeveloped nations. Tuberculosis (TB) is a leading killer of children[39]. The World Health Organisation (WHO) estimates that over a million children contract TB annually, with significant morbidity and mortality. Young children, especially those under five years old, are particularly susceptible to severe varieties of tuberculosis, such as TB meningitis and military TB, which can be fatal if not promptly treated[40]. Infants can contract tuberculosis through several routes. The primary mode of transmission is airborne. The bacteria that cause tuberculosis are transmitted through the airborne droplets that are expelled by an infected individual during coughing, sneezing, or speaking[41]. Infants living in close contact with TB-infected individuals are at high risk of inhaling these droplets. Although rare, congenital TB can occur when a mother transmits the disease to her baby during pregnancy or delivery if the mother has untreated or active TB at the time of childbirth. Additionally, infants can contract TB postnatal if they are exposed to mothers or family members with active

TB, particularly in crowded or pogorly ventilated living conditions[41]. The symptoms of TB in children can be nonspecific and varied, making early diagnosis challenging. A persistent cough, fever, night chills, weight loss, and lethargy are among the most prevalent symptoms. In severe cases, children may develop difficulty breathing, swollen lymph nodes, and symptoms related to TB in other organs if the disease spreads beyond the lungs[42].

The vaccine for tuberculosis, known as the Bacilli Calmette-Guérin (BCG) vaccine, was created by French bacteriologists Albert Chalmette and Camille Guerin in the early 20th century[43]. The development of the BCG vaccine involved the attenuation of a strain of Mycobacterium bovis, a close relative of Mycobacterium tuberculosis, over 13 years. This attenuation process involved repeatedly culturing the bacteria in a medium containing bile, which reduced its virulence while retaining its ability to stimulate an immune response. The first human trial of the BCG vaccine was conducted in 1921, and since then, it has been used worldwide to protect against TB, particularly in countries with high TB prevalence[43].

By training the immune system to identify and destroy Mycobacterium TB, the BCG vaccine protects against the disease. The immune system initiates a response, involving T-cell activation and antibody production, following the administration of a vaccine containing attenuated microbes[44]. The immune system then creates memory cells that "remember" the TB bacteria. If the vaccinated individual is later exposed to Mycobacterium tuberculosis, these memory cells quickly recognise and attack the bacteria, preventing the development of active TB[44].

The BCG vaccine is typically administered to infants soon after birth, especially in countries where TB is common. The vaccine is usually given shortly after birth, often within the first week of life. In some regions, it may be administered later if the initial opportunity is missed, but earlier vaccination is preferable to provide protection as soon as possible. The vaccine is given

as a single dose via intradermal injection, usually in the upper arm. The dosage is 0.05 ml for infants under one year and 0.1 ml for older children and adults. The BCG vaccine does not ensure total protection but markedly diminishes the likelihood of severe tuberculosis forms, including TB meningitis and disseminated TB, in children. Its effectiveness in avoiding pulmonary tuberculosis in adults varies, which is why it is primarily targeted at young children in high-risk areas[46].

**2. Pertussis**

The bacterium Bordetella pertussis induces the highly contagious respiratory disease termed pertussis, or whooping cough. Babies and toddlers are especially vulnerable since it can cause serious breathing problems or even death. Pertussis remains a significant public health concern, even in countries with advanced healthcare systems, due to periodic outbreaks and the high morbidity associated with the disease[47].

The prevalence of pertussis among children varies globally, with millions of cases reported each year. Despite widespread vaccination efforts, pertussis continues to affect many children, particularly those who are unvaccinated or under-vaccinated. Infants under one year of age are especially vulnerable. At least as far as the WHO is concerned, pertussis is responsible for a substantial number of infant deaths annually, particularly in developing countries. The disease can cause severe complications such as pneumonia, seizures, brain damage, and death, contributing to its high morbidity and mortality rates among infants[48].

Infants can contract pertussis primarily through direct contact with infected individuals. The disease transmits when an infected individual coughs or sneezes, dispersing droplets containing the germs into the atmosphere. Infants are often exposed to pertussis by close family members or

mothers who may not realise they are infected, as adults and older children can have milder symptoms[48,49].

The symptoms of pertussis typically appear in stages. Initially, it resembles a common cold, with mild coughing, sneezing, and a runny nose. After one to two weeks, severe coughing fits develop, characterised by the distinctive "whooping" sound as the patient gasps for air after a coughing spell. These coughing fits can be exhausting and may lead to vomiting and difficulty breathing. In infants, pertussis can cause apnea (pauses in breathing), which is life-threatening and requires immediate medical attention[47,49].

The vaccine for pertussis, known as the DTaP vaccine (diphtheria, tetanus, and cellular pertussis), was developed to provide protection against this disease. The development of the pertussis vaccine began in the 20th century, with the first whole-cell pertussis vaccine introduced in the 1940s. This early vaccine, although effective, had side effects. To improve safety and reduce adverse reactions, the cellular pertussis vaccine (aP) was developed and introduced in the 1990s. The cellular vaccine contains purified components of the pertussis bacteria rather than whole cells, making it safer and better tolerated[50].

The DTaP vaccination functions by activating the immune system to identify and combat Bordetella pertussis germs. The administration of the vaccine elicits an immunological response, encompassing T-cell activation and antibody generation against pertussis. The immune system subsequently generates memory cells that retain recognition of the pertussis bacterium. Upon subsequent exposure to Bordetella pertussis, the vaccinated individual's memory cells promptly identify and combat the bacterium, therefore averting the onset of severe disease[50].

Multiple doses of the DTaP vaccination are required to achieve the desired level of protection. Dosage intervals of 4 months, 6 months, 15–18 months, and 4-6 years are suggested, with the

first dosage given at 2 months of age. To keep immunisation going and lessen the chance of passing the bacterium on to babies, booster doses (Tdap) are advised for adults and teenagers[50].

While the DTaP vaccine significantly reduces the risk of pertussis, it does not guarantee crucial for pregnant protect infants from complete immunity, as immunity can wane over time. Therefore, it is women, mothers, and family members to receive booster doses to potential exposure[50].

**3. Diphtheria**

The bacteria Corynebacterium diphtheriae produce the deadly disease diphtheria. The nasal and pharyngeal mucosa are the most common sites of infection in this condition, but it can also impact the skin and other body parts. Diphtheria poses a significant health risk to infants and young children due to its potential for rapid progression and life-threatening complications. Despite being rare in countries with high vaccination coverage, diphtheria remains a concern in regions with low immunisation rates[51].

Vaccination has greatly reduced the incidence of diphtheria in children in various regions of the world. However, it remains a public health threat in some developing countries where immunisation coverage is not optimal. The World Health Organisation reports that diphtheria epidemics are still happening, especially in places where healthcare is not very well-developed. If not treated quickly, severe cases of the disease can cause significant morbidity and death in infants and young children[52].

Infants can contract diphtheria through direct contact with infected individuals or by touching contaminated objects. When a sick individual sneezes or coughs, the virus goes into their respiratory system and can infect others. Close contact with an infected individual or

contaminated surfaces can potentially expose infants to the bacterium, which can then cause infection[53].

The symptoms of diphtheria typically begin with a sore throat, fever, and general malaise. As the disease progresses, a thick, grayish-white membrane forms on the throat and tonsils, which can cause difficulty breathing and swallowing. Other symptoms include swollen glands in the neck, nasal discharge, and hoarseness. In severe cases, the diphtheria toxin can spread to other parts of the body, resulting in consequences such as myocarditis (inflammation of the cardiac muscle), nerve damage, and kidney failure[51].

The diphtheria vaccine, included in the DTaP combination vaccination (diphtheria, tetanus, and acellular pertussis), was created to confer immunity against this illness. The diphtheria toxoid vaccine was first introduced in the 1920s. It is made by inactivating the diphtheria toxin with formaldehyde, rendering it non-toxic while retaining its ability to stimulate an immune response[50].

The diphtheria toxin is recognised and neutralised by the immune system after receiving the DTaP vaccine. The injection of the vaccine causes the body to mount an immunological response, which in turn produces antibodies that can neutralise the diphtheria toxin and activate T cells. Afterwards, the immune system develops cells with the ability to "remember" the poison. These memory cells swiftly identify and destroy the toxin, protecting the vaccinated individual from severe sickness in the event that they are exposed to Corynebacterium diphtheria in the future[50].

The DTaP vaccination is given in several doses to guarantee sufficient immunity. The advised immunisation timetable is as follows: the initial dosage at 2 months, succeeded by subsequent doses at 4 months, 6 months, 15-18 months, and 4-6 years of age. Booster dosages are advised

for teenagers and adults (Tdap) to maintain immunity and reduce the risk of transmitting the bacteria to infants[50].

While the DTaP vaccine significantly reduces the risk of diphtheria, it does not guarantee complete immunity, as immunity can wane over time. Therefore, it is crucial for pregnant women, mothers, and family members to receive booster doses to protect infants from potential exposure[50].

**4. Tetanus**

The Clostridium tetani bacterium causes the dangerous bacterial infection known as tetanus, or lockjaw. Severe muscular rigidity and spasms are symptoms of a toxin produced by this bacterium, which impacts the neurological system. Tetanus is particularly dangerous for infants and young children, with high morbidity and mortality rates if not promptly treated. Unlike many other infectious diseases, tetanus is not contagious but rather acquired through environmental exposure, making vaccination critical for prevention[54,55].

Tetanus is rare in countries with comprehensive immunisation programs but remains a significant public health concern in regions with low immunisation rates and inadequate healthcare systems. The World Health Organisation (WHO) reports that neonatal tetanus, which affects newborns, is a substantial cause of infant mortality in developing countries[55]. Neonatal tetanus often results from unsanitary conditions during childbirth, such as the use of non-sterile instruments to cut the umbilical cord, and can lead to severe complications or death[55,56].

Infants may acquire tetanus via direct exposure to Clostridium tetani spores, which are prevalent in dirt, dust, and animal excrement. The spores can enter the body through wounds, cuts, or punctures, including those resulting from non-sterile medical procedures. For neonates, the most

common route of infection is through the umbilical stump, particularly in settings with inadequate hygiene practices during childbirth[56].

The symptoms of tetanus typically begin with muscle stiffness and spasms near the site of infection, then progress to generalised muscle rigidity. Infants with tetanus may exhibit difficulty feeding, irritability, and muscle stiffness, especially in the jaw and neck, leading to the characteristic lockjaw"[57]. Severe cases can involve painful muscle spasms, respiratory difficulties, and autonomic dysfunction, which can be life-threatening without intensive medical intervention[58].

Protect yourself from tetanus with the help of the DTaP vaccine, which includes diphtheria, tetanus, and a cellular pertussis. Using formaldehyde to render the tetanus toxin inactive, the tetanus toxoid vaccination was first launched in the 1920s. By undergoing this transformation, the toxin loses its poisonous effects while keeping its immunogenic potential intact.

By training the immune system to spot and destroy tetanus toxin, the DTaP vaccine protects against the disease. Immune system responses, including T-cell activation and antibody formation against the tetanus toxin, are set off when the vaccination is given. Afterwards, the immune system develops cells with the ability to "remember" the poison. These memory cells detect and destroy the Clostridium tetani toxin rapidly, protecting the vaccinated person from potentially deadly illness in the future[24,26].

The DTaP vaccination is given in several doses to guarantee sufficient immunity. The advised immunisation timetable is as follows: the initial dosage at 2 months, succeeded by subsequent doses at 4 months, 6 months, 15-18 months, and 4-6 years of age. Booster dosages are advised for teenagers and adults (Tdap) every ten years to maintain immunity and reduce the risk of contracting tetanus[59]. While the DTaP vaccine significantly reduces the risk of tetanus, it does

not guarantee complete immunity, as immunity can wane over time. Therefore, it is crucial for pregnant women, mothers, and family members to receive booster doses to protect infants from potential exposure[55].

**5. Hepatitis B:**

Hepatitis B is a viral infection induced by the hepatitis B virus (HBV) that damages the liver. It may result in both acute and chronic hepatic diseases, encompassing cirrhosis and hepatocellular carcinoma. Hepatitis B is particularly dangerous for infants and young children because they are more likely to develop chronic infections, which can have lifelong consequences. Despite global vaccination efforts, hepatitis B remains a significant public health issue, especially in regions with high HBV prevalence[60].

Hepatitis B is more common in some parts of Asia, Africa, and the Pacific Islands than it is generally among youngsters everywhere. According to the World Health Organisation (WHO), 257 million individuals worldwide—including many children—are thought to be living with chronic hepatitis B. If infected, children are more likely to develop chronic hepatitis B; up to 90% of affected newborns go on to become chronic sufferers compared to just 5–10% of infected adults. Later in life, chronic hepatitis B can cause significant medical issues including hepatocellular carcinoma and liver cirrhosis[60].

Hepatitis B mostly contracted by infants comes from vertical transmission from an infected mother following delivery. This perinatal transmission is the most common route of infection in high prevalence areas[60]. Additionally, horizontal transmission can occur through contact with infected blood or bodily fluids, such as from household members or through unsterile medical procedures. Breastfeeding is generally considered safe if the infant receives appropriate post-exposure prophylaxis at birth[60].

The symptoms of hepatitis B in infants and young children are often mild or non-existent, making early detection difficult. When symptoms do occur, they may include jaundice (yellowing of the skin and eyes), dark urine, fatigue, loss of appetite, nausea, vomiting, and abdominal pain. In many cases, the infection goes unnoticed until liver damage is detected later in life[60,62].

The vaccine for hepatitis B was developed to provide protection against this virus. The first hepatitis B vaccine, derived from plasma, was introduced in the early 1980s. Subsequently, a recombinant DNA vaccine, which is safer and more effective, was developed and is now widely used[63]. The recombinant hepatitis B vaccination is generated by introducing the gene for the hepatitis B surface antigen (HBsAg) into yeast cells, which then generate the antigen inducing an immunological response[64].

Stimulating the immune system to identify and fight the hepatitis B virus helps the hepatitis B vaccination operate. The hepatitis B surface antigen (HBsAg) sets off an immunological response upon vaccination that includes the synthesis of antibodies against the virus60. Memory cells produced by the immune system then "remember" the virus. Should the vaccinated person subsequently come into contact with HBV, these memory cells rapidly identify and destroy the virus, therefore stopping the spread of infection[26,60].

Multiple doses of the hepatitis B vaccination guarantee sufficient immunity. For newborns, the advised schedule is as follows: the first dose within 24 hours of birth; additional doses at 1-2 months and 6-18 months of age. Should the mother be HBV-positive, the newborn should additionally get hepatitis B immunoglobulin (HBIG) within twelve hours of birth to offer instantaneous protection. Older children and teenagers who missed their birth vaccine are advised to get caught-up[66].

The hepatitis B vaccination greatly lowers the risk of HBV infection and related consequences. It is highly effective in preventing both acute and chronic hepatitis B. Immunisation of infants, especially those born to HBV-infected mothers, is crucial for reducing the burden of hepatitis B and its long-term health impacts[60].

6. **Measles:**

Among the Paramyxoviridae family of viruses, the one responsible for the highly infectious disease known as measles is the measles virus (MeV). In newborns and young children in particular, it can cause pneumonia, encephalitis, and even death due to its devastating effects on the respiratory system. Measles outbreaks persist worldwide despite the availability of a vaccine that effectively prevents the disease. This highlights the critical role that immunisation plays in disease control efforts[67].

Measles has historically been one of the leading causes of death among young children worldwide. Although the incidence of measles has declined significantly since the introduction of vaccination programs, outbreaks still occur, particularly in areas with low vaccination coverage[68]. Over 140,000 people died from measles-related causes in 2018, with the majority of those casualties being children younger than five years old, as stated by the World Health Organisation (WHO)[68].

Because of their developing immune systems and limited early age access to vaccinations, infants are more susceptible to measles. Infants who are unvaccinated or under-vaccinated are at the highest risk of severe complications, including pneumonia and encephalitis. Measles is quite contagious and passes by respiratory droplets, hence infants in crowded or poorly ventilated surroundings are most prone to get infected[69].

Before the rash strikes and covers the body, typical measles symptoms include a high temperature, coughing, runny nose, and red, watery eyes. Two or three days following the start of symptoms is when the rash typically shows up and consists of flat, red spots that eventually merge to form raised, blotchy lesions. In severe cases, complications such as pneumonia, encephalitis (swelling of the brain), and blindness can occur, especially in infants and young children[68].

The vaccine for measles, mumps, and rubella (MMR) was developed to provide protection against these viral infections. The development of the measles vaccine began in the 1960s, with the first licensed vaccine introduced in 1963. The current MMR vaccine, which combines vaccines for measles, mumps, and rubella, is highly effective and safe. This is a live attenuated vaccination meant to induce immune system production of antibodies against the measles virus[70]. The MMR vaccination causes weaker versions of the measles virus to enter the body, therefore inducing an immune response. When the vaccine is administered, the immune system recognises the virus as foreign and produces antibodies to fight it. These antibodies provide long-term immunity against measles, mumps, and rubella. The MMR vaccine also induces memory cells that "remember" the viruses, providing ongoing protection against future infections[70].

The MMR vaccine is typically administered in two doses to ensure adequate immunity. Usually starting at 12 to 15 months of age, the initial dose is then followed by a second dose between 4 and 6 years of age. Infants who are at high risk of exposure to measles, such as those traveling to areas with ongoing outbreaks, may receive the vaccine as early as 6 months of age, followed by the standard two-dose schedule[70].

Vaccination against measles is crucial for preventing outbreaks and protecting infants and young children from severe complications. High vaccination coverage within communities is necessary to achieve herd immunity and prevent the spread of measles[68].

7. **Polio:**

Caused by the poliovirus, a member of the Picornaviridae family, poliomyelitis, sometimes known as polio, is a quite contagious viral disease. It predominantly impacts the neurological system, resulting in paralysis, muscular weakness, and, in extreme instances, mortality[71]. Polio has been nearly eradicated in many regions globally due to comprehensive vaccination initiatives; yet, isolated transmission areas persist, posing a threat to infants and young children[71].

Poliomyelitis was once a widespread and devastating disease, causing paralysis and death in millions of children worldwide. However, since the introduction of the polio vaccine, global efforts to eliminate the disease have been successful[71]. The Global Polio Eradication Initiative, launched in 1988 by national governments, the World Health Organisation (WHO), Rotary The international collaboration involving the US Centers for Disease Control and Prevention (CDC) and UNICEF has achieved a reduction of polio cases by nearly 99%[72].

Despite progress, polio remains endemic in a few countries, especially in South Asia and portions of Africa. Young children and infants at the highest risk of getting polio, with the highest incidence of paralysis occurring in children under five years old. The poliovirus is highly contagious and spreads through fecal-oral transmission, often through contaminated water or food. Infants living in unsanitary conditions or crowded environments are particularly susceptible to infection[71].

The manifestations of polio differ based on the intensity of the infection. The majority of individuals infected with poliovirus remain asymptomatic and may exhibit only minor flu-like

symptoms, including fever, sore throat, and lethargy. Nevertheless, in approximately 1% of instances, the virus infiltrates the neurological system, resulting in paralysis, muscular weakness, and, in uncommon circumstances, respiratory failure. Paralytic polio may result in enduring impairment or mortality, particularly in newborns and young children[71].

The vaccine for polio, known as the inactivated poliovirus vaccine (IPV) or the oral poliovirus vaccine (OPV), was developed to provide protection against the poliovirus. The inaugural polio vaccine, created by Jonas Salk in the 1950s, was an inactivated vaccine (IPV) including destroyed poliovirus strains. The vaccine was subsequently supplanted by the oral poliovirus vaccine (OPV), formulated by Albert Sabin, which comprises attenuated live poliovirus strains[71].

The polio vaccine works by stimulating the immune system to produce antibodies against the poliovirus. When the vaccine is administered, either orally or through injection, the immune system recognises the weakened or killed virus and mounts a protective immune response. This immune response includes the production of antibodies that can neutralise the virus and prevent infection. The polio vaccine also induces memory cells that "remember" the virus, providing long-term immunity against poliovirus infection[73].

The polio vaccine is typically administered in multiple doses to ensure adequate immunity. The recommended schedule for IPV is four doses given at 2 months, 4 months, 6-18 months, and 4-6 years of age[74]. For OPV, the schedule may vary depending on the country's vaccination program but typically includes multiple doses given orally, starting at 6-8 weeks of age. Booster doses may be recommended for individuals at high risk of exposure to poliovirus, such as travelers to endemic areas[75].

Vaccination against polio has been instrumental in reducing the global burden of the disease and bringing the world closer to eradication. High vaccination coverage and continued surveillance are essential for achieving and maintaining polio eradication[76].

8. **Yellow fever:**

Yellow fever is a viral hemorrhagic illness induced by the yellow fever virus, which belongs to the Flaviviridae family. It primarily affects the liver and can cause severe illness, including jaundice, fever, and hemorrhage[77]. Yellow fever is endemic in tropical regions of Africa and South America, where it poses a significant risk to infants and young children due to their vulnerability to severe disease and complications[77,78]. Yellow fever has been a significant public health concern for centuries, with devastating outbreaks occurring in regions where the virus is endemic. Infants and young children are particularly susceptible to yellow fever, with higher mortality rates compared to older age groups[79]. The World Health Organisation (WHO) estimates that yellow fever causes 200,000 cases and 30,000 deaths annually, with infants and children accounting for a significant proportion of these cases[77].

Infants can contract yellow fever through the bite of infected mosquitoes, primarily the Aedes aegypti species. These mosquitoes transmit the virus when they bite humans, allowing the virus to enter the bloodstream and infect the liver. Infants living in or traveling to regions where yellow fever is endemic are at the highest risk of exposure to the virus[77,79]. Additionally, vertical transmission from infected mothers to infants during childbirth is possible but rare[80]. The symptoms of yellow fever typically begin with a sudden onset of fever, headache, muscle pain, nausea, and vomiting. In severe cases, the disease progresses to the toxic phase, characterised by jaundice (yellowing of the skin and eyes), liver damage, kidney failure, and hemorrhage[77].

Infants with yellow fever may exhibit symptoms such as irritability, poor feeding, lethargy, and high fever. Severe cases can lead to death within a few days without prompt medical intervention[77,79].

The vaccine for yellow fever was developed to provide protection against the virus. The yellow fever vaccine, a live attenuated vaccine, was first developed in the 1930s and has been widely used since then to prevent yellow fever outbreaks. The vaccine is made from a weakened form of the yellow fever virus, which stimulates the immune system to produce antibodies against the virus[81]. The yellow fever vaccine works by triggering an immune response in the body. When the vaccine is administered, the weakened virus in the vaccine replicates in the body, prompting the immune system to recognise and produce antibodies against the virus[82]. These antibodies provide protection against future yellow fever infections by neutralizing the virus and preventing its spread within the body. The vaccine also induces memory cells that "remember" the virus, providing long-lasting immunity[22,26].

The yellow fever vaccine is typically administered as a single dose and provides long-term immunity against the virus. The vaccine is recommended for infants and children living in or travelling to regions where yellow fever is endemic[77]. The vaccination schedule may vary depending on the country's vaccination program and the age of the child. Booster doses may be recommended for individuals at continued risk of exposure to the virus[83].

Vaccination against yellow fever is essential for preventing outbreaks and protecting infants and young children from severe illness and complications. High vaccination coverage within communities is necessary to achieve herd immunity and prevent the spread of yellow fever[77,83,84].

9. **Meningitis:**

Meningitis is an inflammation of the meninges, the protective membranes encasing the brain and spinal cord, typically resulting from an infection. Bacterial meningitis, in particular, can be severe and life-threatening, especially in infants and young children[85]. Bacterial meningitis is more common in infants than in older children and adults. The predominant bacterial pathogens associated with meningitis in neonates are Streptococcus pneumoniae, Neisseria meningitidis, and Haemophilus influenzae type b (Hib). These bacteria can spread from the respiratory tract or other sites of infection to the meninges, leading to inflammation and swelling[85].

Infants are at higher risk of bacterial meningitis due to their immature immune systems and greater susceptibility to infections. Additionally, factors such as attendance at daycare, exposure to cigarette smoke, and certain medical conditions can increase an infant's risk of developing meningitis. Close contact with individuals who carry the bacteria, such as family members or mothers, also poses a risk[86].

The symptoms of bacterial meningitis in infants can be nonspecific and may include fever, irritability, poor feeding, lethargy, vomiting, and a bulging fontanel (soft spot on the baby's head). As the disease progresses, infants may develop high-pitched crying, seizures, stiffness in the neck, and difficulty waking up. Prompt recognition and treatment of these symptoms are essential to prevent serious complications and improve outcomes[87].

Immunisation is among the most efficacious methods to avert bacterial meningitis in babies. A variety of vaccines exist to safeguard against the predominant bacterial infections that cause meningitis, particularly the pneumococcal conjugate vaccine (PCV), the meningococcal conjugate vaccine (MenACWY), and the Haemophilus influenza type b vaccine (Hib vaccine)[88]. The PCV vaccine protects against Streptococcus pneumonia, a leading cause of bacterial meningitis in infants. The vaccine contains purified polysaccharides from several pneumococcal

serotypes, which stimulate the immune system to produce antibodies against the bacteria. The PCV vaccine is typically administered in a series of doses, starting at 2 months of age, followed by additional doses at 4 months, 6 months, and 12-15 months of age[89]. The MenACWY vaccine protects against Neisseria meningitides, another common cause of bacterial meningitis, as well as other serogroups of the bacteria that can cause invasive disease88. The vaccine contains polysaccharides from several meningococcal serogroups, which induce an immune response to protect against meningococcal infection. The MenACWY vaccine is usually administered as a single dose at 11-12 years of age, with a booster dose recommended at 16 years of age[88].

The Hib vaccine protects against Haemophilus influenzae type b, a significant cause of bacterial meningitis in infants before the introduction of the vaccine. The vaccine contains a protein from the Hib bacteria, which stimulates the immune system to produce antibodies against the bacteria. The Hib vaccine is typically administered in a series of doses, starting at 2 months of age, followed by additional doses at 4 months and 6 months of age, with a booster dose given between 12-15 months of age[90].

In addition to vaccination, other preventive measures can help reduce the risk of bacterial meningitis in infants. These include practicing good hygiene, avoiding close contact with individuals who are sick, and seeking prompt medical attention for any signs or symptoms of infection[85].

10. **Rotavirus:**

Rotavirus is a highly transmissible virus that predominantly impacts newborns and young children, resulting in gastroenteritis marked by intense diarrhea and vomiting. It is a predominant cause of acute diarrhea and dehydration in babies globally, especially in underdeveloped nations with restricted access to clean water and sanitation facilities. Understanding the transmission,

symptoms, and prevention of rotavirus is crucial for protecting infants from this common and potentially serious infection[91]. Infants are most susceptible to rotavirus infection between the ages of 3 months and 2 years. Rotavirus spreads easily in environments where infants and young children are in close contact, such as daycare centers and households[92]. The virus is transmitted through the fecal-oral route, often through contaminated hands, objects, or surfaces. Infants can become infected by touching contaminated surfaces and then putting their hands in their mouths or ingesting contaminated food or water[93].

Symptoms of rotavirus infection generally manifest 1-3 days post-exposure and may encompass watery diarrhea, vomiting, fever, stomach pain, and dehydration. In extreme instances, diarrhea and vomiting may result in fast fluid depletion and electrolyte disturbances, posing a life-threatening risk, particularly to small infants[94]. Dehydration is a particular concern in infants, as they have limited fluid reserves and are more susceptible to complications from fluid loss[95].

Vaccination is the most efficacious method to avert rotavirus illness in babies. The rotavirus vaccine is an oral vaccine that is administered in multiple doses to infants starting at 6 weeks of age. Two or three doses of the vaccine are typically given, depending on the vaccine formulation used. The vaccine contains live attenuated rotavirus strains that stimulate the immune system to produce antibodies against the virus, providing protection against rotavirus infection[96].

The rotavirus vaccine has been shown to be safe and highly effective in preventing rotavirus gastroenteritis and its complications. Studies have demonstrated significant reductions in the incidence of severe diarrhea, hospitalisations, and deaths due to rotavirus infection following the introduction of the vaccine into national immunisation programs. Vaccination also helps to reduce the overall burden of rotavirus disease in communities by decreasing transmission of the virus[97].

In addition to vaccination, other preventive measures can help reduce the risk of rotavirus infection in infants. These include practicing good hygiene, such as regular hand washing with soap and water, especially after diaper changes and before preparing or handling food. Cleaning and disinfecting contaminated surfaces and objects can also help prevent the spread of the virus[92].

11. **Influenza:**

Influenza, often referred to as the flu, is a transmissible respiratory ailment induced by influenza viruses. It may result in mild to severe illness and can lead to significant consequences, particularly in newborns and young children. Understanding the risk factors, symptoms, and preventive measures for influenza is crucial for protecting infants from this seasonal respiratory virus[98]. Infants are at higher risk of influenza-related complications due to their immature immune systems and limited exposure to previous influenza strains. The flu can be particularly severe in infants under six months of age, as they are too young to receive the influenza vaccine. Infants six months and older can receive the flu vaccine, which provides protection against influenza viruses[99].

The symptoms of influenza in infants can be similar to those in older children and adults but may be more difficult to recognise. Common symptoms of influenza in infants may include fever, cough, runny or stuffy nose, sore throat, muscle or body aches, irritability, poor feeding, and difficulty breathing. In severe cases, influenza can lead to pneumonia, dehydration, and hospitalisation[98]. Influenza viruses are transmitted through respiratory droplets when infected individuals cough, sneeze, or talk. Infants can become infected with the flu virus by coming into contact with respiratory droplets from infected individuals or by touching contaminated surfaces and then touching their eyes, nose, or mouth. The flu virus can also spread from mother to infant during childbirth or through close contact with infected mothers [98].

Vaccination is the most effective way to prevent influenza in infants and young children. The flu vaccine is recommended for all children six months and older, including infants, as soon as the vaccine becomes available each year. The flu vaccine helps to stimulate the immune system to produce antibodies against influenza viruses, providing protection against infection and reducing the severity of illness[100].

In addition to vaccination, other preventive measures can help reduce the risk of influenza in infants. These include practicing good hygiene, such as regular hand washing with soap and water, especially after coughing, sneezing, or touching potentially contaminated surfaces. Avoiding close contact with individuals who are sick with the flu and staying home when sick can also help prevent the spread of the virus[101]

**2.1.4 Immunisation Side Effects**

Immunisation side effects can be broadly categorised into two main types: common and rare. Common side effects are typically mild and transient, resolving on their own within a few days. These include pain, redness, and swelling at the injection site, low-grade fever, fatigue, headache, and muscle aches. While these reactions may cause discomfort, they are generally indicative of the body's immune response to the vaccine and are considered normal[102]. On the other hand, rare but serious side effects are less common and may have more severe consequences. These include allergic reactions, such as anaphylaxis, which can be life-threatening if not promptly treated. Guillain-Barré Syndrome (GBS), a rare neurological disorder characterised by muscle weakness and paralysis, has been associated with certain vaccines, albeit extremely rarely. Intussusception, a condition where part of the intestine folds into itself, has been linked to specific vaccines, particularly in infants[103].

The prevalence of immunisation side effects varies depending on factors such as the type of vaccine, individual characteristics, and underlying health conditions. Common side effects, such as pain at the injection site and mild fever, are reported in a significant proportion of vaccine recipients but are generally short-lived and resolve without intervention[26]. Rare side effects, including severe allergic reactions and neurological disorders, occur much less frequently but may have serious implications for affected individuals[104].

Certain population groups may be at higher risk of experiencing vaccine side effects. For example, individuals with a history of allergic reactions to vaccine components or those with compromised immune systems may be more susceptible to adverse reactions. Age can also influence the risk of side effects, with infants and older adults potentially experiencing different reactions compared to healthy adults[26].

Ensuring the safety of vaccines is a top priority for public health authorities and vaccine manufacturers. Extensive systems for monitoring vaccine safety exist to detect and investigate adverse events following immunisation. This encompasses passive monitoring systems, such the Vaccine Adverse Event Reporting System (VAERS), which allows healthcare providers and the public to report adverse occurrences subsequent to vaccination. Active surveillance systems, such as the Vaccine Safety Data link (VSD), use electronic health records to monitor vaccine safety in real-time[105]. Clinical trials, conducted before vaccines are licensed for use, also play a crucial role in evaluating vaccine safety. These trials assess the incidence of adverse events and compare them to a control group to determine the vaccine's safety profile. Post-licensure studies, conducted after vaccines are introduced into the population, provide further insights into long-term safety and effectiveness[106].

While vaccine side effects can occur, it is essential to recognise that the benefits of immunisation far outweigh the risks for the vast majority of individuals. Vaccines have been instrumental in controlling and eradicating numerous infectious diseases, including smallpox, polio, and measles, saving millions of lives and preventing countless cases of disability and suffering. By preventing infections and reducing disease transmission, vaccines not only protect vaccinated individuals but also contribute to herd immunity, protecting vulnerable populations who cannot be vaccinated[84].

### 2.1.5 Benefits of Immunisation

Immunisation offers a multitude of benefits that extend far beyond individual protection. For children, in particular, the advantages of vaccination are profound, playing a pivotal role in safeguarding their health, preventing diseases, and fostering overall well-being[84]. They include:

**Disease Prevention and Control:** One of the primary benefits of immunisation is its ability to prevent and control infectious diseases. Vaccines work by stimulating the body's immune system to recognise and combat pathogens, thereby preventing infection or reducing its severity[107]. For children, who are especially vulnerable to infectious diseases due to their developing immune systems, vaccination provides crucial protection against a wide range of diseases, including measles, polio, pertussis, and influenza. By vaccinating children against these diseases, we not only shield them from potential harm but also contribute to the collective effort to control and eliminate infectious diseases on a global scale[108].

**Protection Against Serious Health Complications:** Immunisation offers children protection against serious health complications associated with vaccine-preventable diseases. Many vaccine-preventable diseases can lead to severe complications, including pneumonia, meningitis, encephalitis, paralysis, and even death[84]. By vaccinating children against these diseases, we

significantly reduce their risk of experiencing these debilitating and potentially life-threatening complications. Vaccines serve as a crucial line of defense, ensuring that children can grow and thrive without the burden of preventable diseases impeding their health and development[84,108].

**Herd Immunity and Community Protection:** Immunisation not only protects vaccinated individuals but also contributes to herd immunity, or community immunity, which benefits the entire population, including those who cannot be vaccinated. When a significant portion of the population is immunised against a disease, it creates a "herd" of immune individuals, making it difficult for the disease to spread within the community[109]. This provides indirect protection to vulnerable individuals, such as newborns, elderly individuals, and those with compromised immune systems, who may be at higher risk of severe complications from vaccine-preventable diseases. By ensuring high vaccination coverage rates, we strengthen community protection and reduce the overall burden of disease in society[84,109].

**Cost-Effectiveness and Economic Benefits:** Immunisation is not only beneficial from a public health standpoint but also from an economic perspective. Vaccines are highly cost-effective interventions, offering significant returns on investment in terms of healthcare savings, productivity gains, and reduced healthcare costs[84]. By preventing diseases and their associated complications, vaccines help alleviate the economic burden imposed by medical treatments, hospitalisations, and lost productivity due to illness. Additionally, immunisation programs can help reduce healthcare disparities and promote equitable access to healthcare services, ensuring that all children can benefit from the protective effects of vaccination[84].

**Long-Term Health Benefits and Lifelong Immunity:** Another key advantage of immunisation is its ability to provide long-term health benefits and confer lifelong immunity against certain diseases. Many vaccines offer durable protection against infections, providing children with

immunity that lasts well into adulthood[107]. By vaccinating children according to recommended schedules, we establish a foundation of immunity that can help protect them throughout their lives, reducing their risk of contracting vaccine-preventable future diseases. This improves individual health and population resilience[84,108].

**Prevention of Outbreaks and Public Health Emergencies:** Immunisation plays a crucial role in preventing outbreaks of vaccine-preventable diseases and mitigating public health emergencies. Vaccines serve as a vital tool in disease surveillance and outbreak response, allowing public health authorities to quickly identify and contain potential outbreaks before they escalate into larger epidemics or pandemics[84,108]. By maintaining high vaccination coverage rates and ensuring timely access to vaccines, we improve our global response to new infectious threats and protect community health[84].

**Enhancing Quality of Life and Well-being:** Ultimately, immunisation contributes to safeguarding children from preventable diseases and improving their quality of life alongside enabling them to live healthy, fulfilling lives[84,108]. Vaccinated children are less likely to experience illness, hospitalisation, and long-term disability associated with vaccine-preventable diseases, allowing them to thrive and reach their full potential. By investing in immunisation, we invest in the future health and prosperity of our children, ensuring that they can grow up in a world free from the burden of preventable diseases and enjoy the benefits of good health and well-being[84].



### 2.1.6 Barriers Against Completion of Immunisation

The factors influencing routine vaccine uptake are intricate and frequently multifaceted, as elaborated below:

### 2.1.6.1 Individual factors

Individual-level factors affecting immunisation in Nigeria are those directly resulting from baby's parents. These factors were usually sociodemographic, socioeconomic, or sociocultural. The primary factors contributing to the low vaccination rates in Nigeria include ignorance, bias, and misconceptions regarding vaccinations. Numerous studies have shown maternal education as a critical factor influencing the likelihood of an infant completing the whole vaccination regimen[111]. An extensive review of the literature indicated that elevated maternal education correlates with an increased rate of vaccination completion[111]. Adedokun et al. contended that children born to moms with minimal education exhibited a greater propensity for incomplete vaccination compared to those born to mothers with higher educational attainment[112]. Higher education enhanced the likelihood of a child receiving complete vaccinations by as much as eightfold. Higher education also correlated with employment in another study[113]. It claimed that such mothers or carers are more likely to vaccinate their children fully since they understand their relevance.

Illiteracy was linked to vaccine ignorance. Numerous studies show that vaccine awareness, necessity, immunisation schedule, and following dose requirements are low. One hundred fourteen. In a research, fewer than 20% of mothers and Carers correctly defined immunisation and identified six vaccine-preventable diseases. An insufficient understanding of the immunisation schedule was the most commonly cited reason for the low vaccine uptake in multiple studies[111]. Certain parents were merely oblivious to the necessity of vaccinations owing to their insufficient information[116].

Recent research indicated that the northern areas of Nigeria possess a much lower average literacy rate compared to the southern regions [117, 118] highlighted illiteracy as the cause of low

Northern immunisation rates. Educational achievement and immunisation rates are similar in northern and southern cultures. Vaccination rates vary greatly throughout the six geopolitical zones. Southern regions have three times the immunisation rate of northern geopolitical zones. Northern Islamic terrorism is another threat, exemplified by groups such as Boko Haram, has significantly obstructed the advancement of immunisation initiatives[119].

Religion also contributes to the north-south immunisation gap. Northerners are mostly Muslim, whereas southerners are mostly Christian, and their beliefs have been shown to effect their vaccination rates. [118] reported a 6% vaccination uptake rate in the northwest and 44.6% in the southeast. A southern state with substantial Islamic influence shows how religion affects schooling and immunisation rates, characterised by elevated illiteracy levels and diminished vaccination uptake[117]. Additional research has closely correlated parental vaccine hesitation with their religious convictions[120] indicated that certain women were unable to escort their children for vaccination appointments due to cultural and religious obligations necessitating their presence at home[120].

Cultural attitudes additionally constrained vaccination adoption. Certain parents expressed the belief that immunisations could result in abnormalities or even fatalities in children. Some ethnocentrists believed vaccines were used by white people to control populations. They contended that their traditional or alternative medicine approaches could treat diseases like measles more effectively than immunisations[114]. Moreover, numerous research has highlighted the influence of vaccination-related rumors on vaccine reluctance in Nigeria[121]. A positive parental impression of vaccines was associated with a twofold increase in vaccine uptake. In light of these stories and their lack of understanding regarding vaccines, some parents and mothers believed that a single vaccination suffices; they assumed that administering the initial

polio vaccine would safeguard the infant against all infections. Furthermore, this worldview exerted a dual impact on vaccination uptake rates; when parents or mothers decline follow-up doses and their children subsequently fall ill, they consequently dissuade other parents or mothers from pursuing vaccinations initially[114].

Some parents had the belief that vaccines were detrimental to infants, leading them to be apprehensive of vaccinating their children. Previous experiences also impacted their decisions to persist with immunisation[121]. The apprehension over negative consequences post-immunisation was cited as the cause for diminished confidence and skepticism in vaccines[121]. A significant portion of that apprehension originated from the observation that infants scream post-vaccination, and occasionally, their arms exhibit swelling as a consequence[121]. Consequently, the parents or mothers perceived that the vaccines were detrimental to the infants and ultimately ceased the injections. Nevertheless, some of this distrust stemmed from their inexperience as mothers or caretakers.

Research demonstrated that younger women (ages 15-24) exhibited the lowest likelihood of fully vaccinating their children. Mother age correlated with full vaccination uptake. This may be due to insufficient childcare experience. More experienced moms are more inclined to recognise the significance of immunisations in disease prevention for children, having faced the challenges of caring for an ill child. Maternal age correlated with maternal education. Older women have more understanding and can appreciate immunisations' benefits[114].

Moms and carers often claimed their children were sick, preventing them from obtaining immunisations at health clinics. Additional mothers also indicated that they were unwell. This was a primary factor for the incomplete vaccinations[113]. The mothers frequently lacked the time

to transport the kid to the vaccination center, as reported by [113]. Some said they couldn't take their kids to immunisation facilities because it took time away from farming[115].

Children born to mothers or carers with steady work were more likely to complete the immunisation schedule, but this was not universal113. Although knowledgeable about vaccines and their efficacy, some women may be too busy to drive their children to vaccination clinics[113]. They may believe they have sufficient time to vaccinate their children as long as the youngster is under one year old. This frequently causes delays that may ultimately lead to incomplete vaccinations.

The family's socioeconomic situation was considered a factor in assessing the likelihood of the child's immunisation completion. Poverty results in diminished health-seeking behaviors due to the inability of individuals to afford healthcare services. Low-income children were less likely to receive all their immunisations111. Additionally, this financial hardship had two effects on these children's health. They lacked nutrition for immune system development and couldn't afford immunisations due to their families' socioeconomic constraints. Parents said the high cost of childhood immunisation in Nigeria prevented them from vaccinating their children[112,117]. Some asserted that they were unable to afford healthcare treatments due to their exorbitant costs. Participants in a study stated they paid up to 70% of their healthcare costs out of pocket, using loans, selling assets, or seeking religious donations[19].

The substantial expense of prenatal care dissuaded numerous parents from pursuing such services. Furthermore, the utilisation of prenatal care has been demonstrated to be a vital factor influencing the comprehensive vaccination status of children[111]. A study indicated that children of moms who got prenatal care had an increased likelihood of being fully immunised. Prenatal physician visits equipped mothers with sufficient awareness regarding immunisations[111].

Prenatal visits promote women to pursue comprehensive vaccines for their offspring. Moreover, this assertion is reinforced by the observation that the utilisation of health services significantly affects vaccine adoption[114].

#### 2.1.6.2 Political factors

Political leaders in Nigeria have a major impact on vaccination hesitancy. Government apathy and overcentralisation of the Expanded Programme on Immunisation caused the 2003 Polio vaccination boycott in North-Western Nigeria[118]These northern states banned federally-endorsed polio vaccinations under pressure from Islamic and political leaders[123]. The strain was intensified by the Christian-Muslim tensions in Nigeria, along with a lack of understanding regarding the intensive polio vaccine campaigns at that time. Furthermore, the previously mentioned pressure stemmed from allegations that the polio vaccines were tainted with substances intended for the sterilisation of Muslim women. Polio spread across twenty countries and three continents because of the prohibition. Polio has been eliminated from Nigeria[124].

The issue of health organisation nomination bias persists. Corruption in Nigeria causes frequent leadership changes and political appointments[118]. Due to political favours and financial transactions, ineffective administrators are appointed. Nepotism and ties effect appointments and officeholder quality. Nonetheless, a significant portion of the responsibility rests with the failure of federal, state, and local governments to effectively execute a robust strategy to enhance both vaccination uptake and coverage. Health awareness campaigns in Nigeria frequently fail to effectively promote the advantages of health-seeking behaviors and the use of health services, such as prenatal care[111]. Notwithstanding the implementation of immunisation policies, their efficacy has been inadequate. This is due to health organisations' excessive politicisation and

poor public cooperation. Lack of long-term vaccine stock and supply plans shows the government's lack of commitment.

**2.1.6.3 Health System Factors**

Some factors were not directly linked to parents' or carers' inability to adequately vaccinate their children. The causes come from a deficient and insolvent healthcare system in Nigeria. The most commonly stated factor was the scarcity or lack of immunisations[115,118].

Immunisation programs depend on vaccinations, hence vaccine shortages in Nigeria hinder vaccination reluctance reduction. Target groups may distrust vaccine supply shortages because they indicate unpreparedness and the gravity of the vaccination campaign[115]. Factors contributing to vaccine shortages encompass insufficient financing, escalating expenses associated with vaccine development, licensing, and manufacture[115]. Nigeria is poor, thus vaccines, cold chain equipment, and logistics for immunisation campaigns are scarce. The National Programme on Immunisation (NPI) approved vaccine purchase funding in 2001, however only 61% was disbursed, according to Ophori et al. After financing ended, vaccines were bought at exorbitant prices in the cash market. The following year's funds were not disbursed, and the 2003 financing cycle was still in budget approval as of March 2003[118].

This is just one of the numerous factors contributing to the vaccination scarcity in Nigeria. A frequently neglected aspect is the influence of capitalism on the vaccination industry. Pharmaceutical corporations frequently opt against producing vaccinations for illnesses that have been eradicated in developed nations but continue to afflict developing ones, owing to diminished financial incentives[118].

Hospital delivery increases vaccination uptake, but health policies limit vaccine use. Weekends and holidays are off for immunisation staff in some hospitals. Thus, newborns born on Friday

evenings, weekends, public holidays, or nationwide strikes must wait until a working day to get vaccinated[125,126]. Parents or mothers may frequently extend this delay due to exhaustion, unavailability, forgetfulness, or negligence[125].

Research indicated that parents and mothers were frequently dissuaded by the scheduling of vaccination sessions[115,125,127]. Numerous individuals expressed dissatisfaction with the excessive duration required for transporting their children to vaccination appointments, as well as the prolonged waiting periods involved[127]. The prolonged waiting periods are exacerbated by the intermittent availability of vaccinations, resulting in a backlog of families seeking to vaccinate their children[115]. As a result, these parents and mothers may hesitate to participate in future immunisations due to the perceived futility of waiting for hours in line for a vaccine that may ultimately be unavailable[33]. Occasionally, these vaccine appointments were scheduled in the morning, when parents or mothers were absent owing to employment, rendering attendance practically difficult. The inadequate vaccination coverage was attributable to the manpower scarcity at vaccination centers. Research indicated that the number of vaccinators was insufficient to satisfy the vaccination requests at the centers, or that they were unavailable altogether[113,121]. The staff's failure to satisfy expectations was exacerbated by the overwork of the limited personnel available[121]. The workforce deficit may be attributed to Nigeria's substantial population, as it is the most populous nation in Africa. In addition to the shortage of vaccinators, numerous women indicated negative attitudes from vaccination personnel, which ultimately dissuaded them from finalizing their children's vaccines[115]. Moreover, vaccination personnel neglected to dispatch timely notifications regarding vaccination appointments and outreach days[121].

Furthermore, the condition of infrastructure in Nigeria results in numerous healthcare facilities lacking Inadequate cold chain equipment to preserve vaccination supply, resulting in shortages. Despite large contributions of cold chain equipment to Nigeria due to its emerging economy and poor infrastructure, a research found that its administration was poor, rendering it irreparable[118]. The investigation indicated that fewer than fifty percent of the refrigeration units at the health clinics examined were operating correctly[118]. Furthermore, several health clinics were unable to acquire sufficient vaccines due to their incapacity to store them properly. This results from the absence of reliable electricity in Nigeria. Consequently, many health centers refrain from bulk purchasing to avoid depleting their inventory during power outages[121]. Inadequate management of vaccination campaigns adversely affected vaccine supply due to deteriorated cold chain equipment[125].

In several instances, the investigations indicated that the vaccination centers were excessively distant for moms or caretakers to consistently transport their children for immunisation appointments[113,127]. Several individuals also mentioned the absence of healthcare facilities in their proximity due to residing in hard-to-access regions[121]. Notwithstanding their distance from health care facilities, certain women nonetheless succeeded in attending immunisation appointments. They expressed their fatigue from visiting immunisation sites, only to be informed that immunisations for their children were unavailable[128]. They expressed that, although understanding their children needed numerous vaccination doses, they perceived little value in visiting sites that were devoid of immunisations.

Furthermore, the likelihood of a kid completing the immunisation regimen was significantly affected by the child's place of residence. Numerous studies emphasised the discrepancy between urban and rural regions, along with their varying rates of vaccination adoption[112,114]. Children of

parents residing in urban areas exhibited a greater propensity for full vaccination[114]. Another study found that urban children were twice as likely to be fully immunised than rural children[112]. The predominance of health care institutions and amenities in metropolitan regions, combined with the inaccessibility of rural areas in Nigeria, accounts for this situation[114].

Inadequate access to these scarce healthcare facilities in rural regions intensifies this discrepancy. The challenging topography of many rural regions limits their accessibility; certain settlements are located in riverine, sandy, or mountainous locations that are inherently difficult to access. In the Niger Delta, one of Nigeria's most isolated regions, around 20% of newborn fatalities were attributable to vaccine-preventable infections. The study found that inaccessibility, inadequate healthcare facilities, and widespread poverty in the Niger Delta reduce the likelihood of complete vaccinations for children[129].

**2.1.7 Overview of Immunisation in Nigeria**

The Nigerian government has launched multiple initiatives and campaigns to enhance the adoption of routine childhood immunisation, including Among others, the Nigerian Expanded Program on Immunisation (EPI), the Universal Child Immunisation (UCI), the Saving One Million Lives program, and the Maternal Neonatal Tetanus Elimination (MNTE) campaign reflect the national routine immunisation strategy plan (2013–15)[122].

These programs have helped to somewhat raise the immunisation rate among children. For example, the percentage of children aged 12 to 23 months who got all basic immunisations rose from 23% in 2008 to 31% in 2018 and dropped from 29% to 19% in the percentage who got none of the fundamental vaccinations. Also certified wild polio-free by the Africa Regional Commission for Certification of Polio Eradication (ARCC) in August 2020 is Nigeria. Notwithstanding these successes, universal child immunisation in Nigeria still presents a major

public health concern. Only one-third (31%), of children aged 12 to 23 months obtained all basic immunisations; 28% received the basic vaccinations by the required age of 12 months; 19% received no vaccinations at all with 52–58% in other Nigerian countries[130].

Several institutional, contextual, and personal-level elements have been identified by several past research and reports as discouraging elements for the acceptance and execution of immunisation campaigns in Nigeria. Some of the institutional factors include inadequate government funding, over-dependence on donor funds, ad-hoc campaigns sponsored by donors, weak health structure and systems, lack of community ownership, vaccine stock-out, distribution difficulties, non-maintenance of Cold Chain Equipment (CCE), and inadequate personnel performance at municipal and state levels [131,132] Among the individual-level and contextual elements are the location of delivery, mother's degree of education, distance to a medical facility, mother's knowledge of vaccine-preventable diseases, family affluence among others[111,113,120,121].

While identifying the factors that hinder optimal uptake of vaccination and programme implementation is important, identifying the factors that account for positive change is significant for sustained progress. With fewer than ten years remaining until 2030, Nigeria must prioritise factors that facilitate positive change to enhance achievements and encourage uptake in order to attain Sustainable Development Goal 3.2.1 and the national target of achieving 90% full immunisation for children under one year, with a minimum of 80% coverage in each state[132].



#### 2.1.7.1 National Programme on Immunisation

In 1974, the World Health Organisation (WHO) launched a worldwide initiative to use vaccination as a public health measure by introducing the Expanded Programme on

Immunisation (EPI). The National Programme on Immunisation (NPI) is a part of Child Survival Programmes. Since the establishment of the National Programme on Immunisation (EPI), immunisation has continuously proven to be one of the most cost-effective public health measures for reducing worldwide child morbidity and mortality[133]. The EPI program outlines the management of technical and administrative functions necessary for the regular immunisation of children with a limited array of vaccines, safeguarding against diphtheria, tetanus, pertussis, measles, poliomyelitis, and tuberculosis, while also preventing maternal and neonatal tetanus by immunising women of childbearing age with tetanus toxoid. The principal aim of EPI was to deliver several vaccinations to all children through a simple schedule of health appointments. This was challenging due to the vulnerability or lack of health systems in numerous disadvantaged and developing countries at that time[134]. Vaccine coverage levels remained below 5% until approximately 1990, when the majority of impoverished nations established immunisation programs based on the EPI framework. By 1991, the global objective of vaccinating 80% of the world's children was proclaimed to have been achieved, potentially saving millions of lives[134]. The achievements were attributed to the improvement of the skills and talents of these nations through the EPI plan created at the program's inception[134].

In 2014, 129 countries, accounting for 66% of the 194 WHO Member States, met the national coverage target of ≥ 90% for DTP3. Of these, 119 nation-states have sustained this coverage for the last three years, and 109 of them over the last five years. By 2014, DTP3 coverage in 35 nations declined below 80%, an increase from 32 in 2013 and 30 in 2011. Of the 35 nations with coverage below 80% in 2014, 27 had already recorded sub-80% levels in 2013, whilst 8 had surpassed 80% in 2013, including 2 with coverage rates exceeding 90%. Nineteen nations have consistently failed to meet the 80% threshold since 2010; five countries recorded DTP3 coverage

below 80% in 2013 but successfully increased it over 80% in 2014, with only one attaining a rate of 90%. In 2014, around 18.7 million children, compared to 18.8 million in 2013 and 19.2 million in 2011, did not obtain three doses of DTP-containing vaccinations. Nigeria's coverage stands at 75% throughout the same period[135].

Nigeria initiated the Expanded Program on Immunisation (EPI) in 1978 to provide routine immunisation for children under two years old, achieving initial, if sporadic, success, culminating in the early 1990s with a childhood immunisation coverage of 81.5%. Since that era of achievement, Nigeria has undergone a gradual but consistent decrease in immunisation coverage. By 1996, overall coverage for all antigens had declined to below 30%, further decreasing to 12.9% in 2003, validating the results of the 2003 national vaccination coverage study. The reduction in antigen coverage seems linked to insufficient governmental political will and commitment, resulting in the ineffective execution of EPI policies, as demonstrated by excessive centralisation in EPI management at the federal level, vaccine shortages, and numerous administrative challenges[118]. In 1999, the government launched a drive to revitalise and sustain the immunisation system alongside the polio eradication initiative, leading to the establishment of the National drive on Immunisation (NPI). The NPI focusses on aiding states and local governments in implementing immunisation programs[135].

The National Programme on Immunisation indicates that the routine immunisation of children in Nigeria utilises the following vaccines: BCG (Bacillus Calmette-Guérin) should be administered prenatally or as soon as practicable thereafter. Oral Polio Vaccine (OPV) is administered at birth and at 6, 10, and 14 weeks of age. Pentavalent vaccine is delivered at 6, 10, and 14 weeks of age. The Hepatitis B vaccine is given at birth, followed by doses at 6 and 14 weeks of age. Measles

immunisation at 9 months, Yellow Fever vaccination at 9 months, and Vitamin A supplementation is given at 9 and 15 months.

#### 2.1.7.2 Country Profile

1. **Geography**

Nigeria, which comprises a land area of approximately 923,768 square kilometres, is located on the western coast of Africa. Its boundaries extend from the Gulf of Guinea on the southern Atlantic coast to the northern periphery of the Sahara Desert. It is bordered by the Atlantic Ocean to the south, the Republic of Niger and Chad to the north, Cameroon to the east, and Benin to the west[130].

Nigeria is characterised by two distinct topographical landforms: lowlands and highlands. The North Central and East highlands are characterised by uplands that reach heights of 600 to 1,300 meters. Conversely, the coastal regions are characterised by lowlands that frequently have elevations below 20 meters. In the northern region of the country, the lowlands extend from the Sokoto to Borno plains. In the southern states, they extend eastward to the Cross River basin and the coastal lowlands of the western geopolitical zone. The climate is divided into two primary types: a dry season and a rainfall season, which divide the country into a northern arid region, a central savannah zone, and southern wetlands and rainforests[130].

2. **Political Atmosphere**

Nigeria is governed by a federal system that includes federal, state, and local government authorities (LGAs). The country is divided into 36 states and a federal capital territory (FCT), which collectively comprise 774 local government areas (LGAs). The states are divided into six geopolitical zones: North West, South West, North Central, South-South, South East, and North

East. In accordance with the federal constitution, elected executives and legislatures are autonomously accountable for administrative matters at every level[130].

The National Population Commission reports that Nigeria comprises more than 350 ethnic groupings. The geopolitical zones were traditionally controlled by specific tribes that constitute the foundation for the grouping. The Kalabari Ijaw, Itsekiri, and Ibibio tribes are the primary inhabitants of the South-South zone. The Nupe, Ebira, Idoma, Tiv, Igala, Angas, and Gwari tribes are the primary inhabitants of the North Central zone. The Yoruba are the primary inhabitants of the Southwest. The Northeast is primarily composed of the Kanuri and Fulani tribes, as well as other tribes such as the Marghi, Babur, Mumuye, and Jukun. The Igbo are the primary dominant tribe in the Southeast zone. The Hausa and Fulani, collectively known as the Hausa-Fulani, are the primary inhabitants of the Northwest zone. Their homogeneity is the reason for their collective moniker. Nigeria is a secular nation that guarantees freedom of worship, with Christianity and Islam as the predominant religions. The North is primarily populated by individuals of the Islamic faith, with a minority of Christians; conversely, the South is chiefly inhabited by Christians, alongside a minority of Muslims[130]. The dynamics within the various geopolitical zones or areas are directly influenced by all of these ethnic and religious considerations. Health-seeking behaviours and perceptions of healthcare services, including immunisation, are influenced by cultural and religious disparities. Consequently, it is imperative to understand the various distinctions and the potential implications for the success or failure of immunisation regimens.



### 3. **Economic Development**

Agriculture was the foundation of the Nigerian economy prior to independence. It provided basic materials for industry and export to generate foreign exchange and employed over 90% of the burgeoning population. In the years that followed the discovery of petroleum, agriculture lost its position as the primary contributor to the Nigerian economy, and petroleum became the primary export commodity[130].

Approximately $262.6 billion was Nigeria's gross domestic product (GDP) in 2013, according to the World Bank. According to sectoral research, agriculture comprised 39% of the total GDP, a decrease from 40% in 2011. Industry and petroleum oil contributed 18% and 14% to GDP, respectively, which was lower than their respective contributions of 19% and 15% in 2011. Solid minerals and manufacturing, which are components of the industrial sector, contributed only 0.4% and 4%, respectively[130].

The Nigerian government recognised the significance of privatisation in the context of economic restructuring in the wake of the oil industry's collapse, which resulted in the liberalisation, deregulation, and privatisation of a variety of economic sectors. The latest alteration occurred in the power industry, following changes in the telecommunications and petroleum downstream sectors. This is anticipated to enhance the economy in the near future, particularly with the implementation of economic policy changes alongside investments in physical infrastructure, human capital development, and the establishment of macroeconomic stability and effective governance.



4. **Health Care System**

The administration of health systems in Nigeria is a collaborative responsibility among federal, state, and local governments. The federal government is tasked with delivering policy directives and technical assistance to state and local governments, in addition to overseeing tertiary health

institutions, which encompass teaching hospitals, federal medical centres in states without teaching hospitals, and various national specialised hospitals, including orthopaedic, psychiatric, eye, ear centres, and laboratories.

The states are responsible for oversight and supervision, as well as providing technical and policy support to the LGAs, in addition to administering secondary health facilities to supply healthcare services through general and specialist hospitals. The Local Government Areas (LGAs) administer primary health care (PHC) centres and provide services at this tier, including maternity and child health care. This level provides various treatments, encompassing curative care, routine immunisation (preventive), and health promotion activities, depending on the institution and its available healthcare staff[136].

Notwithstanding Nigeria's critical position in Africa due to its economic prowess and the sophistication of its governmental control, its healthcare system has seen significant setbacks, leaving the nation severely underserved in this domain. All aspects of the system demonstrate inadequacies, encompassing skilled personnel, healthcare facilities, and medical apparatus, especially in rural areas. Health care services are fragmented, poorly structured, and lacking in vital resources such as prescriptions and supplies. Inadequate and declining infrastructure, unequal distribution of scarce resources and access to care, and inferior quality of service, despite several reforms suggested by the Nigerian government, are significant difficulties within the healthcare system. Nonetheless, most federal reform proposals remain unimplemented at the Local Government Area and State levels, where their impacts are expected to be felt. This failure to execute may be partially ascribed to ambiguity concerning the roles among the three tiers of government[137].

In 2019, the WHO identified eleven countries where 60% of the 19.7 million children had not gotten complete DTP immunisations, either missing an initial dose or being inadequately vaccinated. Nigeria demonstrated a troubling incidence of insufficient immunisation among these 10 nations. Nigeria, possessing a Human Development Index (HDI) of 0.5, ranks 152nd out of 187 countries worldwide. This signifies that the population is vulnerable to health-related financial difficulties arising from unfavourable socio-economic circumstances. Literacy represents the third barrier identified by the multi-year immunisation plan, with 53% of women aged 15-49 possessing literacy skills. The data indicates a disparity in literacy rates between rural and urban regions, with 40% of women in rural areas being literate, in contrast to 70% in urban areas. From 2000 to 2013, the country demonstrated negligible to no fluctuation in particular health indicators, including maternal and child health. Table 2 delineates measures pertaining to child mortality and maternal health[136].

Table 2.1: Indicators for reduced child mortality and improved maternal health (Federal Ministry of Health, 2016).

| Indicator | 2000 | 2013 |
|---|---|---|
| Reduce child mortality (MDG 4) | | |
| Under 5 mortality rates (per 1000 live births) | 213 | 117 |
| Infant mortality rate (per 1000 live births) | 100 | 69 |
| Improve Maternal Health Indicators Baseline (MDG 5) | | |
| Maternal Mortality Ratio (in 100,000) | 545 | 576 |
| Births attended by skilled health personnel (%) | 35 | 36 |
| Prenatal Coverage (at least four visit) (%) | 45 | 51 |

The Nigerian healthcare system comprises public and commercial sectors, with Local Government Area (LGA) institutions designated for primary care responsibilities. The delivery of health services by healthcare systems differs between regions. The Nigerian government instituted three strategies to address the imbalance between the demand and availability of child and maternal health services:

- Midwives Service Scheme (MSS):
- Training and deployment of 4,000 midwives and 1,000 community health extension workers (CHEWs) across 1,000 primary healthcare facilities, with a focus on vaccination.

The Subsidy Reinvestment and Empowerment Program for Maternal and Child Health (SURE-P-MCH):

• Comprehensive enhancements to primary healthcare infrastructure via the Ward Health System:

• Constructing 1,156 Primary Health Care facilities nationwide, 228 maternal health care centres, and 10 health training institutions established by the MDG office

**2.1.7.3 Immunisation Service Delivery and Routine Immunisation Schedule for infants in Nigeria**

In Nigeria, immunisation services are provided through the primary healthcare system, consisting of 25,132 Primary Health Facilities. Immunisation services are being delivered using fixed, outreach, and mobile sites, adhering to a "1-2-3" model. The federal ministry of health acknowledges that the immunisation services implementation strategy is insufficient to meet demand at both the state and local government area levels. Furthermore, the collected data is plagued by flaws that render the adaptation of the service delivery process tedious and insufficient. Routine immunisation is administered at primary healthcare centers for anyone

residing within a 5 km radius. Outreach programs offer identical services bi-monthly for individuals residing 5 to 10 kilometers from the PHC. Individuals residing over 10 kilometers from the Primary Health Centre (PHC) receive equivalent services monthly through mobile units operated by Community Extension Health Workers (CHEW)[122]. This program's routine vaccination schedule is displayed in Table 3.

Table 2.2: **National Immunisation Schedule for Routine Immunisation among Children and Women**

| Minimum Target Age of Child | Type of Vaccine | Dosage | Route of Administration | Site |
|---|---|---|---|---|
| At birth | BCG | 0.05ml | Intradermal | Left upper arm |
| | OPV0 | 2 drops | Oral | Mouth |
| | Hep B0 birth | 0.5ml | Intramuscular | Anterolateral aspect of right thigh |
| 6 weeks | Pentavalent (DPT, Hep B, Hib) 1 | 0.5ml | Intramuscular | Anterolateral aspect of left thigh |
| | Pneumococcal Conjugate Vaccine 1 | 0.5ml | Intramuscular | Anterolateral aspect of right thigh |
| | OPV1 | 2 drops | Oral | Mouth |
| | IPV1 | 0.5ml | Intramuscular | Anterolateral aspect of right thigh (2.5cm apart from PCV) |
| | Rotavirus vaccine 1 | 5 drops | Oral | Mouth |
| 10 weeks | Pentavalent (DPT, Hep B, Hib) 2 | 0.5ml | Intramuscular | Anterolateral aspect of left thigh |
| | Pneumococcal Conjugate Vaccine 2 | 0.5ml | Intramuscular | Anterolateral aspect of right thigh |
| | OPV2 | 2 drops | Oral | Mouth |
| | Rotavirus vaccine 2 | 5 drops | Oral | Mouth |
| 14 weeks | Pentavalent (DPT, Hep B, Hib) 3 | 0.5ml | Intramuscular | Anterolateral aspect of left thigh |
| | Pneumococcal Conjugate Vaccine 3 | 0.5ml | Intramuscular | Anterolateral aspect of right thigh |
| | OPV3 | 2 drops | Oral | Mouth |
| | Rotavirus vaccine 3 | 5 drops | Oral | Mouth |
| | IPV2 | 0.5ml | Intramuscular | Anterolateral aspect of right thigh (2.5cm apart from PCV) |
| 6 months | Vitamin A 1st dose | 100,000 IU | Oral | Mouth |

| | | | | |
|---|---|---|---|---|
| 9 months | Measles 1st dose (MCV1) | 0.5ml | Subcutaneous | Left upper arm |
| | Yellow Fever | 0.5ml | Subcutaneous | Right upper arm |
| | Meningitis Vaccine | 0.5ml | Intramuscular | Anterolateral aspect of left thigh |
| 12 months | Vitamin A 2nd dose | 200,000 IU | Oral | Mouth |
| 15 months | Measles 2nd dose (MCV2) | 0.5ml | Subcutaneous | Left upper arm |
| 9 years | HPV | 0.5ml | Intramuscular | Deltoid muscle (Left upper arm) |

***Notes:***
** BCG should be given at birth but can be given up until 11 months.*
*** OPV0 must be given before the age of two weeks.*
**** Hep B0 should be given at birth or within 24 hours.*
***** HPV is to be introduced soon.*

Source: Federal Ministry of Health, 2016

**2.1.7.4 Global Initiatives and Their Impact on Immunisation in Nigeria**

Increasing vaccine coverage, making vaccines more accessible, and fortifying healthcare systems have all been accomplished via the joint efforts of numerous international organisations and partnerships. Among them are the following:

**1. World Health Organisation (WHO)**

Through its capacity-building programs, technical assistance, and policy-development efforts, the World Health Organisation (WHO) has played a pivotal role in influencing the vaccination landscape in Nigeria. World Health Organisation (WHO) standards cover all the bases when it comes to vaccination administration, monitoring vaccine-preventable diseases, and coordinating response to outbreaks. Specifically within the context of the Expanded Programme on Immunisation (EPI), the group collaborates closely with the government of Nigeria to guarantee that vaccination policies are in line with international standards[165].

By assisting with the monitoring of vaccination coverage through strong data collecting, analysis, and reporting systems, WHO has made one of its most important contributions. The World Health Organisation (WHO) is able to monitor vaccination rates, spot coverage gaps, and develop solutions by making use of sophisticated monitoring technologies. This is of utmost importance in Nigeria, where vaccine reluctance, security concerns, and logistical hurdles cause vaccination coverage discrepancies among regions.

When vaccine-preventable diseases including measles, polio, and meningitis broke out in Nigeria, the World Health Organisation was instrumental in containing the epidemic. The group's technical knowledge and resources will help bring these diseases under control quickly. For instance, millions of children in Nigeria have been vaccinated as part of a countrywide supplementary immunisation effort (SIA) organised by the World Health Organisation (WHO) and the Nigerian health authorities in reaction to measles outbreaks[167]. The World Health Organisation's (WHO) role in the battle against polio marks a watershed moment in its engagement with Nigeria. The World Health Organisation's (WHO) Global Polio Eradication Initiative (GPEI) has backed Nigeria's statewide polio immunisation drives with funding and technical assistance. As a result of these initiatives, Nigeria was officially declared polio-free in August 2020168. Northern Nigeria is one of several high-risk regions where people still face barriers to healthcare, but the World Health Organisation (WHO) is committed to collaborating with local health authorities to ensure that polio does not return[169].

In addition, the World Health Organisation has helped Nigeria incorporate vaccination programs into its existing primary healthcare infrastructure. As part of its efforts to improve healthcare access and overall immunisation coverage, the World Health Organisation (WHO) promotes routine immunisation alongside mother and child health services[170].

**2. United Nations Children's Fund (UNICEF)**

Immunisation efforts in Nigeria have been greatly supported by the United Nations Children's Fund (UNICEF). UNICEF has worked to improve hospital infrastructure, engage communities, and obtain vaccines. Through the COVAX facility, a worldwide program for fair vaccine distribution, UNICEF, the biggest vaccine purchaser in the world, plays a crucial role in maintaining a consistent supply of vaccinations in Nigeria. Nigeria has a long history of vaccination coverage issues due to vaccine shortages and distribution issues, thus this support is very important for them[171].

UNICEF's role extends beyond vaccine supply to demand generation and immunisation advocacy. The organisation collaborates with local communities, religious leaders, and civil society groups to promote vaccine acceptance and counter misinformation[172]. Vaccine hesitancy remains a significant issue in Nigeria, often driven by religious, cultural, or misinformation-related factors. By leveraging community influencers, UNICEF fosters trust in immunisation programmes and encourages parents to ensure their children receive routine vaccines[172,173].

Training and capacity-building for healthcare workers is another area where UNICEF has made a notable impact. The organisation provides training sessions for frontline health workers on immunisation best practices, vaccine handling, and patient communication strategies. These efforts contribute to improving the overall quality of immunisation service delivery in Nigeria[174].

Another key aspect of UNICEF's work in Nigeria is its support for the country's cold chain management system. Effective vaccine storage and transportation are critical for maintaining vaccine potency, particularly in remote and underserved areas. To address this challenge, UNICEF has introduced solar-powered cold chain equipment in hard-to-reach regions, ensuring that vaccines remain effective despite inconsistent electricity supply[175]. This innovation has

significantly improved immunisation coverage in rural communities, where inadequate infrastructure often limits access to healthcare services.

Moreover, UNICEF assists the Nigerian government in formulating and executing initiatives to eliminate zero-dose children—individuals who have never been vaccinated. Special focus is given to children in conflict-affected regions such as the Northeast, where displacement due to insurgency has disrupted routine immunisation services[170].

**3. Global Alliance for Vaccines and Immunisation (GAVI)**

Gavi is a critical partner in Nigeria's immunisation efforts, providing both financial and technical support to enhance vaccine access and strengthen healthcare systems. Since its establishment in 2000, Gavi has played a vital role in Nigeria by funding vaccine procurement, supporting the introduction of new vaccines, and facilitating health system strengthening initiatives[176].

One of Gavi's significant contributions to Nigeria is its financial assistance for the introduction of new vaccines. Nigeria has benefited from Gavi's assistance in the deployment of the pentavalent vaccine, which safeguards against diphtheria, tetanus, pertussis, hepatitis B, and Haemophilus influenzae type B[170]. Additionally, through Gavi's assistance, Nigeria has introduced the pneumococcal conjugate vaccine (PCV), which helps prevent pneumonia—a leading cause of child mortality in the country. These vaccines have contributed significantly to reducing the burden of vaccine-preventable diseases among Nigerian children[177].

Gavi also funds Nigeria's Health System Strengthening (HSS) programme, which is designed to improve immunisation service delivery at state and local government levels. The programme focuses on training healthcare workers, enhancing data reporting systems, and improving

vaccine storage and distribution networks[178]. By addressing systemic challenges, Gavi's interventions help ensure that vaccines reach children in both urban and rural communities.

In addition to financial support, Gavi collaborates with other global health partners, including WHO and UNICEF, to implement immunisation strategies tailored to Nigeria's unique challenges. One such initiative is the Zero-Dose Immunisation Programme, aimed at identifying and vaccinating children who have never received any vaccines[165]. This programme prioritises communities with the lowest immunisation coverage, ensuring that vulnerable children are not left behind.

Furthermore, Gavi has supported Nigeria's efforts in strengthening routine immunisation through innovative funding models. The organisation's co-financing model requires the Nigerian government to gradually increase its financial contribution to vaccine procurement, promoting sustainability and reducing dependence on external aid over time[179]. This approach ensures that immunisation programmes remain viable even as donor funding decreases.

Gavi's involvement in Nigeria has also extended to emergency response efforts, particularly during disease outbreaks. The alliance has provided funding for emergency vaccination campaigns, including those for cholera and yellow fever outbreaks[180]. These rapid-response initiatives have been crucial in containing outbreaks and preventing widespread disease transmission.

**Success Stories from Global Partnerships**

Over the years, global partnerships have significantly improved Nigeria's immunisation landscape. These collaborations have not only increased vaccine coverage but have also led to the eradication and reduction of vaccine-preventable diseases. Some notable success stories include:

**1. Polio Eradication in Nigeria**

One of the most remarkable achievements in Nigeria's immunisation history is the eradication of wild poliovirus, largely due to global partnerships. The collaboration between WHO, UNICEF, Gavi, and the Nigerian government, along with funding from the Bill and Melinda Gates Foundation, led to widespread vaccination campaigns[181]. Through coordinated efforts, innovative strategies such as door-to-door immunisation, mobile vaccination teams, and extensive community engagement were implemented.

A key element in this success was the establishment of emergency operations centers (EOCs) across the country to monitor and coordinate polio eradication efforts. These centers provided real-time data, allowing quick responses to emerging cases and ensuring effective distribution of vaccines[182]. Additionally, religious and traditional leaders played a crucial role in dispelling myths and increasing vaccine acceptance, particularly in northern Nigeria where resistance was initially high. By maintaining a rigorous surveillance system and ensuring that every child was vaccinated, Nigeria successfully eliminated polio transmission[183]. The nation was officially designated polio-free in 2020, signifying a substantial achievement in worldwide public health.

**2. Expanded Routine Immunisation Coverage**

With the support of international organisations, Nigeria has expanded routine immunisation services to reach more children, particularly in underserved areas. The introduction of the National Routine Immunisation Strategic Plan (NRISP), backed by Gavi and WHO, has led to improvements in vaccine coverage rates[184]. The plan focuses on increasing immunisation access through community engagement, improving data reporting, and strengthening healthcare infrastructure.

Technology has played a crucial role in expanding immunisation coverage. Electronic immunisation registries and mobile health (mHealth) tools have enhanced tracking and follow-up for children due for vaccination. These digital solutions help healthcare workers monitor immunisation schedules, send reminders to parents, and ensure timely vaccine administration[185]. Additionally, immunisation campaigns have incorporated Geographic Information System (GIS) mapping to identify and reach unvaccinated children in remote locations, thereby reducing immunisation gaps[186].

**3. Introduction of the MenAfriVac Campaign**

Meningitis has emerged as a substantial public health issue in Nigeria, especially in the northern region states, which fall within the African Meningitis Belt. The introduction of the MenAfriVac vaccine, supported by WHO and Gavi, has significantly reduced the burden of meningococcal meningitis in Nigeria[187]. Mass vaccination campaigns targeting at-risk populations have led to a decline in meningitis outbreaks, demonstrating the effectiveness of global partnerships in disease prevention[188].

Before the MenAfriVac campaign, Nigeria experienced recurrent meningitis outbreaks that claimed thousands of lives. However, the introduction of this vaccine in 2011 marked a turning point. The vaccine, specifically designed for the African meningitis strain, was administered in large-scale campaigns that targeted millions of people[189]. These efforts led to an over 90% reduction in meningitis cases in vaccinated regions, showcasing the power of collaborative immunisation initiatives[190].

**Challenges of Sustaining Global Support for Immunisation in Nigeria**

Despite the remarkable contributions of international organisations, sustaining global support for Nigeria's immunisation programmes remains a challenge. Some of the key issues include:

**1. Financial Sustainability**

Many of Nigeria's immunisation programmes rely heavily on donor funding. As Nigeria progresses economically, it is expected to transition out of Gavi's funding support, meaning the government will have to take full responsibility for vaccine procurement and immunisation services[179]. This raises concerns about whether Nigeria has the financial capacity to sustain these programmes without external assistance.

The Nigerian government has made commitments to increase domestic immunisation funding, but budgetary constraints and competing health priorities often limit the actual allocations. Policymakers must propose new financing methods like public-private partnerships, health insurance schemes, and dedicated immunisation trust funds[179,191]. Without sustained funding, there is a risk of declining immunisation coverage and resurgence of vaccine-preventable diseases.

**2. Vaccine Hesitancy and Misinformation**

Despite the availability of vaccines, vaccine hesitancy remains a significant challenge in Nigeria. Misinformation, particularly in rural and conservative communities, has led to resistance against immunisation campaigns. Some communities perceive vaccines as harmful or unnecessary, resulting in suboptimal coverage rates[192]. This has been exacerbated by rumors and conspiracy theories, including beliefs that vaccines cause infertility or contain harmful substances.

Addressing this challenge requires continued investment in health education and community engagement efforts. Religious and traditional leaders, social media influencers, and healthcare workers must be actively involved in dispelling myths and promoting vaccine acceptance[172]. Campaigns should leverage culturally appropriate messaging, storytelling, and testimonies from immunised individuals to build trust and confidence in vaccination.

**3. Security Challenges in Conflict-Affected Areas**

Armed conflicts and insurgency, particularly in the northern regions, have hindered immunisation efforts. Healthcare workers often face threats from militant groups, and some areas are inaccessible due to insecurity[193]. The inability to reach these populations creates a gap in immunisation coverage, increasing the risk of disease outbreaks.

To mitigate these challenges, international partners and the Nigerian government have adopted alternative strategies such as deploying military escorts for vaccination teams, using local volunteers familiar with the terrain, and setting up immunisation camps in safer areas[194]. However, these measures are not always sufficient, and continuous efforts are needed to ensure that conflict-affected regions are not left behind.

**4. Weak Health Systems and Infrastructure**

Nigeria's healthcare infrastructure remains weak, particularly in rural and hard-to-reach areas. Inadequate cold chain storage facilities, limited healthcare workforce, and logistical challenges have affected vaccine distribution and administration[195]. Without substantial investment in healthcare infrastructure, immunisation coverage may stagnate despite international support.

To strengthen immunisation delivery, investments must be made in training healthcare workers, improving supply chain management, and expanding cold chain storage facilities. The introduction of solar-powered refrigerators in some regions has helped maintain vaccine potency, but more efforts are needed to scale up such initiatives nationwide[196].

**5. Political and Policy Inconsistencies**

Frequent changes in government policies and leadership transitions often disrupt immunisation programmes. A lack of continuity in immunisation policies and funding commitments can

undermine the gains achieved through global partnerships. Strengthening governance and ensuring long-term policy commitment to immunisation is crucial for sustainability[197].

One approach to addressing this issue is the establishment of legal frameworks that mandate consistent immunisation funding and programme implementation, regardless of political transitions[198]. Additionally, strengthening accountability mechanisms and fostering collaboration between federal, state, and local governments will ensure that immunisation remains a top public health priority.

### 2.1.8 Herd Immunity and Its Role in Disease Prevention

Indirect protection from infectious diseases, or herd immunity, happens when a large percentage of a population develops an immunity, which in turn reduces the disease's transmission[199]. Immunity can be achieved through natural infection or vaccination, with vaccination being the preferred method due to its safety and ability to prevent severe disease complications. Because there are fewer susceptible hosts, pathogens spread less when a big percentage of a group are immune[200]. As a result, even those infants and immunocompromised people who cannot be immunised, are indirectly protected.

The concept of herd immunity is particularly significant in public health because it provides a way to control or even eliminate infectious diseases. It is absolutely important in breaking the chain of transmission, ultimately lowering the general load of diseases avoidable via vaccinations. This collective protection is vital in preventing outbreaks, especially in densely populated areas where infections can spread rapidly[201].

Historically, herd immunity has contributed to the near-eradication of diseases such as smallpox and polio. Before the development of vaccines, outbreaks of infectious diseases were common, often leading to high mortality rates, particularly among children[202]. However, with the

introduction and widespread use of vaccines, the incidence of these diseases has significantly declined, demonstrating the power of herd immunity in disease prevention[201].

Another critical aspect of herd immunity is its role in reducing healthcare costs. When vaccine coverage is high, the number of disease cases decreases, leading to lower hospitalisations and treatment costs. This relieves the strain on healthcare systems and allows resources to be allocated to other pressing health issues[201]. Furthermore, the indirect protection provided by herd immunity helps prevent long-term complications associated with certain infectious diseases, such as neurological damage caused by measles or liver disease resulting from hepatitis B infection[203].

**Thresholds for Different Diseases**

Only when a particular percentage of the population is immune to a disease will herd immunity be useful. The characteristics of the disease determine this fraction, sometimes referred to as the herd immunity threshold; especially, its basic reproduction number ($R_0$)204 influences it. $R_0$ is the average secondary infection count in a completely susceptible population produced by one sick person. The $R_0$ will be higher, the greater the proportion of individuals that must be immune to achieve herd immunity[204].

Below are some examples of herd immunity thresholds for various infectious diseases:

Measles ($R_0$ : 12-18) – Requires approximately 95% immunity to prevent outbreaks. Measles is one of the most contagious diseases, spreading through airborne droplets, making high vaccine coverage essential for controlling its spread[205].

Pertussis (Whooping Cough) ($R_0$ : 12-17) – Requires around 92-94% immunity. Pertussis is highly contagious, and immunity from the vaccine wanes over time, necessitating booster doses[206].

Polio ($R_0$ : 5-7) – Requires about 80-86% immunity to prevent outbreaks. Through global vaccination campaigns, wild poliovirus transmission has been significantly reduced[207].

Mumps ($R_0$ : 4-7) – Requires around 75-86% immunity. The mumps vaccine, part of the MMR (measles, mumps, rubella) vaccine, has helped control outbreaks[208].

Diphtheria ($R_0$ : 5-7) – Requires 80-85% immunity. Vaccination has been instrumental in reducing diphtheria cases worldwide[209].

COVID-19 ($R_0$ : 2-5, depending on variant) – Requires varying levels of immunity, often estimated at 60-80%, though emerging variants may shift these numbers. Vaccination campaigns globally aimed to achieve this threshold to curb the spread[210].

Achieving and maintaining these thresholds requires ongoing vaccination efforts. Even in regions where diseases have been largely eliminated, a drop in vaccine coverage can lead to outbreaks, as seen with the resurgence of measles in some countries due to declining immunisation rates[211].

**Herd Immunity and Childhood Vaccination**

Herd immunity is particularly relevant in the context of childhood vaccination, as many vaccine-preventable diseases primarily affect children. Because of their developing immune systems, infants and young children are among the most susceptible to diseases; so, high vaccination rates are absolutely necessary to safeguard this age group[201].

Routine childhood immunisation schedules are designed to provide early and long-term protection against diseases including polio, diphtheria, pertussis, measles, mumps, and hepatitis B. These vaccines safeguard the immunised youngster and enhance herd immunity, hence diminishing disease transmission within the community[6].

One of the most well-documented examples of herd immunity benefiting children is the elimination of polio in many countries. Through mass immunisation campaigns, polio transmission has been interrupted, leading to global eradication efforts. Even children who did not receive the vaccine benefited from herd immunity as transmission chains were broken[207].

Measles is another example where herd immunity plays a vital role. Before the widespread use of the measles vaccine, nearly every child contracted the disease, resulting in high morbidity and mortality rates. However, with vaccination coverage reaching the necessary threshold, measles cases declined significantly. In countries where vaccine coverage dropped, outbreaks re-emerged, emphasizing the necessity of maintaining herd immunity[212].

Another critical aspect of childhood vaccination and herd immunity is the protection of immunocompromised children. Some children are inaccessible to certain vaccinations necessitated by medical conditions such as cancer, HIV/AIDS, or congenital immune disorders[213]. These children rely on herd immunity for protection, as they are at higher risk of severe complications if exposed to vaccine-preventable diseases. For example, children undergoing chemotherapy cannot receive live vaccines, making community-wide immunisation crucial to their safety[214].

### 2.1.9 Vaccine Hesitancy and Its Implications

Vaccine hesitancy denotes the unwillingness or refusal to accept vaccinations notwithstanding their accessibility. The phenomena is intricate, shaped by various reasons such as misinformation, scepticism towards health authorities, religious and cultural convictions, and apprehension regarding side effects[215]. Vaccine hesitancy is a significant public health concern because it weakens herd immunity and increases the risk of vaccine-preventable disease outbreaks. The World Health Organisation (WHO) has recognised vaccine hesitancy as one of

the ten foremost global health challenges, highlighting its influence on disease preventive and control initiatives globally. The World Health Organisation (WHO) has recognised vaccine hesitancy as one of the foremost global health issues, highlighting its influence on disease preventive and control initiatives globally[215,216].

Vaccine hesitancy does not have a single cause; rather, it results from a combination of social, psychological, and structural factors. These causes can be broadly categorised into misinformation and disinformation, religious and cultural beliefs, distrust in government and pharmaceutical companies, fear of side effects, complacency, and access barriers[217].

**1. Misinformation and Disinformation**

One of the most significant drivers of vaccination reluctance is misinformation—the spread of false or misleading details regarding vaccines. Social media has played a major role in amplifying misinformation, making it easily accessible to a wide audience. False claims that vaccines cause autism, infertility, or chronic illnesses have led many people to doubt their safety[218]. Some conspiracy theories suggest that vaccines are part of a population control scheme or that they contain harmful substances designed to alter human DNA. Disinformation, which involves the intentional spread of false information to mislead people, further exacerbates vaccine hesitancy. Some anti-vaccine groups and individuals deliberately promote fear and skepticism about vaccines, often for ideological or financial gain[219]. The rapid spread of disinformation during the COVID-19 pandemic illustrates how dangerous misleading narratives can be in influencing public perceptions and behaviors[220].

**2. Religious and Cultural Beliefs**

Religious and cultural influences significantly impact individuals' perceptions of immunisation. In some communities, religious leaders discourage vaccinations, claiming that they interfere with

divine will or that faith alone should provide protection against diseases. Additionally, cultural traditions that prioritise natural or herbal remedies over modern medicine can lead to resistance against vaccines[221].

For example, in Nigeria, past polio vaccination campaigns faced resistance in certain northern states due to rumors that the vaccines contained anti-fertility agents. This misinformation, rooted in distrust and cultural concerns, led to delays in polio eradication efforts in the country[169].

**3. Distrust in Government and Pharmaceutical Companies**

Many individuals refuse vaccines due to a deep-rooted distrust in government institutions and pharmaceutical companies. Historical incidents, such as unethical medical experiments and cases of corruption in the healthcare system, have contributed to skepticism regarding vaccine safety and efficacy[222].

For example, the Tuskegee Syphilis Study, conducted in the United States From 1932 to 1972, there was a deliberate withholding of treatment from African American men with syphilis to investigate the course of the disease. Incidents like this have left lasting distrust in medical research and public health initiatives, particularly among marginalised populations[223].

Similarly, concerns about pharmaceutical companies prioritizing profit over public health have fueled vaccine hesitancy. Some people believe that vaccines are rushed through development without adequate testing or that companies conceal potential side effects for financial gain[224]. This skepticism was evident during the COVID-19 vaccine rollout, where some individuals feared that the rapid development of vaccines meant they were unsafe.

**4. Fear of Side Effects**

Concerns about vaccine side effects are a common reason for vaccine hesitancy. While vaccines are extensively tested for safety and efficacy, minor side effects Symptoms such as fever,

tiredness, and localised discomfort at the injection site are prevalent[225]. In rare cases, vaccines can cause severe allergic reactions or other complications, which are often magnified by media coverage and social media discussions[218].

For instance, reports of blood clotting linked to certain COVID-19 vaccines led to widespread fear and reluctance, despite the extremely low risk compared to the dangers of COVID-19 itself. When adverse events are highly publicised, they can overshadow the overwhelming benefits of vaccination and discourage people from getting vaccinated[226].

**5. Complacency and Low Perceived Risk**

When vaccine-preventable diseases become rare due to high immunisation coverage, people may perceive them as no longer a threat. This false sense of security leads to complacency, where individuals see vaccination as unnecessary[227]. Parents who have never seen cases of measles, polio, or diphtheria in their communities may not feel the urgency to vaccinate their children. However, this complacency can have dangerous consequences, as it reduces vaccination rates and allows diseases to resurge. For example, measles outbreaks have occurred in countries where vaccination rates declined due to complacency and vaccine skepticism[110].

**6. Access and Convenience Barriers**

In some cases, vaccine hesitancy is not due to opposition to vaccines but rather structural barriers that make vaccination difficult[215]. These barriers include:

1. Limited availability of vaccines in rural or hard-to-reach areas.

2. Long wait times at vaccination centers.

3. High indirect costs such as transportation or missed workdays.

4. Lack of awareness about vaccine schedules and locations.

Improving access to vaccines by setting up mobile clinics, offering free transportation, and providing community-based immunisation programs can help address these barriers[215].

**Consequences of Vaccine Hesitancy**

Vaccine reluctance poses significant repercussions for individuals, communities, and healthcare systems. These consequences range from the resurgence of vaccine-preventable diseases to economic burdens and increased healthcare costs[228].

**1. Resurgence of Vaccine-Preventable Diseases:** When vaccination rates decline, diseases that were previously under control can return. For example, measles, which was nearly eliminated in several countries, has made a comeback in areas with low vaccination coverage. In Nigeria, vaccine hesitancy contributed to the prolonged presence of polio before it was officially eradicated in 2020[229]. Diseases prevented by vaccination can result in serious sequelae, including hospitalisation, disability, and death. Infants, elderly individuals, and immunocompromised persons are particularly vulnerable to outbreaks caused by low vaccination rates[230].

**2. Increased Mortality and Morbidity:** Unvaccinated individuals are more likely to contract and suffer severe outcomes from vaccine-preventable diseases. For example, unvaccinated Individuals infected with COVID-19 faced a markedly elevated risk of hospitalisation and death compared to those who received the vaccine. The same pattern applies to diseases such as influenza, tetanus, and pertussis (whooping cough)[231].

**3. Economic Burden on Healthcare Systems:** Vaccine-preventable disease outbreaks place immense strain on healthcare systems, leading to increased medical expenses, hospital overcrowding, and diversion of resources from other critical health services. Governments spend significant amounts of money on outbreak response, including hospitalisation costs, treatment, and emergency vaccination campaigns[232]. During the COVID-19 pandemic, nations with poor

vaccination rates encountered elevated inpatient rates, resulting in shortages of intensive care unit (ICU) beds, ventilators, and medical personnel. The financial burden of treating severe COVID-19 cases far exceeded the cost of preventive vaccination programs[233].

**4. Impact on Herd Immunity:** Herd immunity transpires when a substantial proportion of the population is immunised, reducing the spread of infectious diseases and protecting those who cannot be vaccinated due to medical reasons. Vaccine hesitancy undermines herd immunity, putting entire communities at risk[201]. For example, if a significant number of people refuse measles vaccination, the virus can spread rapidly, endangering children those who are too young to receive the vaccine and those with compromised immune systems. This weakens overall public health and increases the likelihood of disease outbreaks[26].

## 2.2 Theoretical Framework

### 2.2.1 Anderson Behavioural Model

In order to investigate the hypothesis of health care access inequity in the US, this study utilised the Andersen behavioural model for health care utilisation. Some populations, including ethnic minorities and those residing in urban and rural areas, are disproportionately underserved by the health care system; this model seeks to rectify this[138].

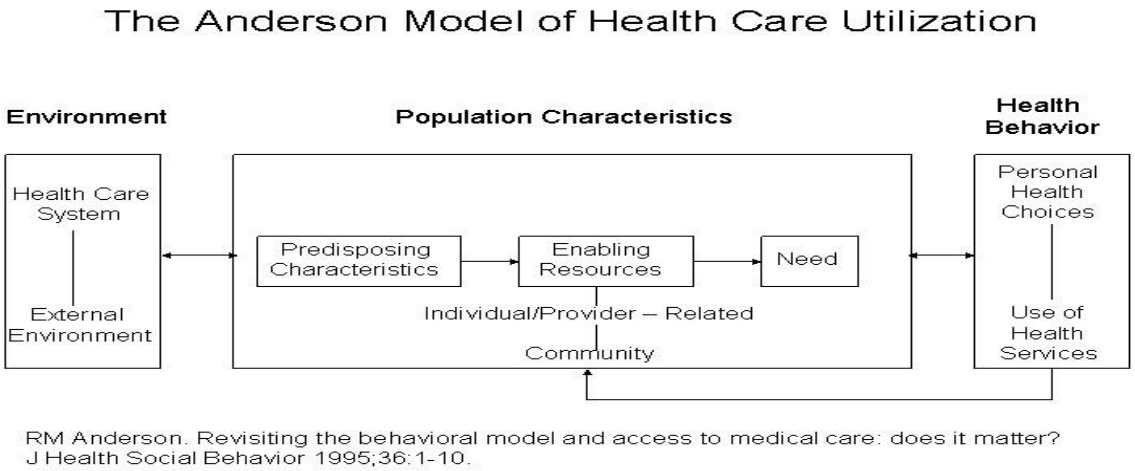


**Figure 2.3 Andersen model of health care utilisation**

More than four decades after its launch, the Andersen model is still going strong as a framework for predicting future healthcare spending. The Andersen model is founded on predisposing factors, enabling factors, and need factors, and has demonstrated significant utility in forecasting worldwide health care service utilisation[234]. The facilitating variables are the bio-socio-demographic traits of persons that precede their sickness. In this study, social structures (education, occupation, ethnicity, social networks, social interactions, and culture), health beliefs (attitudes, values, and knowledge) about the health care system, and demographic factors (age and gender) may predispose parents or carers to use or not use health care services, including RI services, affecting the RI schedule[235].

The Andersen model identifies community-level predisposing factors that influence health service utilisation. Community-level impacts include demographics, morals, culture, and politics. The cultural traits of men and women within a civilisation encompass the traditional behaviors associated with each gender in that community, tribe, or religion, which influence parental attitudes about reproductive health and the utilisation of health care overall. Parents or mothers

possessing a comprehensive understanding, along with favorable attitudes and behaviors towards the utility and effectiveness of healthcare services or RI, are anticipated to be more inclined to utilise these services[138].

Enabling factors relate to the ability of individuals and communities to access services, encompassing health insurance, personal income from salaries or other sources, the quality and breadth of social networks, and the availability of health resources in particular geographical locations. Factors of need are established through either perceived or evaluated necessity. Perceived need is influenced by individuals' evaluations of their overall health and functional status, along with their previous experiences with illnesses. The perceived need acts as the standard for assessing the significance of symptoms in relation to the decision to pursue expert assistance. The assessed need is established through medical investigations, including laboratory and clinical evaluations performed by the examining physician to identify the health requirements of the individual patient. The investigation employed perceived need due to the lack of evaluated need data from the source[138].

The Andersen model is particularly suitable for this study as it examines societal aspects and characteristics across multiple levels and their influence on individuals' and communities' access to health care services, including RI services. These factors affect the behaviour of parents and carers regarding adherence to immunisation schedules. The 2013 NDHS included questions regarding culturally sensitive factors influencing the use of immunisation and other healthcare services. The survey results provided important insights into the cultural factors influencing carers' and parents' access to and use of immunisation and other health services across different socioeconomic, religious, and tribal groups in a diverse nation like Nigeria[130].

The theoretical framework of the Andersen model examines the impact of socioeconomic and demographic characteristics on the access to and consumption of immunisation and other health treatments, whether beneficially or detrimentally. The Andersen model was a highly suitable choice for examining the research issues addressed in this study. This study produced data that enhance understanding of the factors affecting carers' and parents' ability to adhere to immunisation schedules for their children, thus assisting communities in developing effective local interventions to improve compliance with these schedules.

**2.4 Health Belief Model**

The Health Belief Model (HBM) is a psychological framework that explains health behaviours through individual beliefs regarding disease risk and the benefits of preventive measures. The model consists of six fundamental components: perceived vulnerability, perceived severity, perceived advantages, perceived barriers, cues to action, and self-efficacy. In the context of childhood immunisation rates among mothers of children under five in Ajeromi-Ifelodun Local Government Area, Lagos State, each component of the model influences maternal decisions regarding vaccination[237].

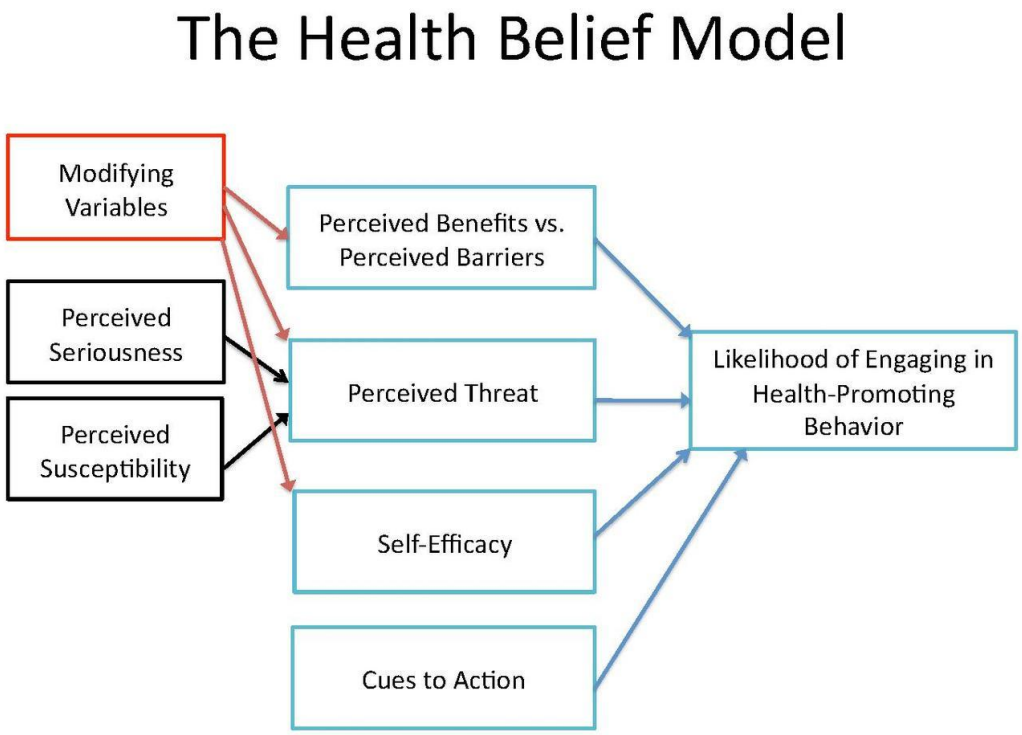


**Figure 2.4 Health Belief Model**

**Source:** Urich[162]

**Perceived Susceptibility:** This pertains to a mother's perception regarding the probability of her child acquiring vaccine-preventable diseases. Some mothers may recognise that their children are at high risk of infections such as measles, polio, and tuberculosis, making them more likely to seek immunisation services[236]. However, others may underestimate these risks due to a lack of awareness, previous experiences, or misinformation, leading to vaccine hesitancy. In Ajeromi-Ifelodun, factors such as educational background, cultural beliefs, and past interactions with the healthcare system may influence these perceptions.

**Perceived Severity:** Perceived severity relates to how serious a mother believes the consequences of vaccine-preventable diseases could be for her child. If a mother understands that diseases like diphtheria, tetanus, and pertussis can result in severe complications, disability, or death, she is more likely to ensure her child receives vaccinations[236]. However, if she perceives these diseases as mild or non-threatening, she may delay or avoid immunisation. In Ajeromi-Ifelodun, some mothers may have limited exposure to cases of severe childhood illnesses, which may affect their urgency in seeking vaccinations.

**Perceived Benefits:** Considered advantages relate to a mother's belief in the effectiveness of vaccines in protecting her child from diseases. Mothers who understand that immunisation reduces the risk of infections and long-term health complications are more likely to follow vaccination schedules. However, misconceptions about vaccine effectiveness or concerns about potential side effects may cause some mothers to question its necessity. In Ajeromi-Ifelodun, social networks, past experiences, and health education efforts play a role in shaping these beliefs.

**Perceived Barriers:** Perceived barriers are the challenges that may discourage mothers from taking their children for immunisation. These barriers could include:

1. Physical barriers such as long distances to health facilities and transportation costs.
2. Institutional barriers such as long waiting times and unavailability of vaccines at health centers.
3. Psychological obstacles including mistrust of medical professionals or anxiety about ill effects from vaccines

4. Social barriers such as negative influence from family members, cultural beliefs, or misinformation spread through social media.

In Ajeromi-Ifelodun, factors like economic status, access to healthcare, and community norms can significantly impact perceived barriers to immunisation.

**Cues to Action:** Cues to action are external or internal factors that prompt a mother to take her child for immunisation[236]. These may include:

- Reminders from healthcare workers.
- Community campaigns and public health announcements.
- Personal experiences or knowledge of a child who suffered from a vaccine-preventable disease.
- Encouragement from family members or peers.

In Ajeromi-Ifelodun, sources of cues to action may include local healthcare facilities, traditional and religious leaders, radio and television messages, and text message reminders.

**Self-Efficacy:** Mothers' self-efficacy is their belief in their abilities to make her child completes the immunisation schedule. A mother with high self-efficacy is more likely to overcome barriers and follow through with vaccination appointments[236]. This can be influenced by:

- Access to reliable health information.
- Encouragement from healthcare providers.
- Positive past experiences with immunisation services.
- Support from family and community members.

Mothers in Ajeromi-Ifelodun with high self-efficacy are more likely to navigate logistical and social challenges to ensure their children are fully vaccinated.

The Health Belief Model provides a structured approach to understanding the factors influencing childhood immunisation uptake in Ajeromi-Ifelodun. Each component highlights different aspects of maternal decision-making regarding vaccination. By analyzing how these factors interact, the study can identify key barriers and motivators affecting immunisation behaviours among mothers in the area. This framework helps explain why some mothers ensure their children are vaccinated while others do not, providing valuable insights for public health initiatives aiming to improve immunisation rates.

**2.5 Theory of Planned Behaviour**

The psychological model Theory of Planned Behaviour (TPB) explains how intentions affect behaviour. It states that attitude, subjective norms, and perceived behavioural control influence behaviour. These elements determine an individual's intention to engage in a behavior, which then affects actual behavior[238]. On childhood immunisation uptake among mothers of under-5s in Ajeromi-Ifelodun Local Government Area, Lagos State, each component of the TPB plays a critical role in shaping maternal decisions regarding vaccination.

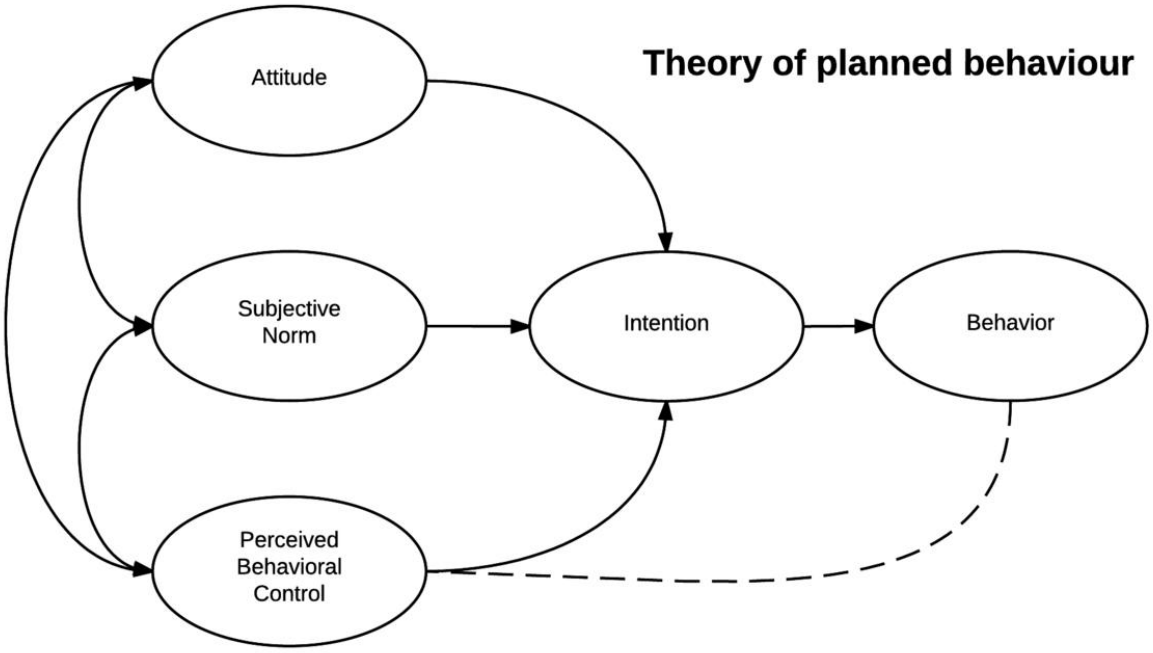


**Figure 2.5 Theory of Planned Behaviour**

**Source:** Ajzen[238]

**Attitude Toward the Behaviour:** This refers to a mother's overall evaluation of childhood immunisation, including her beliefs about the benefits and drawbacks of vaccinating her child. If a mother perceives immunisation as beneficial in preventing diseases, ensuring child survival, and promoting long-term health, she is more likely to have a positive attitude and follow through with the immunisation schedule. Conversely, if she harbors negative beliefs—such as concerns about vaccine side effects, fear of adverse reactions, or doubts about vaccine efficacy—she may develop a negative attitude toward immunisation and hesitate to vaccinate her child[238,239].

In Ajeromi-Ifelodun, attitudes toward immunisation may be influenced by a mother's education level, personal experiences, and exposure to misinformation. Some mothers may have encountered stories of children experiencing fever or swelling after vaccination, reinforcing

hesitancy. Others may have observed the positive effects of vaccination in preventing diseases such as measles and polio, strengthening their favorable attitudes toward immunisation.

**Subjective Norms:** Subjective norms denote the felt societal pressure to either partake in or refrain from an activity. A mother's choice to vaccinate her kid is frequently shaped by societal expectations and opinions of people around her, including family members, healthcare providers, religious leaders, and community members[240]. If influential figures in her life support immunisation and encourage her to vaccinate her child, she is more likely to comply. However, if she is surrounded by individuals who discourage vaccination due to cultural beliefs, religious views, or conspiracy theories, she may be hesitant to follow through with the immunisation schedule[241].

In Ajeromi-Ifelodun, subjective norms can be shaped by local traditions, peer influence, and religious leaders' stance on immunisation. Some communities may have strong pro-vaccine advocacy, where mothers feel a collective responsibility to ensure children are vaccinated. In contrast, other communities may have resistance due to misconceptions or past experiences with failed vaccination campaigns. Social media's involvement in disseminating vaccine misinformation also influences the formation of subjective norms, as mothers encounter contradictory messages regarding immunisation.

**Perceived Behavioral Control:** Perceived behavioural control describes the degree to which a mother feels she has the ability and resources to get her child vaccinated. This includes factors such as access to healthcare facilities, financial ability to cover transportation costs, time availability, and confidence in navigating the immunisation process. Mothers who feel they have control over the situation are more likely to ensure their child receives all necessary vaccinations, whereas those who perceive significant obstacles may delay or forgo immunisation[110,238].

In Ajeromi-Ifelodun, perceived behavioural control can be influenced by multiple factors. Some mothers may live close to health centers, have supportive partners, and receive reminders from healthcare workers, which increase their sense of control over the immunisation process. Others may face obstacles including great distances to medical facilities, financial constraints, unavailability of vaccines at health centers, and work-related time constraints, making it difficult to follow through with vaccination appointments. Additionally, negative past experiences, such as encountering rude healthcare workers or prolonged waiting times at immunisation clinics, may lower a mother's confidence in accessing services.

**Intention to Vaccinate and Actual Behaviour:** According to the TPB, the combination of attitude, subjective norms, and perceived behavioural control influences a mother's intention to vaccinate her child. A mother who has a positive attitude toward immunisation, strong social support, and a high level of perceived control is more likely to form a strong intention to vaccinate, which increases the likelihood of actual immunisation uptake. However, if any of these factors weaken her intention, she may delay or skip vaccinations[242].

In Ajeromi-Ifelodun, some mothers may have the intention to vaccinate but may not follow through due to unforeseen barriers, such as lack of time, transportation issues, or vaccine stockouts at health centers. Others may have low initial intention but eventually decide to vaccinate due to external influences, such as community outreach programs, media campaigns, or advice from a trusted healthcare provider.



## 2.6 Review of Empirical Studies

### 2.6.1 Prevalence of completion of childhood Immunisation among mothers of five

Vaccine-preventable diseases provide a significant issue in many developing nations, particularly in sub-Saharan Africa, where they constitute 25% of infant mortality. Notwithstanding robust vaccination initiatives, immunisation rates for Polio, DPT, and Measles continue to be inadequate in most sub-Saharan nations, including Kenya and Zambia[140,141,142]. Uganda is similarly affected, with child mortality from preventable diseases observable in several regions, including the divisions Karamoja, Bundibugyo, Nebbi, Yumbe, Katakwi, Moyo, Kiboga, Kamuli, Mubende, Kalangala, Kaberamaido, Bulisa, and Kawempe. From 88 deaths per 1,000 live births in 2000 to 90 deaths per 1,000 live births in 2005, Uganda's infant mortality rate grew worse. Children's main cause of death was immunisable childhood diseases. Some more resulted from prenatal and early neonatal disorders, malaria, meningitis, pneumonia, and HIV/AIDS[144].

Findings from a study in Ekiti State, Nigeria revealed that a majority of the mothers (72.3%) demonstrated a high level of compliance, having obtained between 9 and 12 (70–100%) of the appropriate immunisations for their children. Additionally, 19.7% of the mothers had a moderate level of compliance, securing between 6 and 8 (50–69%) of the necessary immunisations. Conversely, 8% of the participants had a low level of compliance, completing less than 50% (0–5) of the recommended immunisations for their children[243]. Similarly, findings from another study in central Ethiopia found that only 35.6% of children aged 12–23 months had completed all the recommended vaccines. This figure was obtained through vaccination card records and maternal recall, highlighting a gap in full immunisation coverage. Additionally, 40.7% of children received at least one vaccine but did not complete the full schedule, while 23.7% had never received any vaccination. This inadequate coverage points to a major obstacle in guaranteeing that children fully benefit from immunisation campaigns. The data further showed

that measles vaccine had lower coverage, with only 29.9% of children receiving it through card verification. Furthermore, the drop-out rate from BCG to measles vaccination was 22.2%, demonstrating a decline in immunisation uptake as children progressed through the vaccination schedule[149].

Findings from another study in Northwest Ethiopia revealed that 64.3% (95% CI: 60.9–67.6%) were entirely immunised, whereas only 31.9% (95% CI: 28.7–35.3%) completed their immunisation on time. Despite a high reported attendance of 89.5% to vaccination schedules based on mothers recall, objective assessment from vaccination cards and registers showed a lower full attendance rate of 72.1%. The study further highlighted vaccine-specific coverage, with a decline in completion rates from Penta I (95.5%) to Penta III (83.2%) and measles vaccine (76.2%). Additionally, the drop-out rate from Pentavalent to measles vaccination was 20.1%, indicating significant gaps in completion[244].

Findings from a systematic review revealed that that immunisation coverage remains suboptimal despite extensive vaccination campaigns[245]. The prevalence of full immunisation completion among children under five ranged significantly, with some studies reporting rates as low as 30% and others showing coverage of over 80%, depending on geographical location, healthcare access, and socioeconomic factors. The review indicated that while certain countries, such as Ethiopia, recorded higher immunisation completion rates in some regions, Nigeria consistently demonstrated lower rates of completion, attributed to factors such as maternal education, place of residence, and healthcare access[245]. A study in Nigeria reported that only 57% of children received all recommended vaccines by the age of five, highlighting gaps in immunisation coverage. The review further indicated that within some communities, a significant proportion of mothers initiated childhood immunisation but did not complete the schedule[245]. This drop-off

was influenced by elements like vaccine stockouts, extended travel distances to healthcare facilities, and maternal perceptions of vaccine safety. Similarly, in Kenya and Uganda, the completion rate fluctuated between 40% and 75%, depending on urban or rural residence, access to healthcare, and level of maternal education. The findings emphasise that despite the efforts of Expanded Programme on Immunisation (EPI) initiatives, there remains a substantial proportion of children who do not complete their full immunisation schedule before the age of five, leaving them vulnerable to vaccine-preventable diseases[245].

Findings from a multi-level analysis revealed that the overall prevalence of Vaccination of infants aged 12–23 months in East Africa to ensure they receive the basic childhood vaccine was 69.21% (95% CI: 69.20, 69.21%). This figure, however, varied significantly among the countries studied. The highest completion rate was observed in Burundi, where 85% of children had received the full schedule of basic childhood vaccinations[246]. Conversely, Ethiopia had the lowest rate, with only 39.5% of children fully immunised. The percentage of infants who were partially vaccinated varied from 13.4% in Zimbabwe to 56.1% in Rwanda, indicating that a substantial number of children did not complete the required immunisation schedule. Similarly, the percentage of children who were entirely unvaccinated ranged from as low as 0.4% in Burundi to as high as 16% in Ethiopia[246]. These disparities highlight the influence of various socio-economic and health system factors on immunisation uptake and completion. Specific vaccine coverage also exhibited significant variation, with Rwanda achieving the highest coverage for BCG (99.1%) and polio 3 (97.1%), while Ethiopia had the lowest coverage for BCG (70.5%) and polio 3 (57.7%). These findings suggest that while overall immunisation rates are relatively high, gaps still exist in achieving complete vaccination coverage, particularly in low-income communities[246].

According to another multilevel analysis, the pooled prevalence of the entire immunisation coverage of children aged 12–23 months in nine SSA countries was 59.40% (95% CI: 58.70, 60.02). However, there were significant variations across countries, with Ghana and Malawi recording the highest full immunisation rates at 77.2%, followed closely by Tanzania at 74.8%. In contrast, Rwanda had the lowest immunisation completion rate at 39%, followed by the Democratic Republic of Congo (40.7%) and Ethiopia (48.6%). These statistics suggest that while a majority of children in some countries complete their immunisation schedules, a substantial proportion still fail to do so, particularly in countries with weaker healthcare infrastructure or barriers to vaccine access[248].

The coverage of specific vaccines also presents a mixed picture. While BCG vaccination coverage was high across SSA, reaching nearly three-quarters of the target population, measles vaccination had the lowest coverage at approximately 70%. This indicates that while initial immunisation efforts are generally successful, follow-through on later vaccines, such as those for measles, remains a challenge. Additionally, polio 1 immunisation coverage exceeded 85%, demonstrating better uptake for some vaccines over others. The observed disparities in full immunisation rates highlight the need for targeted interventions to ensure that children complete the full schedule of recommended vaccines, thereby reducing the burden of vaccine-preventable diseases in SSA[248].

### 2.6.2 Perception of mothers towards childhood immunisation of under five

A multitude of moms regard childhood immunisation as crucial for the prevention of diseases such as measles, polio, and tuberculosis. A favorable opinion markedly affects immunisation uptake, as one study indicated that moms with a positive view of immunisation were 2.6 times tendency to fulfill their ward's immunisation schedule (AOR = 2.60; 95% CI: 1.50, 4.51).

Furthermore, faith in vaccine safety emerged as a critical determinant, as women who trusted vaccination safety were markedly more inclined to have fully immunised children. vaccination hesitation persists, as seen by four studies indicating apprehension regarding vaccination adverse effects (AOR = 1.92; 95% CI: 1.01, 3.70), which has led to inadequate immunisation[245].

Perceived vulnerability to vaccine-preventable diseases also affected uptake, since some mothers underestimated the probability of their children developing illnesses such as polio or diphtheria. This attitude was especially prevalent among moms in rural regions with little access to healthcare education. Moreover, the perceived severity of these diseases differed, with certain mothers believing that natural immunity was adequate to safeguard their children, thereby diminishing their propensity to comply with immunisation schedules. Mothers who comprehended the seriousness of vaccine-preventable diseases were markedly more inclined to guarantee their children adhered to the immunisation schedule ($p = 0.045$)[245].

Furthermore, the perceived advantages of immunisation influenced decision-making, with three studies indicating that moms who acknowledged the long-term health benefits of vaccines were 5.51 times more likely to fulfill their child's immunisation schedule (AOR = 5.51; 95% CI: 1.52, 19.94). These data indicate that health education programs aimed at enhancing maternal understanding of the dangers of vaccine-preventable diseases and emphasizing the advantages of immunisation could elevate uptake and completion rates[245].



### 2.6.3 Factors Associated with the Uptake and Completion of Immunisation

**Education Level of Parents/Mothers**

Studies show that the most important and consistent factor determining a child's immunisation status is mother education. Research indicates that female education enhances child survival due to increased awareness of the benefits of childhood immunisation. Education is likely to enhance receptivity to novel concepts and services, as well as increase social confidence in interactions with healthcare professionals. Moreover, education may augment the capacity and inclination to traverse distances in pursuit of healthcare treatments[151].

Furthermore, studies carried out in several Nigerian and other African countries show that immunisation coverage is independently influenced by sufficient mother knowledge about routine immunisation. Research done in Bungudu LGA of Zamfara State found that a mother's decision to appropriately immunise her kid is favourably influenced by her awareness of the benefits and schedules of regular immunisation programs. This result is consistent with the Ethiopian research showing that low coverage results from ignorance about immunisation. Children of moms who know the starting and finishing ages for vaccinations are more likely to follow their immunisation schedule than those whose mothers are ignorant of normal immunisation campaigns. 147.

Parental/mother Attainment in Education Maternal education was found to be a major determinant of immunisation coverage in a peri-urban area of Kenya investigated for this purpose among children aged 12 to 23 months. Similar studies in Bungudu LGA of Zamfara State, Nigeria, a study on correlates of complete immunisation in East African countries, and research in Uganda on factors influencing childhood immunisation indicated that possessing at least a secondary education remained a singular independent determinant of full immunisation coverage. A study in Angola also looked at elements related to children under five years of age's immunisation coverage. The results ran counter to another study done in Ambo Woreda, Central

Ethiopia, showing that children aged 12 to 23 months' immunisation completion had no discernible link with mother educational level[149].

In Kaptembwo, the percentage of totally immunised children whose mothers or guardians had reached secondary education or above was 81.6%, higher than the 76.7% of those whose mothers or guardians had completed elementary education and the 42.9% of those without any official education. 141. Previous studies have found a clear relationship between immunisation coverage and living in areas with high degrees of mother or guardian education. The literature links mother educational attainment to complete immunisation coverage by means of links between attitudes, customs, and beliefs as well as enhanced autonomy and control over household resources, so fostering health care use and demand for childhood immunisation148. Higher education also improves individuals's access to resources, knowledge, and the capacity to interact with professionals and healthcare providers as well as increases parental awareness, especially in relation to health concerns. On the other hand, people from less educated groups, marked by limited social inclusion, can lack basic knowledge, which raises the possibility of non-compliance with vaccination campaigns[150].

Another study's findings indicated a positive correlation between mothers' educational achievement and compliance levels. Specifically, 76.8% of moms with tertiary education completed the requisite vaccines for their children, as contrast to 50% of those with no formal education, 62.5% with primary education, and 62% with secondary education. Statistical investigation revealed that a one-unit enhancement in maternal educational status led to a 16.9% rise in compliance levels243. The understanding of mothers concerning immunisation was another essential aspect. The research indicated that a one-unit augmentation in understanding resulted in a 24.3% enhancement in adherence to immunisation schedules. This highlights the

significance of awareness and comprehension of immunisation advantages in achieving elevated compliance rates[243].

**Role of Maternal Age and Parity, Child's Sex, and Birth Order in Completion of Immunisation Schedule**

Along with a similar study on factors influencing acceptance of complete immunisation coverage for children under five years in rural Bangladesh, a study looking at mother determinants of immunisation status in children aged 12 to 23 months in urban slums of Varanasi, India, found mother age, employment status, education, and parity as the main factors influencing complete immunisation status[154,160].

Studies showed that mothers with lower parity were more likely than those with higher parity to have fully immunised children; these women might lack the self-motivation to take care of their most recent child. According to studies done in rural Bangladesh, mother age is statistically relevant and middle-aged moms are more likely than older women to make sure their children have all recommended vaccinations. This could be explained by their continuous message on the value of immunisation programs and combined knowledge of modern medicine[154].

The study revealed that gender discrimination influences immunisation coverage, indicating that male children are more frequently fully immunised than female children. Additionally, moms who had the TT injection were identified as important predictors of full immunisation coverage for their children. Unlike the results of the above stated research, a study looking at elements affecting vaccination coverage in children under five years old in Angola found no gender differences in immunisation rates. This corresponds with a 2006 study on elements related with inadequate basic vaccination programs carried out in São Luís, MA, Northeastern Brazil. These studies looked at similar problems in areas outside Nigeria; however, it is crucial to understand

how these factors affect the completion of immunisation campaigns, especially in North West Nigeria, where health indices are worse than in other Nigerian areas.

**Attitudes, Motivation, Performance, and Competence of Health Staff**

Even after starting the process, in Ethiopia, Zimbabwe, Niger, Kenya, Bangladesh, West Africa, Uganda, Benin, Nigeria, and Syria, healthcare professionals who interacted with mothers in an unfavourable, disrespectful, and occasionally abusive manner were found to be linked with the mothers' refusal to bring their children for vaccinations or to return for the completion of vaccination schedules. Many reports surfaced of doctors chastising women for missing planned visits, failing to present their children's immunisation record cards, or for their children showing signs of hunger or wearing dirty clothes[161].

**Distance of Parents/Mothers from RI-Providing Facilities**

The distance from a health center is a significant predictor of complete immunisation, as it affects access to the services provided there. Studies indicate that mothers residing within a one-kilometer radius of a health facility offering routine immunisation Services are more likely to adequately immunise their children than those living in places lacking surrounding medical facilities offering such services[154].

Comparable research in underdeveloped nations indicates that walking or travel time and distance are critical determinants affecting the utilisation of healthcare services[154]. Long walking distances and long waiting times at the facility are major determinants of poor completion of RI schedules, according to a study on the causes for incomplete immunisation and elements for missed chances among rural children in Awe LGA of Nasarawa state Nigeria[153].

Notwithstanding the aforementioned findings, there remain deficiencies in the literature concerning the North West region of this country; the studies conducted do not adequately

represent this area. Although Abdul Raheem's research pertains to the North Central region, which may exhibit certain similarities to the North West, its applicability is limited to Nasarawa State and cannot be generalised to the broader Nigerian population due to insufficient representativeness. The NDHS 2013 data is highly representative, possessing a sufficient sample size and randomisation to allow for generalisation across all states; thus, this study is necessary to address the existing gap in the literature.

**Role of Religious/Ethnic Affiliation of Parents/Mothers in Completion of RI Schedules**

Many books and papers and investigations examine the effect of religious affiliations of mothers or carers on the completion of regular immunisation schedules for their children before their first birthday. Many studies were conducted outside of Nigeria or in the southern part, leading to the northern region—including the North West—having either little or no expertise on the subject matter.

With other personal characteristics of women, religious affiliation and ethnic origin were statistically linked with the complete immunisation status of their children, according a study done in Ojo Local Government Area, Lagos State, Nigeria. The results matched studies on the impact of mother and provider traits on the present immunisation status of children aged 19 to 35 months among Hispanics, attributed by their strong cultural focus on child welfare, which increases their awareness of preventive care and results in higher immunisation coverage[156].

**The function of women's autonomy in completing an immunisation schedule**

Many academics define women's autonomy as a woman's capacity to make autonomous decisions about her family, which affect either her children or herself free from family interference. The word autonomy is always related with volitional control and empowerment[157].

Many studies have also documented related ideas of women's autonomy. Bharati defined autonomy as the chance for women to pursue education and work outside the house. He also cited Miles-Doan, whose definition of autonomy as a woman's position within home power relations especially related to her negotiating ability[157].

He defined autonomy as the ability to manage domestic and societal resources. He ultimately cited Jejeeboy and Sathar, who elucidated that autonomy is composed of five interrelated components: acquired knowledge or experience; decision-making authority; physical autonomy, which includes the ability to move freely without seeking permission based on necessity; emotional independence; and economic and social sovereignty, which includes the right to manipulate and utilise resources. Fifty-seven. Researchers have been motivated to investigate the influence of women's autonomy on their own health and the health of their offspring as a result of the convergence of definitions and concepts[157].

A study evaluated the impact of women's autonomy on the nutritional and immunisation status of their offspring by evaluating the decision-making power of women in relation to four primary parameters: personal healthcare decisions, significant household purchases, visiting relatives or friends, and the allocation of their husband's earnings[157].

The decision-making controls are directly or indirectly linked to the household's socioeconomic attributes and the societal cultural conditions, aligning with analogous findings from a study conducted in India and Nepal[157]. This study revealed that the percentage of women engaging in autonomous decision-making is significantly lower than that of joint decision-making with their husbands, while the proportion of Indian women unable to make any decisions alone is notably high. Urban women possess greater decision-making authority than their rural counterparts, while literate women have more autonomy than illiterate women; nevertheless, in terms of

utilizing their husband's finances, illiterate women exhibit nearly double the autonomy of their more educated peers[157].

The results of Bharati's research on the impact of women's autonomy on child health fit those of another study on women's decision-making and child health carried out in India and Nepal. Women's autonomy improves their use of emergency and preventive healthcare services, including children's immunisations, and can also influence women with less decision-making power according to familial and social hierarchies. Not even ladies in positions of power may experience a significant reduction in their authority when residing in areas where women possess limited decision-making capabilities. Consequently, physicians may decline to treat emergency patients solely based on the decisions of women in a predominantly male-dominated society[157].

According to a study in Central Ethiopia, maternal knowledge, antenatal care (ANC) attendance, and maternal tetanus toxoid (TT) immunisation were significant determinants. Mothers who knew that vaccination prevents diseases were more likely to have fully immunised children (OR: 4.5, 95% CI: 2.5-7.9)[149]. Additionally, knowledge of the age at which immunisation begins (OR: 5.9, 95% CI: 3.9-8.7) and ends (OR: 10, 95% CI: 5.7-17.7) strongly predicted full immunisation uptake. Furthermore, ANC follow-up during pregnancy was a critical factor, as mothers who attended ANC were nearly seven times more likely to have their children fully vaccinated (OR: 6.8, 95% CI: 4.0-10)[149]. Tetanus toxoid immunisation during pregnancy was also associated with higher immunisation rates among children (OR: 4.9, 95% CI: 3.1-7.7). In multivariate analysis, ANC follow-up (AOR: 2.4, 95% CI: 1.2-4.9) and knowledge of when to start (AOR: 2.9, 95% CI: 1.9-4.6) and complete immunisation (AOR: 4.3, 95% CI: 2.3-8) remained significant predictors of full immunisation. These findings suggest that maternal education, healthcare access, and prenatal care interventions can improve childhood immunisation uptake and

completion rates[149]. Findings from another study revealed that socioeconomic status, maternal healthcare utilisation, and accessibility of vaccination services are among the strongest determinants[244]. The study in northwest Ethiopia found that mothers from the richest households were 2.4 times more likely than those from the poorest homes to have their child vaccinated on schedule (AOR = 2.381; 95% CI: 1.502–3.773). Additionally, maternal healthcare utilisation, particularly antenatal and postnatal care attendance, was significantly associated with vaccination completion. Mothers who attended at least the four prenatal appointments were 2.8 times more likely to fully vaccinate their child on time (AOR = 2.844; 95% CI: 1.310–6.174), while those who had at least two postnatal care (PNC) visits had twice the likelihood of completing immunisation (AOR = 2.054; 95% CI: 1.377–3.063)[244].

Access to vaccination sites also played a crucial role in immunisation completion. Mothers who had to travel more than 30 minutes to a vaccination centre were 84% Vaccination rates were lower among parents who lived more than 15 minutes away from the clinic (AOR = 0.158; 95% CI: 0.033–0.739). Furthermore, the place of vaccination influenced adherence, with children vaccinated at health posts being 86% less likely to complete vaccination on time than those vaccinated in hospitals (AOR = 0.144; 95% CI: 0.048–0.428)[244].

Findings from a systematic review revealed that modifiable factors such as maternal healthcare engagement significantly impact immunisation completion. Studies reported that place of delivery was a crucial determinant, as children born in healthcare facilities were 2.11 to 3.13 compared to babies born in a hospital, they are four times more likely to finish all of their vaccines (AOR = 2.11–3.13; 95% CI: 1.09, 7.13). Similarly, postnatal care follow-up increased the likelihood of full immunisation (AOR = 1.8–5.8; 95% CI: 1.21, 3.16), while antenatal care attendance was associated with a higher probability of vaccine adherence (AOR = 2.4–3.7; 95%

CI: 1.1, 10.0). Furthermore, maternal tetanus toxoid vaccination was linked to increased immunisation uptake, suggesting that mothers who received vaccinations themselves were more likely to ensure their children were vaccinated (AOR = 2.43–3.2; 95% CI: 1.10, 10.00)[245].

Maternal knowledge also played a crucial role in immunisation uptake. Studies indicated that mothers with adequate knowledge of child immunisation were 3.3 times more likely to complete the schedule (AOR = 3.3; 95% CI: 1.87, 7.43). Similarly, awareness of immunisation programs (AOR = 1.9–2.8; 95% CI: 1.44, 2.49) and understanding of vaccine-preventable diseases (AOR = 2.5; 95% CI: 1.5, 4.2) significantly influenced uptake. Vaccine ignorance, on the other hand, was responsible for 50% of reasons for non-compliance, emphasizing the need for increased public health education[245].

Environmental factors such as religious and cultural beliefs also played a role in immunisation uptake. Religious beliefs were identified as a barrier in some communities, with studies showing that mothers who considered vaccines incompatible with their religious teachings were less likely to vaccinate their children (OR = 1.65; 95% CI: 1.15, 2.36). Cultural beliefs similarly affected vaccine adherence, particularly in communities with traditional healing practices[245].

Non-modifiable factors such as parental socioeconomic status, maternal age, and education level were also found to significantly impact immunisation uptake. Nine studies reported that maternal education was a statistically significant predictor, with higher educational levels increasing the likelihood of full immunisation (AOR = 3.55–7.50; 95% CI: 1.02, 10.60). Similarly, paternal education (AOR = 3.1; 95% CI: 1.3, 7.4) and family income (AOR = 3.2; 95% CI: 1.4, 7.4) influenced vaccine uptake, as wealthier households were more likely to complete immunisation schedules[245].

Another demographic variable was the place of residence; for example, there was a 2.7-fold increase in the completion rate of immunisation among children living in urban areas as compared to those living in rural regions (AOR = 2.70; 95% CI: 1.52, 4.81). Aside from immunisation rates, other factors affecting vaccination completion were travel time, accessibility of vaccination sites, and distance to healthcare services. A substantial decrease in the likelihood of full immunisation was seen among children from nomadic homes (odds ratio of 11.06) (95% CI: 4.29, 28.54), highlighting mobility as a barrier to vaccine access[245].

Findings from a multilevel analysis revealed that factors such as maternal age, education level, media exposure, antenatal care visits, postnatal checkups, place of delivery, birth interval, parity, and household wealth status are significantly associated with childhood immunisation completion[246].

One crucial factor is the age of the mother. Compared to women aged 15-24 years, those aged 25-34 years and those aged ≥35 years are more likely to make sure their children have full vaccinations (AOR = 1.21, 95% CI: 1.10, 1.32) respectively. It can be inferred from this that moms who are older may possess greater knowledge, expertise, or means to adhere to immunisation regimens[246]. Babies whose moms have completed elementary school also have a leg up in life (AOR = 1.26, 95% CI: 1.15, 1.38) and secondary education or higher (AOR = 1.54, 95% CI: 1.36, 1.75) had higher odds of completing vaccination compared to those whose mothers had no formal education. The father's education level also influenced immunisation uptake, indicating that paternal awareness and involvement contribute to childhood vaccination decisions[246].

Media exposure was another significant factor, with mothers who had access to media being 1.23 times (AOR = 1.23, 95% CI: 1.13, 1.33) more likely to complete their child's immunisation.

This underscores the role of public health campaigns in promoting vaccine awareness and countering misinformation. Additionally, antenatal and postnatal healthcare visits were strong predictors of immunisation completion. Mothers who attended one to three antenatal care (ANC) visits (AOR = 3.24, 95% CI: 2.78, 3.77) and four or more visits (AOR = 3.68, 95% CI: 3.17, 4.28) were significantly more likely to ensure full immunisation. Similarly, mothers who had postnatal checkups were 1.34 times (AOR = 1.34, 95% CI: 1.23, 1.47) more likely to complete their child's vaccination[246].

Place of delivery also had an impact on immunisation rates. Mothers who delivered in health facilities were 1.48 times (AOR = 1.48, 95% CI: 1.35, 1.62) more likely to fully immunise their children than those who had home deliveries. This indicates the importance of healthcare interventions and follow-up services in vaccination programs. The timing of births also played a role, with children born at a birth interval of 24–48 months (AOR = 1.28, 95% CI: 1.15, 1.42) and greater than 48 months (AOR = 1.35, 95% CI: 1.21, 1.50) being more likely to receive full immunisation compared to those born less than 24 months apart. This may be due to better maternal readiness and resource availability for child healthcare[246].

Household wealth status significantly influenced immunisation uptake, with children from middle-income households (AOR = 1.16, 95% CI: 1.06, 1.28) and rich households (AOR = 1.20, 95% CI: 1.09, 1.33) being more likely to be fully vaccinated compared to those from poor households. This reflects the role of financial stability in accessing healthcare services. At the community level, children in Burundi (AOR = 4.21, 95% CI: 3.47, 5.11), Kenya (AOR = 1.96, 95% CI: 1.69, 2.27), and Malawi (AOR = 2.08, 95% CI: 1.72, 2.52) had significantly greater probability of full immunisation compared to Ethiopia, highlighting country-specific healthcare policies and infrastructure differences[246].

An additional study found that health education interventions greatly increased vaccination rates, with a relative risk (RR) of 1.36 (95% CI 1.15 to 1.62). There was also a significant uptick in vaccination rates when health workers received training in effective interpersonal communication, with an RR of 5.65 (95% CI 3.62 to 8.83), suggesting that well-informed mothers are more likely to trust and comply with vaccination schedules[247]. Another influential factor is accessibility to immunisation services. Geographic barriers, such as long distances to healthcare facilities, often discourage mothers from completing their children's vaccinations. Community-based interventions, including home visits and immunisation outreach programs, have been shown to improve immunisation rates. Home visits were associated with increased vaccine uptake (RR 1.29, 95% CI 1.15 to 1.45), while immunisation outreach interventions demonstrated an RR of 1.32 (95% CI 1.11 to 1.56). These findings highlight the effectiveness of bringing immunisation services closer to communities, particularly in rural and underserved areas[247].

Socioeconomic factors also play a significant role, as financial constraints can hinder access to immunisation services. While most vaccines are provided free of charge, indirect costs such as transportation expenses and lost wages from taking time off work can pose barriers. Incentive-based programs, including household incentives and performance-based payments, have been explored to improve immunisation rates, although their effectiveness varies[247].

Community engagement is another crucial factor, as involving local leaders and influential figures in immunisation campaigns fosters trust and increases participation. This study also found that community leader involvement, combined with provider interventions, increased vaccine uptake (RR 1.37, 95% CI 1.11 to 1.69). Additionally, integrating immunisation services with other health services, such as malaria prevention programs, was associated with higher

completion rates (RR 1.29, 95% CI 1.16 to 1.44), demonstrating the effectiveness of a holistic approach to healthcare service delivery[247].

Findings from a multilevel analysis revealed that maternal education is a strong predictor of childhood immunisation. Children whose mothers attained secondary school education or higher were 1.38 times more likely to be fully immunised (AOR = 1.38; 95% CI: 1.25, 1.53) compared to those whose mothers had no formal education. Educated mothers are more likely to understand the importance of immunisation, adhere to vaccination schedules, and overcome misinformation. Similarly, paternal education also plays a role, as children born to fathers with secondary education or above had 1.28 times higher odds of being fully immunised (AOR = 1.28; 95% CI: 1.11, 1.48)[248]. Maternal age also influences immunisation uptake. Younger mothers (aged 15–19 years) were more likely to fully immunise their children compared to older mothers aged 35–49 years, who had 0.64 times lower odds of completing childhood immunisation (AOR = 0.64; 95% CI: 0.55, 0.74). This finding suggests that older mothers may either perceive fewer benefits in vaccination due to past experiences or face competing responsibilities that interfere with adherence to immunisation schedules[248].

Marital status is another significant factor, as married mothers were 1.41 times more likely to fully immunise their children (AOR = 1.41; 95% CI: 1.27, 1.56) than those who were single. Married women may receive additional support from their spouses, both financially and in decision-making, which facilitates better healthcare-seeking behavior[248]. Healthcare accessibility plays a critical role in immunisation uptake. Mothers who attended at least four antenatal care (ANC) visits were twice as likely (AOR = 2.01; 95% CI: 1.17, 2.30) to complete their child's immunisation schedule compared to those who had no ANC visits. Similarly, postnatal care (PNC) visits also increased the likelihood of full immunisation, as mothers who had PNC

checkups were 1.55 times more likely to fully immunise their children (AOR = 1.55; 95% CI: 1.46, 1.65). These findings highlight the importance of integrating immunisation services into routine maternal healthcare visits to enhance uptake[248].

Wealth status significantly affects immunisation coverage, with children from wealthier households being 1.26 times more likely to be fully immunised (AOR = 1.26; 95% CI: 1.18, 1.40) compared to those from poor households. Economic stability enables families to afford transportation to healthcare facilities and access better healthcare services. In contrast, financial constraints often lead to missed vaccinations, particularly in low-income communities[248].

Place of residence also determines immunisation completion. Children from rural areas had a lower likelihood of being fully immunised (AOR = 0.79; 95% CI: 0.70, 0.89) compared to their urban counterparts. Rural populations often face longer distances to health centers, limited healthcare infrastructure, and lower awareness about immunisation schedules[248].

Media exposure positively influences immunisation uptake, as mothers with access to media (radio, television, newspapers) were 1.11 times more likely to fully immunise their children (AOR = 1.11; 95% CI: 1.04, 1.18). Exposure to health-related information through media platforms enhances awareness and reinforces the importance of immunisation, leading to higher compliance rates[248].



**2.7 Conceptual Framework**

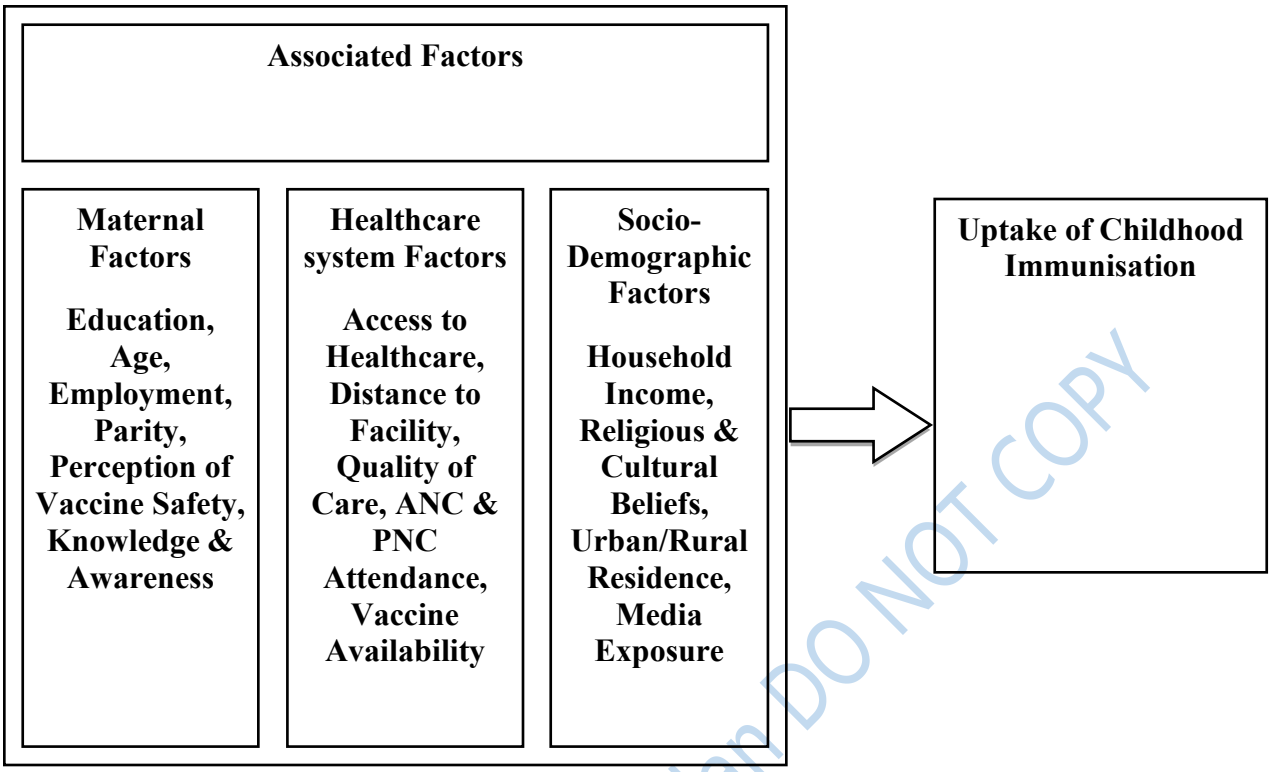


**Figure 2.6 Researcher Designed Conceptual Framework**

The dependent variable in this study is the uptake of childhood immunisation, which is measured by the completion of childhood immunisation among children under five years. The independent variables influencing immunisation uptake are categorised into maternal factors, healthcare system factors and socio-demographic factors.

Maternal factors play a crucial role in determining whether a child completes the recommended immunisation schedule. These factors include maternal education level, age, employment status, knowledge and awareness of immunisation benefits, perception of vaccine safety, and general health-seeking behavior. Additionally, the number of children a mother has, also known as parity, may influence her decision-making regarding immunisation. For instance, a more educated mother is likely to have better knowledge of the benefits of immunisation and, consequently, may ensure that her child receives all necessary vaccines. In contrast, mothers with limited education may be more susceptible to vaccine misinformation and hesitancy.

Beyond maternal characteristics, healthcare system factors also play a significant role. The distance to healthcare facilities, availability and accessibility of immunisation services, quality of healthcare services, and the attitude and competence of healthcare workers can either facilitate or hinder immunisation uptake. Antenatal care (ANC) attendance and postnatal care (PNC) follow-ups serve as additional points of contact where mothers can receive information and encouragement regarding childhood immunisation. A mother who attends ANC is more likely to receive counseling on immunisation, which increases the likelihood of completing her child's vaccination schedule. However, if the healthcare system is inefficient—characterised by stockouts of vaccines, inadequate cold chain management, or long waiting times—mothers may be discouraged from returning for subsequent immunisation visits.

Finally, Socio-demographic and economic factors also influence childhood immunisation uptake. Household income level determines whether a mother can afford transportation to healthcare facilities or access private healthcare services when necessary. Religious and cultural beliefs can either support or hinder immunisation, depending on the prevailing norms in a particular community. Additionally, women's autonomy in making healthcare decisions can affect their ability to take their children for immunisation, especially in patriarchal households where healthcare decisions are largely made by male family members. The urban or rural setting of a mother's residence further influences access to immunisation services, with urban dwellers generally having better access than those in remote areas. Furthermore, media exposure and access to health information significantly impact mothers' knowledge and perceptions of immunisation. Exposure to immunisation awareness campaigns through television, radio, social media, and community health outreach programs can positively influence vaccine uptake.

The interaction between these factors ultimately influences childhood immunisation uptake. Some factors serve as facilitators, enhancing immunisation rates, while others act as barriers, preventing mothers from completing their children's immunisation schedules. For example, a well-educated mother with high healthcare autonomy, good access to healthcare services, and exposure to immunisation awareness campaigns is more likely to ensure her child receives full immunisation. Conversely, a mother with low education, financial constraints, limited access to healthcare, and cultural beliefs opposing vaccination may be less likely to complete the immunisation process.

**2.8 Summary of Gaps in the Literature**

This systematic review focusses on research conducted in sub-Saharan Africa and finds that there are a number of factors that affect mothers' decisions to vaccinate their children, especially those under the age of five. While existing research has established the prevalence rates, maternal perceptions, and socio-economic determinants of immunisation, there are notable gaps that require further investigation, particularly in the context of Ajeromi-Ifelodun Local Government Area of Lagos State.

Firstly, although studies have examined immunisation coverage across different regions, there is significant variation in reported prevalence. Research from Nigeria, Ethiopia, Kenya, and other African countries shows disparities in full immunisation rates, with some areas achieving over 70% coverage, while others fall below 40%. However, these studies do not provide a comprehensive understanding of the specific challenges faced in urban, densely populated areas such as Ajeromi-Ifelodun, where unique socioeconomic and infrastructural factors may influence immunisation uptake. Additionally, while some research identifies vaccine-specific disparities—

such as lower measles vaccine coverage compared to BCG and polio—there is limited analysis of whether these trends are consistent in all urban settings, particularly in Lagos.

Another gap in the literature is the limited focus on the specific perceptions and attitudes of mothers in urban slums or highly populated areas. While maternal confidence in vaccine safety and awareness of immunisation benefits have been studied, there is insufficient research on how these factors interact with urban-specific challenges such as overcrowding, high mobility, and limited access to quality healthcare facilities. Furthermore, while previous studies indicate that maternal education plays a significant role in immunisation uptake, there is a lack of context-specific analysis on how formal and informal education influences vaccine adherence among mothers in Lagos.

The influence of healthcare system factors, such as the attitudes and competence of healthcare workers, has been noted in several studies. Reports from Ethiopia, Zimbabwe, and Nigeria suggest that rude or dismissive healthcare staff discourage mothers from completing vaccination schedules. However, there is limited research on the extent of this issue in Lagos State, particularly in Ajeromi-Ifelodun, where a high patient-to-healthcare worker ratio may exacerbate negative experiences. Additionally, while geographical barriers have been widely studied in rural settings, less attention has been given to the impact of healthcare accessibility in urban slums, where distance may not be the primary issue but rather long waiting times, overcrowded clinics, and the financial burden of indirect costs such as transportation and lost wages.

Cultural and religious influences on immunisation have been examined in some Nigerian studies, with findings suggesting that certain ethnic and religious groups exhibit lower vaccination rates due to beliefs about natural immunity or vaccine safety. However, most of these studies have been conducted in Southern Nigeria or among specific ethnic groups, leaving gaps in

understanding how these factors affect immunisation uptake in highly diverse urban areas such as Ajeromi-Ifelodun.

Women's autonomy has been identified as a determinant of immunisation completion, with studies from India and Nepal showing that maternal decision-making power significantly influences vaccination adherence. However, there is limited research exploring how autonomy manifests in urban Nigerian households, particularly in relation to financial independence, spousal influence, and social support systems.

Another notable gap in the literature is the lack of research on the impact of community-based interventions, outreach programs, and public health campaigns specifically in Ajeromi-Ifelodun. While studies from Ethiopia and other countries suggest that home visits and incentive-based programs improve immunisation rates, there is insufficient data on whether similar approaches would be effective in the urban Nigerian context.

## Endnotes


1. World Health Organisation. Health topics: *Immunisation*. Available from www.who.int/topics/immunisaton/en.

2. World Health Organisation. *Global eradication of poliomyelitis*: report of the sixth meeting of the Technical Consultative Group for poliomyelitis eradication. Geneva, 2001. Available from www.who.int/vaccinesdocuments/

3. Centers for Disease Control and Prevention. *Ten Great Public Health Achievements in the 20th Century [Internet]*. (800-232-4636) TTY: (888) 232-6348.

4. World Health Organisation. *Emergencies, preparedness, response: Smallpox vaccines*. Available from www. Who.int/csr/disease/smallpox/vaccines/en [Accessed date: November 2017]

5. World Health Organisation. *Expanded Programme on Immunisation*. Geneva, Switzerland, 1976. Available from www.doh.gov.ph>expanded programme-onimmunisation. [A

6. Ophori EA, Tula MY, Azih AV, Okojie R, Ikpo PE. Current trends of immunisation in Nigeria: prospect and challenges. Trop **Med Health. 2014;42(2):67-75. doi:10.2149/tmh.2013-13**

7. World Health Organisation. Nigeria: WHO coverage: 2019 revision. WHO. Available monitoring surveillance/data/nga.pdf and UNICEF estimates of immunisation from https://www.who.int/immunisation/

8. Federal Ministry of Health. Comprehensive EPI multi-year plan 2016 - 2020. National Primary Health Care Development Agency. Available from http://www.africanchildforum.org/clr/policy%20per%20country/2018%20Update/Nigeria/nigeria_comprehensivemultiyearp_2016-2020.pdf

9. National Population Commission. *Nigeria demographic and health survey* 2013. Available from http://www.dhsprogram.com/pubs/**pdf/FR293/FR293.pdf**

10. World Health Organisation. Immunisation surveillance, assessment and monitoring. *Vaccine preventable diseases* 2012. Available at http:// www.who.int/ immunisation monitoring/ diseases/en/ accessed 16/3/16.

11. World Immunisation Week (2013). Available at www.who.int/mediacenter/news/releases/2006/prll/en/ Accessed 05/05/2016.

12. WHO/UNICEF Joint news release. *Global measles deaths plunge* by 48% over past six years. WHO Media center. Available at http:// www.who.int/ mediacentre/news/releases/2006/pr11/ en/ .Accessed 6/04/2016.)

13. R. S.Sabirovna. To study the effects of viral diseases on the human body and their effective treatment. **International Journal of Current Research and Review, 13(1), 52-55.**

14. Pathakumari, B., Liang, G., & Liu, W. (2020). *Immune defence to invasive fungal infections:* A comprehensive review. **Biomedicine & Pharmacotherapy, 130, 110550.**

15. Yadav, M. (2022). *Innate Immunity*. In An Interplay of Cellular and Molecular Components of Immunology (pp. 27-59). CRC Press.

16. Abós, B., Bailey, C., & Tafalla, C. (2022). *Adaptive immunity.* In Principles of Fish Immunology: From Cells and Molecules to Host Protection (pp. 105-140). Cham: Springer International Publishing.

17. Marshall, J. S., Warrington, R., Watson, W., & Kim, H. L. (2018). *An introduction to immunology and immunopathology*. Allergy, Asthma & Clinical Immunology, 14, 1-10.

18. Li, Q., Wang, Y., Sun, Q., Knopf, J., Herrmann, M., Lin, L., ... & Shi, Y. (2022). Immune response in COVID-19: what is next?. *Cell Death & Differentiation*, 29(6), 1107-1122.

19. *National Institute of Allergy and Infectious Diseases*. Understanding How Vaccines Work (cdc.gov). http://www.niaid.nih.gov/topics/vaccines/

20. Malik, J. A., Ahmed, S., Yaseen, Z., Alanazi, M., Alharby, T. N., Alshammari, H. A., & Anwar, S. (2022). Association of SARS-CoV-2 and polypharmacy with Gut, Lung Axis: from *pathogenesis to treatment*. ACS omega, 7(38), 33651-33665.

21. Bhattacharya, S., Bohara, V. S., Sevda, S., & Kumar, S. (2024). *Vaccine and vaccine types*. In Bioreactor Design Concepts for Viral Vaccine Production (pp. 73-82). Academic Press.

22. Ghattas, M., Dwivedi, G., Lavertu, M., & Alameh, M. G. (2021). *Vaccine technologies and p l a t f o r m s f o r i n f e c t i o u s d i s e a s e s :* C u r r e n t p r o g r e s s , c h a l l e n g e s , a n d opportunities. Vaccines, 9(12), 1490.

23. Bailey, A., & Sapra, A. (2020). MMR Vaccine. In StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing

24. Gupta, S., & Pellett, S. (2023). Recent developments in vaccine design: From live vaccines to recombinant toxin vaccines. Toxins, 15(9), 563.

25. Bashiri, S., Koirala, P., Toth, I., & Skwarczynski, M. (2020). Carbohydrate immune adjuvants in subunit vaccines. Pharmaceutics, 12(10), 965.

26. Pollard, A. J., & Bijker, E. M. (2021). A guide to vaccinology: from basic principles to new developments. Nature Reviews Immunology, 21(2), 83-100.

27. Taghinezhad-S, S., Keyvani, H., Bermúdez-Humarán, L. G., Donders, G. G., Fu, X., & Mohseni, A. H. (2021). *Twenty years of research on HPV vaccines based on genetically modified lactic acid bacteria:* an overview on the gut-vagina axis. Cellular and Molecular Life Sciences, 78, 1191-1206.

28. Rohokale, R., & Guo, Z. (2023*). Development in the concept of bacterial polysaccharide repeating unit-based antibacterial conjugate vaccines*. ACS infectious diseases, 9(2), 178-212.

29. Angsantikul, P., Fang, R. H., & Zhang, L. (2017). *Toxoid vaccination against bacterial infection using cell membrane-coated nanoparticles. Bioconjugate chemistry*, 29(3), 604-612.

30. Al Fayez, N., Nassar, M. S., Alshehri, A. A., Alnefaie, M. K., Almughem, F. A., Alshehri, B. Y., ... & Tawfik, E. A. (2023). Recent Advancement in mRNA Vaccine Development and Applications. Pharmaceutics, 15(7), 1972.

31. Chavda, V. P., Soni, S., Vora, L. K., Soni, S., Khadela, A., & Ajabiya, J. (2022). mRNA-based vaccines and therapeutics for COVID-19 and future pandemics. Vaccines, 10(12), 2150.

32. Travieso, T., Li, J., Mahesh, S., Mello, J. D. F. R. E., & Blasi, M. (2022). *The use of viral vectors in vaccine development*. npj Vaccines, 7(1), 75.

33. Stefanetti, G., Borriello, F., Richichi, B., Zanoni, I., & Lay, L. (2022). *Immunobiology of carbohydrates: implications for novel vaccine and adjuvant design against infectious diseases.* Frontiers in Cellular and Infection Microbiology, 11, 808005.

34. Rastogi, I., Jeon, D., Moseman, J. E., Muralidhar, A., Potluri, H. K., & McNeel, D. G. (2022). Role of B cells as antigen presenting cells. *Frontiers in immunology*, 13, 954936.

35. Gaudino, S. J., & Kumar, P. (2019). *Cross-talk between antigen presenting cells and T cells impacts intestinal homeostasis, bacterial infections, and tumorigenesis*. Frontiers in immunology, 10, 422031.

36. Seiwert, C. (2019). Immune System. Human Biology. (**pp. 123-150). New York, NY: McGraw-Hill.**

37. Bugya, Z., Prechl, J., Szénási, T., Nemes, É., Bácsi, A., & Koncz, G. (2021). *Multiple levels of immunological memory and their association with vaccination.* Vaccines, 9(2), 174.

38. Carabalí-Isajar, M. L., Rodríguez-Bejarano, O. H., Amado, T., Patarroyo, M. A., Izquierdo, M. A., Lutz, J. R., & Ocampo, M. (2023). *Clinical manifestations and immune response to tuberculosis*. **World Journal of Microbiology and Biotechnology, 39(8), 206.**

39. Visca, D., Ong, C. W. M., Tiberi, S., Centis, R., D'ambrosio, L., Chen, B., ... & Goletti, D. (2021). *Tuberculosis and COVID-19 interaction*: a review of biological, clinical and public health effects. Pulmonology, 27(2), 151-165.

40. World Health Organisation (2023) Tuberculosis. https://www.who.int/news-room/fact-sheets/detail/tuberculosis

41. Patterson, B., & Wood, R. (2019). Is cough really necessary for TB transmission?. Tuberculosis, 117, 31-35.

42. Luies, L., & Du Preez, I. (2020). *The echo of pulmonary tuberculosis: mechanisms of clinical symptoms and other disease-induced systemic complications*. Clinical microbiology reviews, 33(4), 10-1128.

43. Luca, S., & Mihaescu, T. (2013). *History of BCG vaccine*. Maedica, 8(1), 53-58.

44. Covián, C., Fernández-Fierro, A., Retamal-Díaz, A., Díaz, F. E., Vasquez, A. E., Lay, M. K., ... & Kalergis, A. M. (2019). *BCG-induced cross-protection and development of trained immunity*: implication for vaccine design. Frontiers in immunology, 10, 504051.

45. Badurdeen, S., Marshall, A., Daish, H., Hatherill, M., & Berkley, J. A. (2019). *Safety and immunogenicity of early Bacillus Calmette-Guérin vaccination in infants who are preterm and/or have low birth weights: a systematic review and meta-analysis.* JAMA pediatrics, 173(1), 75-85.

46. Kuan, R., Muskat, K., Peters, B., & Arlehamn, C. S. L. (2020). *BCG vaccine efficacy, immune correlates of protection and antigen-specific T cell responses.* **Journal of internal medicine, 288(6), 651.**

47. Decker, M. D., & Edwards, K. M. (2021). Pertussis (whooping cough). The Journal of Infectious Diseases, 224(Supplement_4), S310-S320.

48. Stein-Zamir, C., Shoob, H., Abramson, N., Brown, E. H., & Zimmermann, Y. (2023). Pertussis outbreak mainly in unvaccinated young children in ultra-orthodox Jewish groups, Jerusalem, Israel 2023. Epidemiology & Infection, 151, e166.

49. Lauria, A. M., & Zabbo, C. P. (2019). Pertussis (Whooping Cough). StatPearls. Treasure Island: StatPearls Publishing.

50. Ogden, S. A., Ludlow, J. T., & Alsayouri, K. (2019). Diphtheria Tetanus Pertussis (DTaP) Vaccine.

51. Lamichhane, A., & Radhakrishnan, S. (2024). Diphtheria. In StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing.

52. Abdulrasheed, N., Lawal, L., Mogaji, A. B., Abdulkareem, A. O., Shuaib, A. K., Adeoti, S. G., ... & Abdul-Rahman, T. (2023). Recurrent diphtheria outbreaks in Nigeria: A review of *the underlying factors and remedies. Immunity, Inflammation and Disease*, 11(11), e1096.

53. World Health Organisation (2024) Diphtheria. https://www.who.int/news-room/fact-sheets/detail/*diphtheria*

54. Bae, C., & Bourget, D. (2021). Tetanus.[Updated 2021 May 12]. StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing.

55. World Health Organisation (2023) Tetanus. https://www.who.int/news-room/fact-sheets/detail/tetanus

56. Dhir, S. K., Dewan, P., & Gupta, P. (2021). Maternal and Neonatal Tetanus Elimination: Where are We Now?. Research and Reports in Tropical Medicine, 247-261.

57. Samaila, A., Abdulkadir, B., Kabir, K., Aliyu, S., & Umar, Z. (2018). Pathogenesis and management of tetanus. **UMYU Journal of Microbiology Research (UJMR), 3(1), 16-23.**

58. Karnad, D. R., & Gupta, V. (2021). Intensive care management of severe tetanus. Indian **Journal of Critical Care Medicine: Peer-reviewed, Official Publication of Indian Society of Critical Care Medicine, 25(Suppl 2), S155.**

59. Balasundaram, P., & Sakr, M. (2021). Understanding and Application of CDC Immunisation Guidelines.

60. WHO (2024) *Hepatitis* B. (Retrieved from https://www.who.int/news-room/fact-sheets/detail/hepatitis-b)

61. Tan, M., Bhadoria, A. S., Cui, F., Tan, A., Van Holten, J., Easterbrook, P., ... & Hutin, Y. (2021). Estimating the proportion of people with chronic hepatitis B virus infection eligible for hepatitis B antiviral treatment worldwide: a systematic review and meta-analysis. The lancet Gastroenterology & herpetology, 6(2), 106-119.

62. Mehta, P., & Reddivari, A. K. R. (2022). *Hepatitis*. In StatPearls [Internet]. StatPearls Publishing.

63. Romano', L., & Zanetti, A. R. (2022). *Hepatitis B vaccination*: A historical overview with a focus on the Italian achievements. Viruses, 14(7), 1515.

64. Lazarevic, I., Banko, A., Miljanovic, D., & Cupic, M. (2024). Hepatitis B Surface Antigen Isoforms: Their Clinical Implications, Utilisation in Diagnosis, Prevention and New Antiviral Strategies. Pathogens, 13(1), 46.

*65.* Lei, D., Miller, T., Carr, J., Buttery, J., Nold-Petry, C. A., Nold, M. F., & Malhotra, A. (2022). *Timing of the First Dose of the Hepatitis B Vaccine in Preterm Infants. Vaccines, 10(10), 1656.*

66. Matthews, P. C., Ocama, P., Wang, S., El-Sayed, M., Turkova, A., Ford, D., ... & Hamid, S. (2023). *Enhancing interventions for prevention of mother-to-child-transmission of hepatitis B virus.* JHEP Reports, 5(8), 100777.

67. Rabaan, A. A., Mutair, A. A., Alhumaid, S., Garout, M., Alsubki, R. A., Alshahrani, F. S. & Ahmed, N. (2022). Updates on measles incidence and eradication: emphasis on the immunological aspects of measles infection. Medicina, 58(5), 680.

68. WHO (2024) Measles. https://www.who.int/news-room/fact-sheets/detail/measles

69. Turaiche, M., Grigoras, M. L., Bratosin, F., Bogdan, I., Bota, A. V., Cerbu, B., ... & Marincu, I. (2022). *Disease progression, clinical features, and risk factors for pneumonia in unvaccinated children and adolescents with measles: a re-emerging disease in Romania.* **International Journal of Environmental Research and Public Health, 19(20), 13165.**

70. WHO (2020) *History of the Measles Vaccine.* https://www.who.int/news-room/spotlight/history-of-vaccination/history-of-measles-vaccination

71. WHO (2023) *Poliomyelitis*. https://www.who.int/news-room/fact-sheets/detail/poliomyelitis

72. Nasir, U. N., Bandyopadhyay, A. S., Montagnani, F., Akite, J. E., Mungu, E. B., Uche, I. V., & Ismaila, A. M. (2016). *Polio elimination in Nigeria*: a review. Human vaccines & immunotherapeutic, 12(3), 658-663.

73. Malave Sanchez, M., Saleeb, P., Kottilil, S., & Mathur, P. (2021, August). *Oral Polio Vaccine to protect against COVID-19:* Out of the box strategies?. In Open Forum Infectious Diseases (Vol. 8, No. 8, p. ofab367). US: Oxford University Press.

74. Hotta, C., Ogawa, T., & Shirasawa, H. (2019). *Surveillance of immunity acquired from poliovirus immunisation including vaccination* with the Sabin strain-derived inactivated vaccine. Human Vaccines & Immunotherapeutic.

75. Estivariz, C. F., Kovacs, S. D., & Mach, O. (2023). Review of use of inactivated poliovirus vaccine in campaigns to control type 2 circulating vaccine derived poliovirus (cVDPV) outbreaks. Vaccine, 41, A113-A121.

76. González-Silva, M., & Rabinovich, N. R. (2021). *Some lessons for malaria from the Global Polio Eradication Initiative*. **Malaria Journal, 20(1), 210.**

77. WHO (2023) *Yellow Fever*. https://www.who.int/news-room/fact-sheets/detail/yellow-fever

78. Nwaiwu, A. U., Musekiwa, A., Tamuzi, J. L., Sambala, E. Z., & Nyasulu, P. S. (2021). *The incidence and mortality of yellow fever in Africa*: a systematic review and meta-analysis. BMC infectious diseases, 21, 1-11.

79. Gianchecchi, E., Cianchi, V., Torelli, A., & Montomoli, E. (2022). *Yellow fever*: origin, epidemiology, preventive strategies and future prospects. Vaccines, 10(3), 372.

80. Marinho, P. S., Cunha, A. J., Amim Junior, J., & Prata-Barbosa, A. (2017). *A review of selected Arboviruses during pregnancy. Maternal Health, Neonatology and Perinatology*, 3, 1-9.

81. Hansen, C. A., & Barrett, A. D. (2021). *The present and future of yellow fever vaccines*. Pharmaceuticals, 14(9), 891.

82. Bovay, A., Fuertes Marraco, S. A., & Speiser, D. E. (2021). *Yellow fever virus vaccination:* an emblematic model to elucidate robust human immune responses. Human Vaccines & Immunotherapeutic, 17(8), 2471-2481.

83. Domingo, C., Fraissinet, J., Ansah, P. O., Kelly, C., Bhat, N., Sow, S. O., & Mejia, J. E. (2019). *Long-term immunity against yellow fever in children vaccinated during infancy*: a longitudinal cohort study. The Lancet Infectious Diseases, 19(12), 1363-1370.

84. Rodrigues, C. M., & Plotkin, S. A. (2020). Impact of vaccines; health, economic and social perspectives. Frontiers in microbiology, 11, 1526.

85. WHO (2023). *Meningitis*. https://www.who.int/news-room/fact-sheets/detail/meningitis

86. MacNeil, J. R., Bennett, N., Farley, M. M., Harrison, L. H., Lynfield, R., Nichols, M., ... & Cohn, A. C. (2015). *Epidemiology of infant meningococcal disease in the United States*, 2006-2012. Pediatrics, 135(2), e305-e311.

87. Anderson, R. M., & May, R. M. (1991). *Infectious diseases of humans*: dynamics and control. Oxford university press.

88. Di Pietro, G. M., Biffi, G., Castellazzi, M. L., Tagliabue, C., Pinzani, R., Bosis, S., & Marchisio, P. G. (2022). *Meningococcal disease in pediatric age:* a focus on epidemiology and prevention. **International Journal of Environmental Research and Public Health, 19(7), 4035.**

89. Tereziu, S., & Minter, D. A. (2018). *Pneumococcal vaccine*. In StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing.

90. Gilsdorf, J. R. (2021). *Hib vaccines*: their impact on Haemophilus influenzae type b disease. **The Journal of infectious diseases, 224(Supplement_4), S321-S330.**

91. Yeasmin, S., Hasan, S. T., Chisti, M. J., Khan, M. A., Faruque, A. S. G., & Ahmed, T. (2022). *Factors associated with dehydrating rotavirus diarrhea in children under five in Bangladesh*: An urban-rural comparison. Plos one, 17(8), e0273862.

92. Sadiq, A., & Khan, J. (2024). *Rotavirus in developing countries*: molecular diversity, epidemiological insights, and strategies for effective vaccination. Frontiers in Microbiology, 14, 1297269.

93. Cantrell, M. E., Sylvestre, É., Wharton, H. C., Scheidegger, R., Curchod, L., Gute, D. M., & Pickering, A. J. (2023). *Hands are frequently contaminated with fecal bacteria and enteric pathogens globally*: A systematic review and meta-analysis. ACS Environmental Au, 3(3), 123-134.

94. Crawford, S. E., Ramani, S., Tate, J. E., Parashar, U. D., Svensson, L., Hagbom, M., ... & Estes, M. K. (2017). *Rotavirus infection.* Nature Reviews Disease Primers, 3(1), 1-16

95. Asim, M., Alkadi, M. M., Asim, H., & Ghaffar, A. (2019). *Dehydration and volume depletion:* how to handle the misconceptions. **World journal of nephrology, 8(1), 23.**

96. Varghese, T., Kang, G., & Steele, A. D. (2022). *Understanding rotavirus vaccine efficacy and effectiveness in countries with high child mortality.* Vaccines, 10(3), 346.

97. Di Martino, G., Mazzocca, R., Camplone, L., Cedrone, F., Di Giovanni, P., & Staniscia, T. (2023). *Attitudes and Beliefs towards Rotavirus Vaccination in a Sample of Italian Women*: A Cross-Sectional Study. Vaccines, 11(6), 1041.

98. WHO (2023) Influenza (seasonal). Retrieved from https://www.who.int/news-room/fact-sheets/detail/influenza-(seasonal)

99. Alexander-Miller, M. A. (2020). *Challenges for the newborn following influenza virus infection and prospects for an effective vaccine.* Frontiers in immunology, 11, 568651.

100. Mameli, C., Cocchi, I., Fumagalli, M., & Zuccotti, G. (2019). *Influenza vaccination:* effectiveness, indications, and limits in the pediatric population. Frontiers in pediatrics, 7, 317.

101. Moncion, K., Young, K., Tunis, M., Rempel, S., Stirling, R., & Zhao, L. (2019). *Effectiveness of hand hygiene practices in preventing influenza virus infection in the community setting:* A systematic review. Canada communicable disease report= Releve des maladies transmissible au Canada, 45(1), 12-23.

102. Haider, S. M. S., Alvi, S. A., Khan, H., Majeed, R., Syed, T., Anwar, A., & Hashmi, A. A. (2023). Common Side Effects of Pfizer COVID-19 Vaccine: An Experience From Pakistan. Cureus, 15(6).

103. Guo, Y., Tian, X., Wang, X., & Xiao, Z. (2018). *Adverse effects of immunoglobulin therapy*. Frontiers in immunology, 9, 362740.

104. Drutz, J. E. (2021). *Patient education*: Vaccines for infants and children age 0 to 6 years (Beyond the Basics).

105. Chandler, R. E. (2020). *Optimizing safety surveillance for COVID-19 vaccines*. Nature reviews immunology, 20(8), 451-452.

106. Younus, M. M., & Al-Jumaili, A. A. (2021). An *overview of COVID-19* vaccine safety and post-marketing surveillance systems. Innovations in Pharmacy, 12(4).

107. Laupèze, B., Del Giudice, G., Doherty, M. T., & Van der Most, R. (2021). *Vaccination as a preventative measure contributing to immune fitness*. npj Vaccines, 6(1), 93.

108. WHO (2024) *Vaccines and Immunisation*. Retrieved from https://www.who.int/news-room/fact-sheets/detail/vaccines-and-immunisation

109. Bullen, M., Heriot, G. S., & Jamrozik, E. (2023). *Herd immunity,* vaccination and moral obligation. **Journal of Medical Ethics, 49(9), 636-641.**

110. Cooper, S., Schmidt, B. M., Sambala, E. Z., Swartz, A., Colvin, C. J., Leon, N., & Wiysonge, C. S. (2021). *Factors that influence parents' and informal caregivers'* views and practices regarding routine childhood vaccination: a qualitative evidence synthesis. Cochrane Database of Systematic Reviews, (10).

111. Adedokun ST, Uthman OA, Adekanmbi VT, Wiysonge CS. *Incomplete childhood immunisation in Nigeria:* a multilevel analysis of individual and contextual factors. BMC Public Health 2017; 17:236 https://dx.doi.org/10.1186%2Fs12889-017-4137-7

112. Itimi K, Dienye PO, Ordinioha B. *Community participation and childhood immunisation coverage:* A comparative study of rural and urban communities of Bayelsa State, South-S o u t h N i g e r i a . N i g e r M e d J 2 0 1 2 ; 5 3 : 2 1 2 5 . h t t p s : / / d x . d o i . o r g / 10.4103%2F0300-1652.99826

113. Tagbo BN, Eke CB, Omotowo BI, Onwuasigwe CN, Onyeka EB, and Mildred UO. *(2014) Vaccination coverage* and its determinants in children aged 11 - 23 months in an urban district of Nigeria. **World Journal of Vaccines, 4, 175-183. http://dx.doi.org/10.4236/ wjv.2014.44020**

114. Chidiebere ODI, Uchenna E, Kenechi OS. *Maternal sociodemographic factors* that influence full child immunisation uptake in Nigeria. S Afr J Child Health.2014;8(4):138 42. https://doi.org/10.7196/SAJCH.661

115. Tobin-West CI, Alex-Hart BA. *Identifying barriers and sustainable solutions to childhood immunisation* in Khana local government area of Rivers State, Nigeria Int Q Community Health Educ 2011-2012; 32:149 158. http://dx.doi.org/https://doi.org/10.2190/IQ.32.2.e

116. Obasohan PE, Mustapha MA, Makada A, Obasohan DN. *Evaluating the reasons for partial and non-immunisation of children* in Wushishi local government area, Niger State, Nigeria: methodological comparison Afr JReprod Health 2018; 22:113:https://doi.org/10.29063/ajrh2018/v22i4.12

117. Statistica.com. *Literacy rate in Nigeria* in 2018, by zone and gender. https://www.statista.com/statistics/1124745/literacy-rate-in-nigeria-by-zone-and-gend er/

118. Ophori EA, Tula MY, Azih AV, Okojie R, Ikpo PE. *Current trends of immunisation* in Nigeria: prospect and challenges. Trop Med Health. 2014;42(2):67-75. doi:10.2149/ tmh.2013-13

119. Chidiebere ODI, Uchenna E, Kenechi OS. *Maternal sociodemographic factors* that influence full child immunisation uptake in Nigeria. S Afr J Child Health.2014;8(4):138 42. https://doi.org/10.7196/SAJCH.661

120. Babalola S. *Maternal reasons for non-immunisation and partial immunisation* in northern Nigeria . J Paediatr Child Health 2011; 47:276 . https://doi . org/10 . 1111/ j.1440-1754.2010.01956.x

121. Akwataghibe NN, Ogunsola EA, Broerse J, Popoola OA, Agbo AI, DielemanMA. *Exploring factors influencing immunisation utilisation in Nigeria-A mixed methods study.* Front Public Health. 2019;7:392. https://doi.org/10.3389/fpubh.2019.00392.

122. Federal Ministry of Health. Comprehensive EPI multi-year plan 2016 - 2020. National Primary Health Care Development Agency. Available from www.africanchildforum.org/clr/policy%20per%20country/2018%20Update/Nigeria/nigeria_comprehensivemultiyearp_2016-2020.pdf

123. Kaufmann JR, Feldbaum H. Diplomacy and the polio immunisation boycott in Northern Nigeria. Health Aff (Millwood). 2009 Jul-Aug;28(4):1091-101. doi:10.1377/ hlthaff.28.4.1091. PMID: 19597208

124. UN News. *Polio* is no longer endemic in Nigeria UN health agency. Available from https://www.un.org/africarenewal/news/polio-no-longer-endemic-nigeria-%E2%80%9 3-un-health-agency

125. Ibraheem R, Abdulkadir M, Akintola M, Adeboye M. Determinants of timely presentation for birth dose vaccination at an immunisation Centre in North-Central Nigeria. Ann Glob Health. 2019;85(1):20. https://doi.org/10.5334/aogh.725

126. Okenwa UJ, Dairo MD, Uba B, Ajumobi O. *Maternal reasons for non-receipt of valid hepatitis B* birth dose among mother-infant pairs attending routine immunisation clinics, south - east, Nigeria . Vaccine . 2019;37(46):68949 . https://doi . org/10 . 1016/ j.vaccine.2019.09.056.

127. Oladokun RE, Adedokun BO, Lawoyin TO. *Children not receiving adequate immunisation in Ibadan,* Nigeria: what reasons and beliefs do their mothers have? Niger J Clin Pract. 2010;13(2):173 8

128. Cockcroft A, Usman MU, Nymucherera OF, Emori H, Duke B, Umar NI, Andersson N. *Why children are not vaccinated against measles:* a cross-sectional study in two Nigerian states. Arch Public Health. 2014;72:48http://www.archpublichealth.com/content/72/1/48

129. *Antai, D. Migration and child immunisation in Nigeria:* individual- and community-level contexts. BMC Public Health 10, 116 (2010). https://doi.org/10.1186/1471-2458-10-116

130. National Population Commission (NPC) [Nigeria] and ICF. (2019). *Nigeria Demographic and Health Survey 2018*. NPC and ICF

131. Gooding, E., Spiliotopoulou, E., & Yadav, P. (2019). *Impact of vaccine stockouts on immunisation coverage in Nigeria. Vaccine*, 37(35), 5104 5110.

132. National Primary Health Care Development Agency. (2012). *National Guidelines for the Development of Primary Health Care System in Nigeria* (Fourth Revised Edition). National Primary Health Care Development Agency, Federal Republic of Nigeria.

133. Machingaidze, S., Wiysonge, C. S., & Hussey, G. D. (2015). Strengthening the expanded programme on immunisation in Africa: Looking beyond 2015. *PLoS Medicine, 10*(3), 1-5. http://doi.org/10.1371/journal.pmed.1001405

134. Shen, A. K., Fields, R., & McQuestion, M. (2014). The future of routine immunisation in the developing world: challenges and opportunities. *Global Health, Science and Practice*, *2*(4), 381 94. http://doi.org/10.9745/GHSP-D-14-00137

135. World Health Organisation. (2015). *National immunisation coverage scorecards estimates for 2014.* Retrieved from http://www.who.int/immunisation/global_vaccine_action_plan/WHA_Scorecards _2014.pdf

136. Health Reform Foundation of Nigeria. (2008). *Nigerian health review 2007: Primary health care in Nigeria: 30 years after Alma-Ata.* Abuja, Nigeria: Mmm-nat Educational Window Consultant Ltd.

137. Osain, M. (2011). The Nigerian health care system: Need for integrating adequate medical intelligence and surveillance systems. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3249694/

138. Andersen, R., & Newman, J. F. (1973). Societal and individual determinants of medical care utilisation in the United States. *Health and Society*, *51*(1), 95-124. http://doi.org/10.2307/3349613

139. World Bank (2006). *Disease and Mortality in Sub-Saharan Africa.* Washington, World Bank Headquarters.

140. American Red Cross (2002). *Measles Initiative to Vaccinate 14 Million Children in Kenya During One-week Campaign*. Nairobi: American Red Cross. [Online], Available: http:// www.redcross.org/press/intl/in_pr/020614measles.html [04/18/08 10: 12 AM].

141. American Red Cross (2003). *Zambia Mass Measles Vaccination Campaign First on Measles Initiative's 2003 Schedule*. Washington: American Red Cross. [Online], Available: http:// www.measlesinitiative.org/030606press.html [04/18/08 09:25 AM].

142. American Red Cross (2004). *Measles Initiative Partners Fight the Two Most Deadly Childhood Diseases in Africa Testing an Integrated Approach to Reach Every Child*. Washington: American Red Cross. [Online], Available: http://www.redcross.org/pressrelease/ 0,1077,0_314_3818,00.html [04/18/08 11:20 AM].

143. Ministry of Health, (2007). *Annual Health Development Report for Uganda, 2005/2007*. Kampala, Ministry of Health.

144. Ministry of Finance, Planning and Economic Development, (2007). *Infant Mortality in Uganda 2000-2005.* Kampala, Ministry of Finance, Planning and Economic Development.

145. Maina, L. C., Karanja, S., & Kombich, J. (2013). Immunisation coverage and its determinants among children aged 12-23 months in a peri-urban area of Kenya. *Pan African Medical Journal 14*(3), 1-7. http://doi.org/10.11604/pamj.2013.14.3.2181

146. Gidado, S., Nguku, P., Biya, O., Waziri, N. E., Mohammed, A., Nsubuga, P., … Sabitu, K. (2014). Determinants of routine immunisation coverage in Bungudu, Zamfara State, Northern Nigeria, May 2010. *The Pan African Medical Journal, 18 Suppl1*(9). http://doi.org/ 10.11694/pamj.supp.2014.18.1.4149

147. Canavan, M. E., Sipsma, H. L., Kassie, G. M., & Bradley, E. H. (2014). Correlates of complete childhood vaccination in East African countries, *9*(4), 1-7. http://doi.org/10.1371/ journal.pone.0095709

148. Bbaale, E. (2015). Factors influencing childhood immunisation in Uganda. *Journal of Health Population and Nutrition, 31*(1), 118-129. http://doi.org/10.3329/jhpn.v31i1.14756

149. Etana, B., & Deressa, W. (2012). Factors associated with complete immunisation coverage in children aged 12-23 months in Ambo Woreda, Central Ethiopia. *BMC Public Health*, *12*(1), 566. http://doi.org/10.1186/1471-2458-12-566

150. De Oliveira, M. F. S., Martinez, E. Z., & Rocha, J. S. Y. (2014). Factors associated with vaccination coverage in children < 5 years in Angola. *Revista de Saúde Pública*, *48*(6), 906-915. http://doi.org/10.1590/S0034-8910.2014048005284

151. .Kiros, G. & White, J.M. (2004). Migration, Community Context, and Child Immunisation in Ethiopia. *Social Science & Medicine*, 59: 2603,16.

152. Streatfield, K., Singarimbun, M., & Diamond, I. (1990). Maternal Education and Child Immunisation. *Demography*, 27: 447,55.

153. Abdulraheem, I., & Onajole, A. (2011). Reasons for incomplete vaccination and factors for missed opportunities among rural Nigerian children. *Journal of Public Health and Epidemiology*, *3*, 194-203. Retrieved from http://www.academicjournals.org/journal/JPHE

154. Rahman, M., & coverage Obaida-Nasrin, S. (2010). Factors affecting acceptance of complete immunisation of children under five years in rural Bangladesh. *Salud Publica de Mexico*, *52*(2), 134-140. http://doi.org/10.1590/S0036-36342010000200005

155. Oyefara, J. L. (2014). Mothers' characteristics and immunisation status of under-five children in Ojo Local Government Area, Lagos State, Nigeria. *SAGE Open*, *4*(3). http://doi.org/10.1177/2158244014545474

156. Kim, S. S., Frimpong, J. A., Rivers, P. A., & Kronenfeld, J. J. (2007). Effects of maternal and provider characteristics on up-to-date immunisation status of children aged 19 to 35 months. *American Journal of Public Health, 97*(2), 259 266. http://doi.org/10.2105/ AJPH.2005.076661

157. Bharati, P. (2014). Women autonomy, nutritional and immunisation status of their children. *Anthropology*, *2*(2), 118-124. http://doi.org/10.4172/2332-0915.1000118

158. Ebot, J. O. (2015). Girl Power!: The relationship between women's autonomy and children's immunisation coverage in Ethiopia. ***Journal of Health, Population and Nutrition*, 1-9**. http://doi.org/10.1186/s41043-015-0028-7

159. Singh, K., Haney, E., & Olorunsaiye, C. (2013). Maternal autonomy and attitudes towards gender norms: Associations with childhood immunisation in Nigeria. *Maternal and Child Health* ***Journal, 17*(5), 837-841.** http://doi.org/10.1007/s10995-012-1060-5

160. Awasthi, A., Pandey, C. M., Singh, U., Kumar, S., & Singh, T. B. (2015). Maternal determinants of immunisation status of children aged 12-23 months in urban slums of Varanasi, India. *Clinical Epidemiology and Global Health*, *3*(3), 110-116. http://doi.org/ 10.1016/j.cegh.2014.07.004

161. Favin, M., Steinglass, R., Fields, R., Banerjee, K., & Sawhney, M. (2012). Why children are not vaccinated: A review of the grey literature. *International Health*, *4*(4), 229-238. https://

162. Urich, A. (2017). *The health belief model*. Pressbooks.

163. Boulanger, A. (2023, February 6). *Everything you need to know about vaccinations*. Healthline. https://www.healthline.com/health/vaccinations.

164. Richter, G. (2023, April 3). Why do mRNA Vaccines Cause Strongest Immune Response in Younger Individuals.

165. World Health Organisation: WHO. (2024, August 13). *Breaking barriers, building bridges: the collaborative effort to reach every child in Nigeria*.

166. WHO (2024). *Immunisation coverage*. https://www.who.int/teams/immunisation-vaccines-and-biologicals/immunisation-analysis-and-insights/global-monitoring/immunisation-coverage.

167. Olugbade, O. T., Adeyemi, A. S., Adeoti, A. H., Ilesanmi, O. S., Gidado, S. O., Waziri, N. E., & Aworh, M. K. (2019). Measles outbreaks and Supplemental Immunisation Activities (SIAs): the Gwagwalada experience, Abuja 2015. *The Pan African Medical* ***Journal*****,** ***32*****(Suppl 1), 10.**

168. Nasir, U. N., Bandyopadhyay, A. S., Montagnani, F., Akite, J. E., Mungu, E. B., Uche, I. V., & Ismaila, A. M. (2016). Polio elimination in Nigeria: a review. *Human vaccines & immunotherapeutics*, *12*(3), 658-663.

169. Eze, O. V., Meyer, J. C., & Campbell, S. M. (2025). Poliomyelitis in Nigeria: Impact of Vaccination Services and Polio Intervention and Eradication Efforts. *Vaccines*, *13*(3), 232.

170. Mahachi, K., Kessels, J., Boateng, K., Baptiste, A. E. J., Mitula, P., Ekeman, E., ... & Gabrielli, A. F. (2022). Zero-or missed-dose children in Nigeria: contributing factors and interventions to overcome immunisation service delivery challenges. *Vaccine*, *40*(37), 5433-5444.

171. UNICEF (2021). COVID-19 vaccines shipped by COVAX arrive in Nigeria.

172. Song, M. Y., Blake-Hepburn, D., Karbasi, A., Fadel, S. A., Allin, S., Ataullahjan, A., & Ruggiero, E. D. (2024). Public health partnerships with faith-based organisations to support vaccination uptake among minoritised communities: A scoping review. *PLOS Global Public Health*, *4*(6), e0002765.

173. Olaniyan, A., Isiguzo, C., & Hawk, M. (2021). The Socioecological Model as a framework for exploring factors influencing childhood immunisation uptake in Lagos state, Nigeria. *BMC Public Health*, *21*(1), 867.

174. Brown, V. B., Oluwatosin, O. A., & Ogundeji, M. O. (2017). Impact of training intervention on immunisation providers' knowledge and practice of routine immunisation in Ibadan, south-western Nigeria: a primary health care experience. *The Pan African Medical* ***Journal*****,** ***26*****(216).**

175. Oyadiran, O. T., Usman, S. A., Osoba, M. E., Olukorode, S. O., & Lucero-Prisno III, D. E. (2021). Towards effective and efficient COVID-19 vaccination in Nigeria. ***Journal of global health reports*****,** ***5*****, e2021023.**

176. Gavi (2013). GAVI aims to improve access to vaccines in Nigeria through supply chains project.

177. Gavi (2024). The fight against pneumonia in five charts.

178. Dansereau, E., Miangotar, Y., Squires, E., Mimche, H., UND group Alexis Ngarmbatedjimal Haroun Koumakoi Djimet Seli, IFORD group Hénoque Blaise Nguendo Yongsi Julien Guy Ewos Bomba Léopold Cyriaque Donfack Mbasso Mariane Kenmegni Omgba Patrice Tanang Tchouala Vivien Meli Meli, & El Bcheraoui, C. (2017). Challenges to implementing Gavi's health system strengthening support in Chad and Cameroon: results from a mixed-methods evaluation. *Globalisation and health*, *13*, 1-12.

179. Faniyan, O., Opara, C., Oyinade, A., Botchway, P., & Soyemi, K. (2017). Vaccine financing in Nigeria: are we making progress towards self-financing/sustenance?. *The Pan African Medical* ***Journal*****,** ***27*****(Suppl 3), 9.**

180. Nomhwange, T., Jean Baptiste, A. E., Ezebilo, O., Oteri, J., Olajide, L., Emelife, K., ... & Tomori, O. (2021). The resurgence of yellow fever outbreaks in Nigeria: a 2-year review 2017–2019. *BMC infectious diseases*, *21*, 1-12.

181. Lindstrand, A., Cherian, T., Chang-Blanc, D., Feikin, D., & O'Brien, K. L. (2021). The world of immunisation: achievements, challenges, and strategic vision for the next decade. ***The Journal of Infectious Diseases*****,** ***224*****(Supplement_4), S452-S467.**

182. Braka, F., Adamu, U., Siddique, A., Bolu, O., Damisa, E., Banda, R., ... & Shuaib, F. (2023). The role of polio emergency operations centers: perspectives for future disease control initiatives in Nigeria. ***The Pan African Medical Journal*****,** ***45*****(Suppl 2), 8.**

183. Agbede, G. T., Emezirinwune, D., Adedokun, T., & Idowu-Collins, P. (2024). Vaccine hesitancy in Nigeria: overcoming cultural, linguistic and religious obstacles. *Information Impact:* ***Journal of Information and Knowledge Management*****,** ***15*****(1), 153-168.**

184. Ogunniyi, T. J. (2024). Revealing the challenges and efforts of routine immunisation coverage in Nigeria. *Health Science Reports*, *7*(8), e70000.

185. Pavia, G., Branda, F., Ciccozzi, A., Romano, C., Locci, C., Azzena, I., ... & Scarpa, F. (2024). Integrating digital health solutions with immunisation strategies: Improving immunisation coverage and monitoring in the post-COVID-19 era. *Vaccines*, *12*(8), 847.

186. Ingle, Erin A., Priyanka Shrestha, Aparna Seth, Mathias S. Lalika, Jacinta I. Azie, and Rena C. Patel. "Interventions to vaccinate zero-dose children: a narrative review and synthesis." *Viruses* 15, no. 10 (2023): 2092.

187. Alderson, M. R., LaForce, F. M., Sobanjo-ter Meulen, A., Hwang, A., Preziosi, M. P., & Klugman, K. P. (2019). Eliminating meningococcal epidemics from the African meningitis belt: the case for advanced prevention and control using next-generation meningococcal conjugate vaccines. ***The Journal of infectious diseases*****,** ***220*****(Supplement_4), S274-S278.**

188. Mohammed, I., Iliyasu, G., & Habib, A. G. (2017). Emergence and control of epidemic meningococcal meningitis in sub-Saharan Africa. *Pathogens and global health*, *111*(1), 1-6.

189. Trotter, C. L., Lingani, C., Fernandez, K., Cooper, L. V., Bita, A., Tevi-Benissan, C., ... & Stuart, J. M. (2017). Impact of MenAfriVac in nine countries of the African meningitis belt, 2010–15: an analysis of surveillance data. The Lancet infectious diseases, 17(8), 867-872.

190. Bender, R. G., Shen, J., Aravkin, A., Fouda, A. A. B., Bwaka, A. M., Galles, N. C., ... & Kyu, H. H. (2023). Meningococcal A conjugate vaccine coverage in the meningitis belt of Africa from 2010 to 2021: a modelling study. *EClinicalMedicine*, *56*.

191. Onwujekwe, O., Ezumah, N., Mbachu, C., Obi, F., Ichoku, H., Uzochukwu, B., & Wang, H. (2019). Exploring effectiveness of different health financing mechanisms in Nigeria; what needs to change and how can it happen?. *BMC health services research*, *19*, 1-13.

192. Sadiq, M., Croucher, S., & Dutta, D. (2023). COVID-19 vaccine Hesitancy: a content analysis of Nigerian YouTube videos. *Vaccines*, *11*(6), 1057.

193. Svallfors, S., Båge, K., Ekström, A. M., Elimian, K., Gayawan, E., Litorp, H., & Kågesten, A. (2024). Armed conflict, insecurity, and attitudes toward women's and girls' reproductive autonomy in Nigeria. *Social Science & Medicine*, *348*, 116777.

194. Duru, J. I., Usman, S., Adeosun, O., Stamidis, K. V., & Bologna, L. (2019). Contributions of volunteer community mobilisers to polio eradication in Nigeria: the experiences of non-governmental and civil society organisations. *The American Journal of Tropical Medicine and Hygiene*, *101*(4 Suppl), 74.

195. Olutuase, V. O., Iwu-Jaja, C. J., Akuoko, C. P., Adewuyi, E. O., & Khanal, V. (2022). Medicines and vaccines supply chains challenges in Nigeria: a scoping review. *BMC Public Health*, *22*, 1-15.

196. Geneti, L., Shallo, S. A., Yebasa, M. A., & Daba, D. B. (2024). Health workers' knowledge and practices toward vaccine cold chain management and its associated factors in a resource-limited setting of Sheger, Oromia, Ethiopia: a multicenter cross-sectional study. *BMC pediatrics*, *24*(1), 786.

197. Nnaji, C. A., Owoyemi, A. J., Amaechi, U. A., Wiyeh, A. B., Ndwandwe, D. E., & Wiysonge, C. S. (2021). Taking stock of global immunisation coverage progress: the gains, the losses and the journey ahead. *International Health*, *13*(6), 653-657.

198. Gostin, L. O., Monahan, J. T., Kaldor, J., DeBartolo, M., Friedman, E. A., Gottschalk, K., ... & Yamin, A. E. (2019). The legal determinants of health: harnessing the power of law for global health and sustainable development. *The lancet*, *393*(10183), 1857-1910.

199. Clemente-Suárez, V. J., Hormeño-Holgado, A., Jiménez, M., Benitez-Agudelo, J. C., Navarro-Jiménez, E., Perez-Palencia, N., ... & Tornero-Aguilera, J. F. (2020). Dynamics of population immunity due to the herd effect in the COVID-19 pandemic. *Vaccines*, *8*(2), 236.

200. Rasmussen, A. L. (2020). Vaccination is the only acceptable path to herd immunity. *Med*, *1*(1), 21-23.

201. Bullen, M., Heriot, G. S., & Jamrozik, E. (2023). Herd immunity, vaccination and moral obligation. *Journal of medical ethics*, *49*(9), 636-641.

202. Kayser, V., & Ramzan, I. (2021). Vaccines and vaccination: history and emerging issues. *Human vaccines & immunotherapeutics*, *17*(12), 5255-5268.

203. Rodrigues, C. M., & Plotkin, S. A. (2020). Impact of vaccines; health, economic and social perspectives. *Frontiers in microbiology*, *11*, 1526.

204. Randolph, H. E., & Barreiro, L. B. (2020). Herd immunity: understanding COVID-19. *Immunity*, *52*(5), 737-741.

205. Guerra, F. M., Bolotin, S., Lim, G., Heffernan, J., Deeks, S. L., Li, Y., & Crowcroft, N. S. (2017). The basic reproduction number (R0) of measles: a systematic review. *The Lancet Infectious Diseases*, *17*(12), e420-e428.

206. Lauria, A. M., & Zabbo, C. P. (2024). Pertussis.[Updated 2022 Oct 7]. *StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing*.

207. Voorman, A., Hoff, N. A., Doshi, R. H., Alfonso, V., Mukadi, P., Muyembe-Tamfum, J. J., ... & Rimoin, A. W. (2017). Polio immunity and the impact of mass immunisation campaigns in the Democratic Republic of the Congo. *Vaccine*, *35*(42), 5693-5699.

208. Lam, E., Rosen, J. B., & Zucker, J. R. (2020). Mumps: an update on outbreaks, vaccine efficacy, and genomic diversity. *Clinical Microbiology Reviews*, *33*(2), 10-1128.

209. Truelove, S. A., Keegan, L. T., Moss, W. J., Chaisson, L. H., Macher, E., Azman, A. S., & Lessler, J. (2020). Clinical and epidemiological aspects of diphtheria: a systematic review and pooled analysis. *Clinical Infectious Diseases*, *71*(1), 89-97.

210. Aleem, A., Ab, A. S., & Slenker, A. K. (2021). Emerging variants of SARS-CoV-2 and novel therapeutics against coronavirus (COVID-19).

211. Hamson, E., Forbes, C., Wittkopf, P., Pandey, A., Mendes, D., Kowalik, J., ... & Mugwagwa, T. (2023). Impact of pandemics and disruptions to vaccination on infectious diseases epidemiology past and present. *Human Vaccines & Immunotherapeutics*, *19*(2), 2219577.

212. Olufadewa, I., Bamidele, D., Olufadewa, T., Adesina, M., & Oladele, R. (2024). Combating recurrent measles outbreaks in Nigeria: Short-term and long-term strategies. *Journal of Medicine, Surgery, and Public Health*, *3*, 100123.

213. Pittet, L. F., & Posfay-Barbe, K. M. (2021). Vaccination of immune compromised children—an overview for physicians. *European journal of pediatrics*, *180*, 2035-2047.

214. Velavan, T. P., Pollard, A. J., & Kremsner, P. G. (2020). Herd immunity and vaccination of children for COVID-19. *International Journal of Infectious Diseases*, *98*, 14.

215. Galagali, P. M., Kinikar, A. A., & Kumar, V. S. (2022). Vaccine hesitancy: obstacles and challenges. *Current pediatrics reports*, *10*(4), 241-248.

216. Nuwarda, R. F., Ramzan, I., Weekes, L., & Kayser, V. (2022). Vaccine hesitancy: contemporary issues and historical background. *Vaccines*, *10*(10), 1595.

217. Sinuraya, R. K., Nuwarda, R. F., Postma, M. J., & Suwantika, A. A. (2024). Vaccine hesitancy and equity: lessons learned from the past and how they affect the COVID-19 countermeasure in Indonesia. *Globalisation and Health*, *20*(1), 11.

218. Rodrigues, F., Ziade, N., Jatuworapruk, K., Caballero-Uribe, C. V., Khursheed, T., & Gupta, L. (2023). The impact of social media on vaccination: a narrative review. *Journal of Korean Medical Science*, *38*(40).

219. Zimmerman, T., Shiroma, K., Fleischmann, K. R., Xie, B., Jia, C., Verma, N., & Lee, M. K. (2023). Misinformation and COVID-19 vaccine hesitancy. *Vaccine*, *41*(1), 136-144.

220. Caceres, M. M. F., Sosa, J. P., Lawrence, J. A., Sestacovschi, C., Tidd-Johnson, A., Rasool, M. H. U., ... & Fernandez, J. P. (2022). The impact of misinformation on the COVID-19 pandemic. *AIMS public health*, *9*(2), 262.

221. Tiwana, M. H., & Smith, J. (2024). Faith and vaccination: a scoping review of the relationships between religious beliefs and vaccine hesitancy. *BMC Public Health*, *24*(1), 1806.

222. Richard, O. (2023). Fraud, corruption and counterfeits in the Nigerian pharmaceutical industry. Univ Portsm.

223. Scharff, D. P., Mathews, K. J., Jackson, P., Hoffsuemmer, J., Martin, E., & Edwards, D. (2010). More than Tuskegee: understanding mistrust about research participation. *Journal of health care for the poor and underserved*, *21*(3), 879-897.

224. Capurro, G., Maier, R., Tustin, J., Jardine, C. G., & Driedger, S. M. (2022). "They're trying to bribe you and taking away your freedoms": COVID-19 vaccine hesitancy in communities with traditionally low vaccination rates. *Vaccine*, *40*(50), 7280-7287.

225. Najjar, M., Albuaini, S., Fadel, M., & Mohsen, F. (2023). Covid-19 vaccination reported side effects and hesitancy among the Syrian population: a cross-sectional study. *Annals of Medicine*, *55*(2), 2241351.

226. Zhao, L., Tran, H., Risk, M., & Nair, G. (2024). Risk of blood clots after COVID-19 vaccination and infection: a risk-benefit analysis. *Research square*, rs-3.

227. González-Block, M. Á., Arroyo-Laguna, J., Rodríguez-Zea, B., Pelcastre-Villafuerte, B. E., Gutiérrez-Calderón, E., Díaz-Portillo, S. P., ... & Sarti, E. (2021). The importance of confidence, complacency, and convenience for influenza vaccination among key risk groups in large urban areas of Peru. *Human vaccines & immunotherapeutics*, *17*(2), 465-474.

228. Frenkel, L. D. (2021, September). The global burden of vaccine-preventable infectious diseases in children less than 5 years of age: implications for COVID-19 vaccination. How can we do better?. In *Allergy and asthma proceedings* (Vol. 42, No. 5, pp. 378-385). OceanSide Publications, Inc.

229. Packham, A., Taylor, A. E., Karangwa, M. P., Sherry, E., Muvunyi, C., & Green, C. A. (2024). Measles vaccine coverage and disease outbreaks: A systematic review of the early impact of COVID-19 in low and lower-middle income countries. *International Journal of Public Health*, *69*, 1606997.

230. Rodrigues, C. M., & Plotkin, S. A. (2020). Impact of vaccines; health, economic and social perspectives. *Frontiers in microbiology*, *11*, 1526.

231. Briciu, V., Topan, A., Calin, M., Dobrota, R., Leucuta, D. C., & Lupse, M. (2023, January). Comparison of COVID-19 severity in vaccinated and unvaccinated patients during the Delta and Omicron wave of the pandemic in a Romanian tertiary infectious diseases hospital. In *Healthcare* (Vol. 11, No. 3, p. 373). MDPI.

232. Hasan, T., Lynch, M., King, C., Wehbe, C., Plymoth, M., Islam, M. S., ... & Sheel, M. (2024). Vaccine-Preventable Disease Outbreaks Among Healthcare Workers: A Scoping Review. *Clinical Infectious Diseases*, *79*(2), 555-561.

233. Blanchard-Rohner, G., Caprettini, B., Rohner, D., & Voth, H. J. (2021). Impact of COVID-19 and intensive care unit capacity on vaccination support: Evidence from a two-leg representative survey in the United Kingdom. *Journal of virus eradication*, *7*(2), 100044.

234. Alkhawaldeh, A., ALBashtawy, M., Rayan, A., Abdalrahim, A., Musa, A., Eshah, N., ... & Khraisat, O. (2023). Application and use of Andersen's behavioral model as theoretical framework: a systematic literature review from 2012–2021. *Iranian journal of public health*, *52*(7), 1346.

235. Adongo, A. A., Dapaah, J. M., Azumah, F. D., & Onzaberigu Nachinaab, J. (2022). The influence of sociodemographic behavioural variables on health-seeking behaviour and the utilisation of public and private hospitals in Ghana. *International Journal of Sociology and Social Policy*, *42*(5/6), 455-472.

236. Alyafei, A., & Easton-Carr, R. (2024). The health belief model of behavior change. In *StatPearls [Internet]*. StatPearls Publishing.

237. Adeyanju, G. C., & Betsch, C. (2024). Vaccination decision-making among mothers of children 0–12 months old in Nigeria: A qualitative study. *Human Vaccines & Immunotherapeutics*, *20*(1), 2355709.

238. Ajzen, I. (1991). The theory of planned behavior. Organisational behavior and human decision processes, 50(2), 179-211.

239. Almutairi, W. M., Alsharif, F., Khamis, F., Sallam, L. A., Sharif, L., Alsufyani, A., ... & Alqasimi, R. (2021). Assessment of mothers' knowledge, attitudes, and practices regarding childhood vaccination during the first five years of life in Saudi Arabia. *Nursing reports*, *11*(3), 506-516.

240. Finlay, K. A., Trafimow, D., & Moroi, E. (2006). The importance of subjective norms on intentions to perform health behaviors. *Journal of Applied Social Psychology*, *29*(11), 2381-2393.

241. Nurmi, J., & Jaakola, J. (2023). Losing trust: Processes of vaccine hesitancy in parents' narratives. *Social Science & Medicine*, *331*, 116064.

242. Badran, E. F., Qasem, Z., Alqutob, R., Khaled, M. W., Aldabbas, A. M., Mansour, A. A., ... & Salhout, S. I. (2024). Understanding Parental Intentions for COVID-19 Child Vaccination: A Cross-Sectional Study From Jordan Using Theory of Planned Behavior. *Journal of Multidisciplinary Healthcare*, 2729-2740.

243. Konwea, P. E., David, F. A., & Ogunsile, S. E. (2018). Determinants of compliance with child immunisation among mothers of children under five years of age in Ekiti State, Nigeria. *Journal of Health Research*, *32*(3), 229-236.

244. Mekonnen, Z. A., Gelaye, K. A., Were, M. C., & Tilahun, B. (2020). Timely completion of vaccination and its determinants among children in northwest, Ethiopia: a multilevel analysis. *BMC public health*, *20*, 1-13.

245. Galadima, A. N., Zulkefli, N. A. M., Said, S. M., & Ahmad, N. (2021). Factors influencing childhood immunisation uptake in Africa: a systematic review. *BMC Public Health*, *21*, 1-20.

246. Tesema, G. A., Tessema, Z. T., Tamirat, K. S., & Teshale, A. B. (2020). Complete basic childhood vaccination and associated factors among children aged 12–23 months in East Africa: a multilevel analysis of recent demographic and health surveys. *BMC Public Health*, *20*, 1-14.

247. Oyo-Ita, A., Oduwole, O., Arikpo, D., Effa, E. E., Esu, E. B., Balakrishna, Y., ... & Meremikwu, M. M. (2023). Interventions for improving coverage of childhood immunisation in low-and middle-income countries. *Cochrane Database of Systematic Reviews*, (12).

248. Fenta, S. M., Biresaw, H. B., Fentaw, K. D., & Gebremichael, S. G. (2021). Determinants of full childhood immunisation among children aged 12–23 months in sub-Saharan Africa: a multilevel analysis using Demographic and Health Survey Data. *Tropical medicine and health*, *49*, 1-12.

# Chapter Three

# Methodology

Included in this section are the study's methodology, location, intended participants, research tool, sampling strategy, sample size, and validity of the instrument, data collection methods, and data analysis methodologies. The amalgamation of all these components results in the findings drawn.

## 3.1 Study Design

A cross-sectional design was used in this investigation. Research design is a systematic approach for investigation and the framework through which this strategy is implemented, detailing the methods and procedures for data gathering, measurement, and analysis. This study utilised a descriptive survey approach to gather information through the administration of a questionnaire to a sample of mothers. For populations that are too big to research in person, descriptive surveys are the way to go.

## 3.2 Study Area

The setting of this study was Ajeromi - Ifelodun Local Government Area of Lagos, Lagos State. Ajeromi-Ifelodun was created/calve from Badagry Local Government Area of Lagos State. The Local Government has its headquarters at Ajegunle by Ago Hausa towards the boundary road it shares boundaries with Amuwo -Odofin Local Government, The development areas of the Apapa Iganmu Local Council and the Apapa Local Government Area.

.

The local government was created for the development of the area and to improve the living standard of the people living in the community. Most places in the area are slump and hard to rich. The community comprises different tribes with different languages, and the major language used in the area is pidgin English, and their main occupation is trading, hence we have different markets situated in the area like Boundary Market, Alaba/Suru Market, Akere Market and the likes. More so street trading is not prohibited in the community.

The educational background of the citizens in the area is average compared to the people living in the Apapa Local Government Area, due to their educational background most of the people do not know the value of immunisation hence I selected the L.G.A for the study to improve immunisation coverage to reduce diseases more so the study will help the mothers of under-five by providing sound knowledge on immunisation to improve the wellbeing of childhood to adulthood. It will also educate clinic staff on the best way to ensure that mothers find it interesting to attend immunisation clinics with their wards.

In the study area, there are different types of healthcare services, including public and private facilities, as well as alternative medicine practitioners and traditional birth attendants. Specifically, Ajeromi General Hospital in Awodiora has several primary health care centers (PHC) such as Akere PHC, Layeni PHC, Amukoko PHC, Oridilu PHC, Alaba PHC, Ibafon PHC, Tolu PHC, and Agejunle PHC.

As of 2015, Ajeromi General Hospital reported a population of 1,905,700, with a population density of 12.49k per square kilometer. The annual population change from 2006 to 2015 was 3.2%.

Established in 1996, Ajeromi -Ifelodun Local Government Area is one of three district councils under the Badagry Division. It was divided into eleven wards: Ago Hausa, Alabo Oro, Awodi-Ora, Layeni, Mosetejo, Ojo Road, Olodi Apapa, Temidire 1, Temidire II, Tolu, and Wilmer. These wards represent the administrative structure of the local government with the population of 1,456,783 as at 2022 and the LGA has a high density of approximately 211,000 people per square mile (81,470 perKM$^2$).

And it was the second largest local government in Lagos State after Alimosho Local Government and their main occupation was trading.

### 3.3 Study Population

No nursing mothers were excluded from the study in Ajeromi-Ifelodun Local Government Area of Lagos State and the sampling of the population of the study was 801 respondents.

### 3.4 Sample and Sample Method/Procedure

Fishers' calculation determined the minimum sample size for descriptive investigations with populations over 10,000. For this investigation, the following variables were considered while estimating sample size:

Ajeromi-Ifelodun LGA, Lagos State, carer population. 95% confidence interval, 1.96 standard normal deviation. The allowed error margin is 5%.

Based on Fisher's calculation, that is

$$n = \frac{Z^2Pq}{d^2}$$

Where: n - minimum sample size required

d - Is the margin of error 5%

z - Confidence level 95%

p - The estimated proportion: According to UNICEF (2018), approximately 20% of children under 5 years old had not received full immunisation[79].

$$n = \frac{Z^2Pq}{d^2}$$

$$n = \frac{(1.96)^2\,(0.5)(0.5)}{(0.05)^2}$$

$$n = \frac{3.8416 \times 0.25}{0.0025}$$

$$n = \frac{0.9604}{0.0025} = 384.16$$

$$n = 384$$

The sample size for this study was increased to 805 individuals. The initial study took place in Ojo Local Government Area, Lagos State, with a calculated total of 384 respondents[1]. To ensure a more representative population for this study, the estimated proportion needs to be increased above 50 percent, in order to improve progression of measure and to increase statistical power.

**Data Analysis conditions:**

- The primary data was obtained through the administration of structured questionnaire to mothers and mothers of under five children
- The data set reflected the realities of mothers in Ajeromi-Ifelodun LGA, a densely populated urban selfing with diverse socio-economic characteristic.

- Completeness data is dependent on responses willingness and ability to provide accurate information by the carer.

**Data Management**

The age was recoded into 6 groups by a 5-year interval: 1 (less than 20 years), 2(20-24), 3(25-29), 4(30-34), 5(35-39) and 6(40 years and above).

Descriptive statistics were used to summarise the demographic characteristics of the respondents.

Determine the prevalence of completion childhood immunisation among mothers of under-5

The age of the babies was recoded into 8 groups based on the immunisation schedule using the approved vaccination schedule. 1(1month), 2(2months), 3(3-5months), 4(6-8months), 5(7-9months), 6(9-11months), 7(12-14months) and 8(15months and above). Group 8 represents the cohort of babies that completed their immunisation.

Group 8 was selected from the rest using data select, then each immunisation was selected and the preceding years/ages were excluded using data select again and the frequency and percentage were then determined.

To examine the barriers to the uptake of childhood immunisation by mothers of under five

The frequency and percentage of Q25-31 were analyzed and reported.

To assess the perception of mothers towards childhood immunisation of under five

The Q32-39 were recoded as 1(SA), 2(A), 3(N), 4(D) and 5(SD). But for Q36 whose correct response is SD, it was recoded as 1(SD), 2(D), 3(N), 4(A), and 5(SA). A new variable was generated by computing the response for each question. The frequency was determined with the lowest as 8 and the highest as 35. The result was recoded to 8-16 as 1(good perception) while 17 and above as 0(poor perception).

Determine the factors associated with the completion of childhood immunisation by mothers.

The frequency and percentage of Q44-45 and Q48-49 were analyzed and recorded.

### 3.5 Sample Procedure

A multi-stage cluster sample Procedure was used to select the participants for this study as follows:

There are eleven wards in Ajeromi Ifelodun LGA with the total population of 1,456,783 as at 2022.

**Stage 1:** Five (5) wards was selected for the work.

**Stage 2:** Mosafejo ward – 170 participants, Temidire ward – 145 participants, Layeni – 150 participants, Ojo road ward – 185 participants, Ago Hausa wards – 155 participants

**Stage 3:** Cluster sample procedure was used to select the participants, being a community-based procedure, the participants was selected among the mothers in the community.

**3.5.1 Inclusion:** Mothers aged 18-49 years who have lived in Ajeromi Ifelodun LGA for at least six months and have at least one child under five years

**3.5.2 Exclusion:** Mothers who where temporary residents, those who were ill at the time of data collection, and those who did not provide informed consent.

### 3.6 Research Instrument

The research instrument used was questionnaire. The questionnaire was divided into four (4) **sections a, b, c, & d.**

**Section (a)** sort information about Age, Sex/gender, Location, Parent level of education, Religion, Family type, financial status, Spouse education level, Spouse occupation, and birth order.

**Section (b)** determined the prevalence of complete immunisation among under five with the belief of mothers that immunisation will prevent diseases

**Section (c)** examined the barrier to the uptake of childhood immunisation among mothers of five, could financial involvement affect the uptake of their children's Immunisation

**Section (d)** Identified predictors of completion of childhood immunisation by mothers of under five could be as a result of single motherhood was designed specifically to investigate factors associated with uptake of childhood immunisation by mothers of under-five in Ajeromi - Ifelodun Local Government Area of Lagos State.

### 3.7 Validation of the Instrument

This study used self-structured questionnaire as the primary research instrument to collect data. The questionnaire was developed based on a comprehensive review of existing literature and previously validated instruments. The content validity of the questionnaires was also established through a thorough literature review and consultations with my supervisor who reviewed the initial draft of the questionnaire to ensure the relevance, comprehensiveness, and clarity of the items. Feedback was incorporated into the final version of the instruments. Research Assistants were engaged and trained and the instrument was pretested. The questionnaire was self-administered.

### 3.8 Reliability of the Instrument

Using the test-retest procedure, a subset of respondents were given the questionnaire twice to test its reliability. The reliability of the research instrument was assessed using Cronbach's Alpha to determine the internal consistency of the 49-item questionnaire. The analysis yielded a Cronbach's Alpha coefficient of 0.82, which is above the recommended threshold of 0.70. This indicates that the instrument has a high level of reliability and is suitable for measuring the factors associated with the uptake of childhood immunisation among mothers of under-five children in Ajeromi-Ifelodun Local Government Area, Lagos State.

This result confirms that the questionnaire used in this study is reliable for data collection, as the Cronbach's Alpha value of 0.82 demonstrates good internal consistency across the items. Therefore, the responses obtained from the participants can be considered consistent and dependable for the purpose of achieving the study objectives.

### 3.9 Method of Data Collection

The research team in this study relied on a self-administered questionnaire that nursing moms in the study area filled out and returned as their main source of data.

Before collecting data in the chosen wards, the researcher trained four(4) research assistants and acquired the required ethical consideration clearance from the Lead City University Ethical Committee and the Community Development Association.

### 3.10 Method of Data Analysis

The disseminated questionnaire was self-administered and collected immediately to guarantee a high response rate.

The questionnaire's gathered data underwent sanitising and verification for errors. The statistical package for the social sciences (SPSS) version 28.0 received the questionnaire's gathered data for statistical calculation and analysis. We used descriptive and inferential statistics. Percentage representations of categorical and nominal data were used; continuous variables were shown as means.

A chi-square test of association was conducted to determine the relationship between independent variables and the dependent variable about factors influencing vaccine uptake. The significance level is established at a 5% alpha level.

### 3.11 Ethical consideration

The Health Research and Ethics Committee at Lead City University gave their stamp of approval to this study. The numbers of study was 801

Since the study populations were mothers, approval was obtained from the community development

Respondents were given verbal informed permission after being briefed about the project and assured that their confidentiality would be strictly upheld.

## Endnotes

1. Oyefara John Lekan: *Mothers characteristics and immunisation status of under-five children in Ojo Local Government Area, Lagos State*, Nigeria August 2014: SAGE Open 4(3) DOI:10:1177/21582440145454

# Chapter Four

## Results and Discussion of Findings

### Results

Tables 4.1: Illustrates the socio-demographic characteristics of the mothers/ mothers residing in Ajeromi-Ifelodun Local Government Area, June 2024. Among the respondents those within the group of 25-29 years were 281 (35.1%), and those less than 20 years of age were 13 (1.6%). Among the respondents, 688 (86.0%) were married, and Christians were 398 (49.7%). The data collected from the participants shows that 232 (29.0%) were skilled.

The study also revealed that 402 (50.2%) of the respondents were secondary school graduates, 330 (41.2%) as tertiary institution graduates and only 17 (1.7%) had no formal education. Similarly, as reported 309 (38.6%) of the respondents earn more than 50,000 monthly.

The result further reveals that 461 (57.6%) of the respondents had partners who were graduates of tertiary institutions, while 284 (35.5%) were employed. In all, 413 (51.6%) of the children were within the first six months of birth, and female 444 (55.4%). As reported, 255 (31.8%) of the babies were first born in the family's birth order.

Among the respondents those within the group of 25-29 years were 281 (35.1%), those less than 20 years of age were 13 (1.6%). Among the respondents, 688 (86.0%) were married; those that are practicing Christianity were 398 (49.7%). The data collected from the participants shows that 232 (29.0%) were skilled.

The study also revealed that 402 (50.2%) of the respondents were secondary school graduates, 330 (41.2%) as tertiary institution graduates and only 17 (1.7%) have no formal education. Similarly, as reported 309 (38.6%) of the respondents earn more than 50,000 monthly.

The result further reveals that 461 (57.6%) of the respondents had partners who were graduates of tertiary institutions, while 284 (35.5%) were employed. In all, 413 (51.6%) of the children were within the first six months of birth, and female 444 (55.4%). As reported, 255 (31.8%) of the babies were first born in the family's birth order.

**Table 4.1: Socio-demographic characteristics of mothers of under five children in Ajeromi-Ifelodun LGA, June 2024.**

| Socio demographic characteristics | n | % |
|---|---|---|
| **Age group (years)** | | |
| <20 | 13 | 1.6 |
| 20-24 | 126 | 15.7 |
| 25-29 | 281 | 35.1 |
| 30-34 | 230 | 28.7 |
| 35-39 | 109 | 13.6 |
| ≥40 | 42 | 5.2 |
| **Marital status** | | |
| Single | 66 | 8.2 |
| Married | 688 | 86.0 |
| Divorced/ Separated/ Widow | 47 | 5.8 |
| **Religion** | | |
| Christian | 398 | 49.7 |
| Muslim | 358 | 44.7 |
| Traditional | 45 | 5.5 |
| **Occupation** | | |
| Professional | 272 | 34.0 |
| Skilled | 232 | 29 |
| Unskilled | 39 | 4.9 |
| Self-employed | 258 | 32.1 |
| **Educational level** | | |
| No formal education | 17 | 1.7 |
| Primary | 52 | 6.5 |
| Secondary | 402 | 50.2 |
| Tertiary | 330 | 41.2 |
| **Monthly income (₦)** | | |
| No income | 33 | 4.1 |
| 10,000 -20,000 | 66 | 8.2 |
| > 20,000-30,000 | 78 | 9.7 |
| > 30,000-40,000 | 123 | 15.4 |
| > 40,000-50,000 | 182 | 22.7 |
| > 50,000 | 309 | 38.6 |

**Field Survey, 2024**

**Table 4.1: Socio-demographic characteristics of mothers in Ajeromi-Ifelodun LGA, June 2024. (con't)**

| Socio demographic characteristics | N | % |
|---|---|---|
| **Partner educational level** | | |
| No formal education | 10 | 1.2 |
| Primary | 22 | 2.7 |
| Secondary | 308 | 38.5 |
| Tertiary | 461 | 57.6 |
| **Partner Occupation** | | |
| Professional | 308 | 38.5 |
| Skilled | 154 | 19.2 |
| Unskilled | 55 | 6.8 |
| Self employed | 284 | 35.5 |
| **Mother Educational level** | | |
| No formal education | 90 | 11.2 |
| Primary | 215 | 27.0 |
| Secondary | 206 | 26.0 |
| Tertiary | 290 | 36.2 |
| **Mother Occupation** | | |
| Professional | 61 | 8.0 |
| Skilled | 287 | 36.0 |
| Employed | 384 | 48.0 |
| Unempoloyed | 69 | 9.0 |
| **Age of child** | | |
| Birth - 6 months | 413 | 51.6 |
| 7-12months | 231 | 28.8 |
| 13-18months | 52 | 6.5 |
| 19-24months | 41 | 5.1 |
| 25-30months | 23 | 2.9 |
| 31-36months | 21 | 2.6 |
| > 36 months | 20 | 2.5 |
| **Gender of child** | | |
| Male | 357 | 44.6 |
| Female | 444 | 55.4 |
| **Birth order** | | |
| 1 | 255 | 31.8 |
| 2 | 236 | 29.5 |
| 3 | 166 | 20.7 |
| 4 | 83 | 10.4 |
| > 4 | 61 | 7.6 |

**Field Survey, 2024**

Table 4.2 Illustrates other respondents' medical history. In all 316 (39.5%) of the babies were born in primary health care centers with 9 (1.1%) at home. Also 672 (83.9%) were born through vaginal delivery. Furthermore, 745(93%) of the births were registered, and 784 (97.9%) had their immunisation card; although, 724 (90.4%) provided their cards, while 752(90.4%) of the mothers received postnatal care.

**Table 4.2: Characteristics of under 5 children in Ajeromi Ifelodun LGA, June, 2024.**

| **Socio demographic characteristics** | **N** | **%** |
|---|---|---|
| **Place of birth** | | |
| General hospital | 108 | 13.5 |
| Private hospital | 304 | 38 |
| Primary health care | 316 | 39.5 |
| Church | 34 | 4.2 |
| TBA | 30 | 3.8 |
| Home | 9 | 1.1 |
| **Delivery type** | | |
| Caesarean section | 82 | 10.2 |
| Vaginal delivery | 672 | 83.9 |
| Induction | 43 | 5.4 |
| Vacuum extraction | 4 | 0.5 |
| **Birth registration** | | |
| Yes | 745 | 93 |
| No | 56 | 7 |
| **Immunisation card available** | | |
| Yes | 784 | 97.9 |
| No | 17 | 2.1 |
| **Immunisation card seen** | | |
| Yes | 724 | 90.4 |
| No | 77 | 9.6 |
| **Postnatal care** | | |
| Yes | 752 | 93.9 |
| No | 49 | 6.1 |

**Field Survey, 2024**

Figure 4.1 shows the percentage distribution of the respondents' immunisation uptake. A majority (99.5%) had taken the Bacillus Chalmette-Guerin (BCG) vaccine, Oral Polio vaccine (opv0), Hepatitis B (hep B), and Pneumococcal Conjugate vaccine (pcv1) vaccines, with Meningitis vaccine being the least (47.1%).

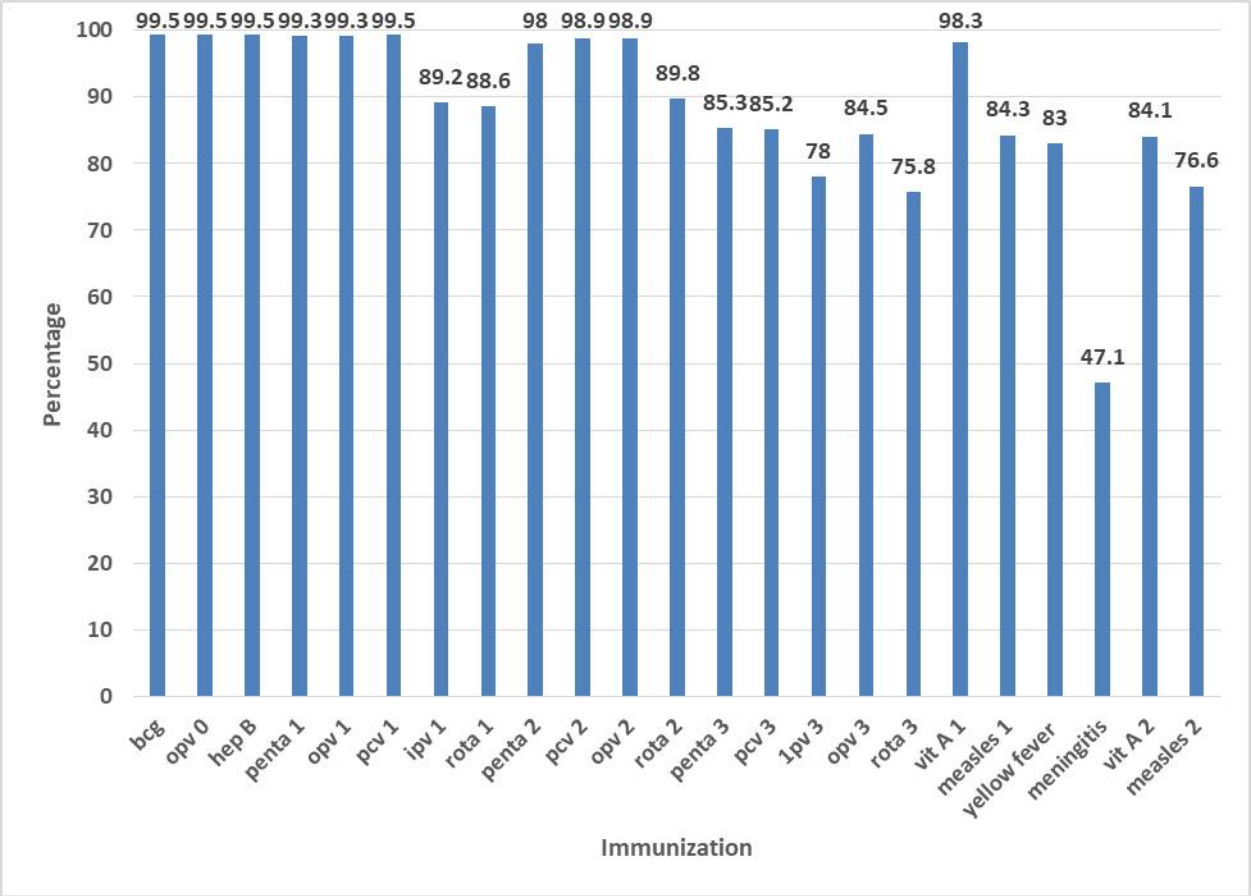


**Figure 4.1: Percentage distribution of immunisation uptake**

Figure 4.2 shows the prevalence of immunisation completion among under-5 in the study population. The report indicates 83 (55.7%) did not complete their vaccination while 66 (44.3%) completed their immunisation.

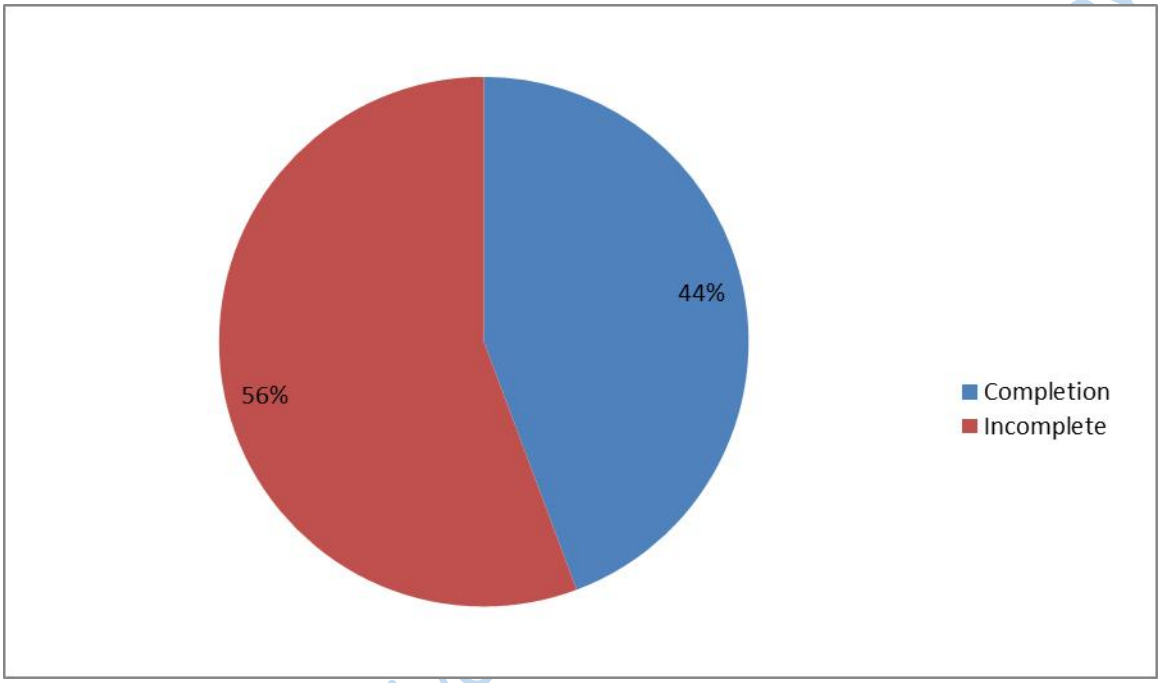


**Figure 4.2:** Prevalence of immunisation completion among under-5 Children in Ajeromi-Ifelodun LGA June, 2024.

Figure 4.3 shows the percentage distribution of the respondents' perceived barriers to the uptake of childhood immunisation. The chart reveals that 67.8% identified inadequate staffing as a perceived barrier to the uptake and completion of childhood immunisation among under-5, while lack of trained staff is the least (1.1%).

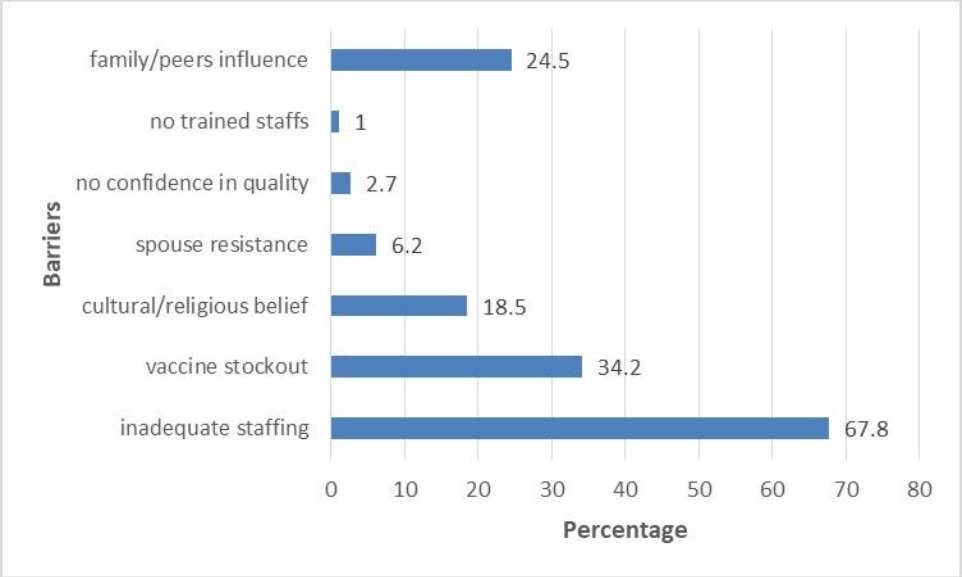


**Figure 4.3: Perceived Barriers to the Uptake of Childhood Immunisation among mothers in Ajeromi-Ifelodun LGA, June, 2024**

Figure 4.4 presents the perception of mothers towards childhood immunisation in Ajeromi-Ifelodun LGA, June 2024. The result reveals 630 (78.7%) of mothers have good perception, while 171 (21.3%) showed poor perception. This supports the finding that children who were not born in a health facility are likely to be incompletely immunised[5]. Another study reported that children born in health facilities are more likely to receive all vaccines at birth compared to those born elsewhere[4] However, some studies in the Northern part of the country reported low birth antigens immunisation coverage[6].



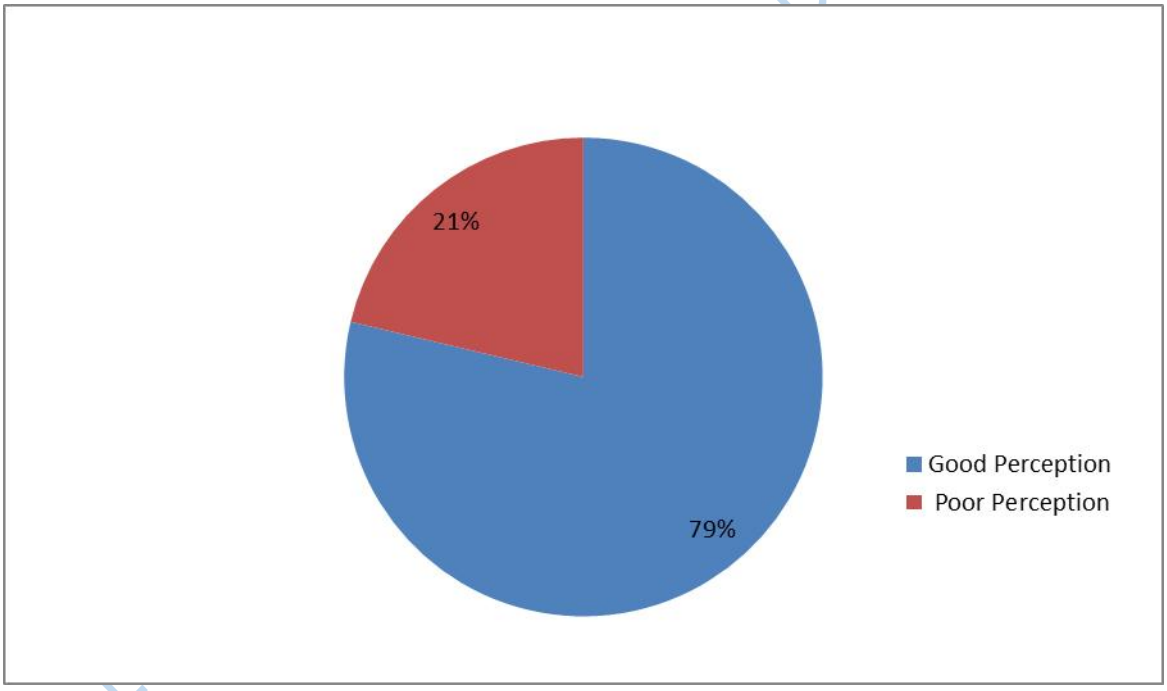


**Figure 4.4: Perception of Mothers of under five children Towards Childhood Immunisation in Ajeromi-Ifelodun LGA, June 2024.**

Table 4.3 shows the factors associated with the completion of childhood immunisation. According to the findings 144 (96.6%) of the mothers are aware of the importance of immunisation and its benefits which was the main factor associated with their child's completion of childhood immunisation. This was followed by the absence of health workers 81(54.4%), forgetting the appointment date was 37 (22.8%) and financial constraints was 18 (12.1%) as the least factor.

Table 4.3 also displays the possible suggestions from mothers that could enable them to complete their vaccination 30(20.1%) of the respondents confessed to forgetting vaccination appointments. (46.6%) of these said they don't receive reminders from the health facility while 80 (80%) reportedly said they would love the clinic to send them prompts about their next appointment.

**Table 4.3: Barriers to the uptake of childhood immunisation by mothers of under five in Ajeromi-Ifelodun L.G.A Lagos State June, 2024**

| Barriers to the uptake of childhood immunisation | n | % |
|---|---|---|
| Awareness | | |
| Yes | 144 | 96.6 |
| No | 50 | 3.3 |
| Forget appointment | | |
| Yes | 34 | 22.8 |
| No | 115 | 77.2 |
| Absence of health workers | | |
| Yes | 81 | 54.4 |
| No | 68 | 45.7 |
| Financial constraints | | |
| Yes | 18 | 12.1 |
| No | 130 | 87.2 |
| Needs to be reminded | | |
| Yes | 80 | 80.0 |
| No | 20 | 20.0 |
| Not receiving reminders from the health facility | | |
| Yes | 16 | 53.3 |
| No | 14 | 46.7 |

**Field Survey, 2024**

Figure 4.5 illustrates the reasons why vaccination could be delayed. 430 (67.2%) of the respondents revealed that they had delayed their baby's vaccination. It was reported that 256 (60.0%) were due to travelling within the scheduled period for vaccination. It was also recorded in the survey that, 74 (17.2%) of the children did not receive the immunisation due to illness and 60 (14.0%) lack of transport fare while only 40 (9.3%) reported far distance from the vaccination site as a reason for delayed vaccination.

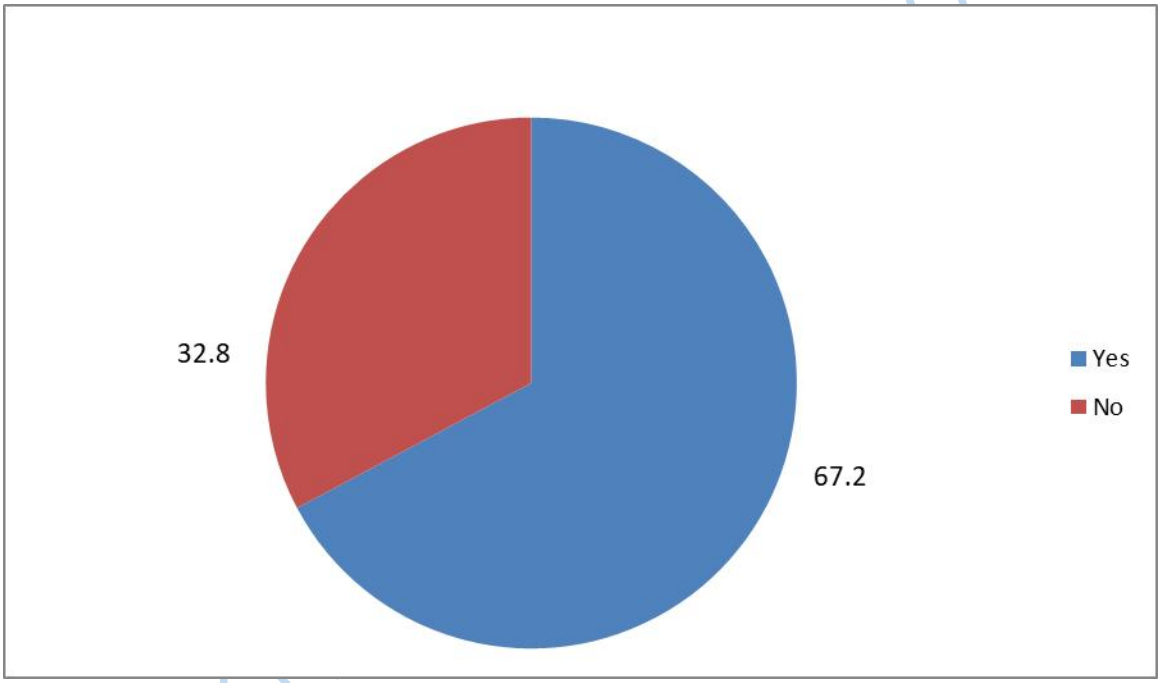


**Figure 4.5a: Presence of barriers to the uptake of childhood immunisation by mothers of under five in Ajeromi-Ifelodun L.G.A Lagos State, June 2024**

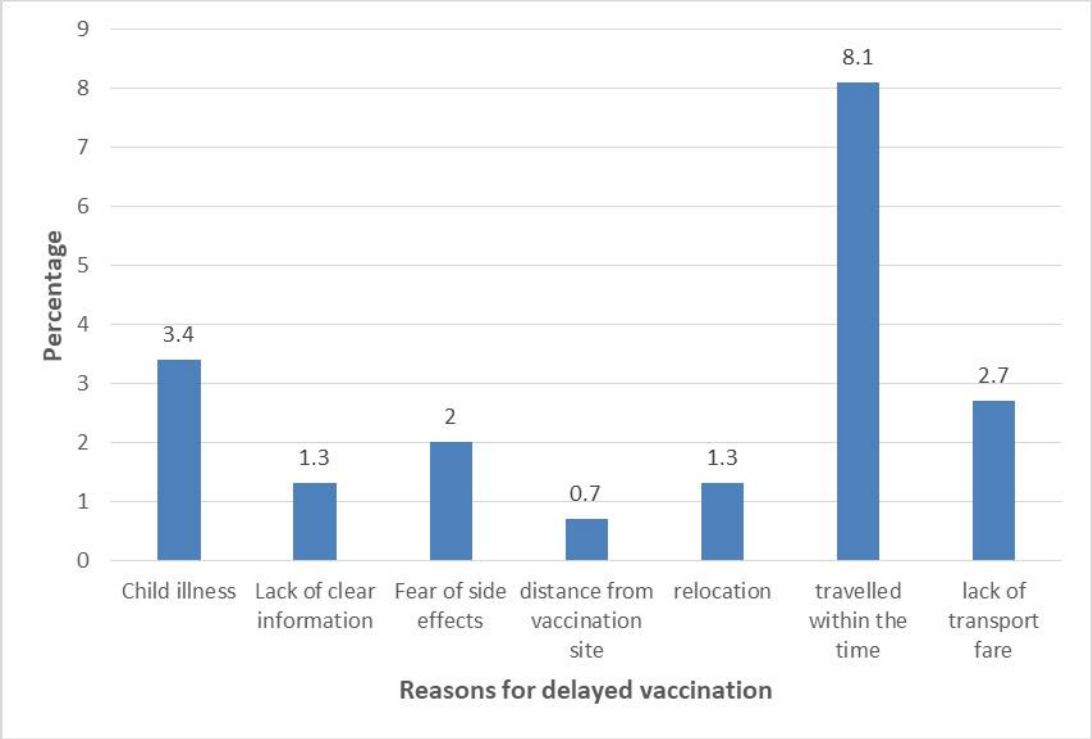


**Figure 4.5b: Reasons for delayed vaccination**

Table 4.4 shows the Immunisation completion and other variables. The result shows that (18.2%) of respondents who were singles completed their immunisation compared to others. The respondents practicing Christianity (10.6%) completed as well as 10.0% of mothers who are skilled workers, while 12.4% of respondents who were university graduates completed their vaccination.

Also, the association between immunisation completion and child age was very significant. 35.9% of babies 12 months and above completed their vaccination ($p<0.001$).

Furthermore, the place of birth was significantly associated with immunisation completion ($p=0.003$). 5.9% of babies born in public hospitals completed their vaccination, while 9.1% of babies whose mothers earn 50,000 and above completed their vaccination.

**Table 4.4: Socio-Demographic Characteristics and Completion of Immunisations among Mothers/ of Under Five Children in Ajeromi-Ifelodun LGA, June 2024.**

| Socio demographic characteristics | Immunisation | | $X^2$ | P-value |
|---|---|---|---|---|
| | Not completed | Completed | | |
| **Mothers' Age (group)** | | | | |
| < 30 years | 386(91.9%) | 34(8.1%) | 1.86 | 0.39 |
| 30-39 years | 310(91.4%) | 29(8.6%) | | |
| 40 years and above | 36(85.7%) | 6(14.3%) | | |
| **Marital status** | | | | |
| Single | 54(81.8%) | 12(18.2%) | 8.75 | 0.01 |
| Married | 636(92.4%) | 52(7.6%) | | |
| Once married | 38(90.5%) | 4(9.5%) | | |
| **Religion** | | | | |
| Christianity | 356(89.4%) | 42(10.6%) | 3.61 | 0.06 |
| Others | 372(93.2%) | 27(6.8%) | | |
| **Occupation** | | | | |
| Skilled | 287(90.0%) | 32(10.0%) | 1.57 | 0.46 |
| Employed | 384(92.1%) | 33(7.9%) | | |
| Unemployed | 61(93.8%) | 4(6.2%) | | |
| **Level of education** | | | | |
| University graduate | 290(87.6%) | 41(12.4%) | 10.90 | 0.001 |
| None university graduate | 441(94.2%) | 27(5.8%) | | |
| **Income** | | | | |
| No income | 32(97.0%) | 1(3.0%) | 1.41 | 0.495 |
| <50,000 | 409(91.1%) | 40(8.9%) | | |
| 50,000 and above | 281(90.9%) | 28(9.1%) | | |
| **Place of birth** | | | | |
| Public hospital | 399(94.1%) | 25(5.9%) | 8.67 | 0.003 |
| Others | 330(88.2%) | 44(11.8%) | | |
| **Delivery type** | | | | |
| Vaginal delivery | 616(91.7%) | 56(8.3%) | 0.45 | 0.501 |
| Others | 115(89.8%) | 13(10.2%) | | |
| **Birth Order** | | | | |
| 1st - 3rd born | 603(91.8%) | 54(8.2%) | 0.39 | 0.54 |
| 4th - 6th born | 99(90.0%) | 11(10.0%) | | |
| **Child Age** | | | | |
| 0-5 months | 275(100.0%) | 0(0.0%) | 239.490 | 0.00 |
| 6-11 months | 334(100.0%) | 0(0.0%) | | |
| 12 months and above | 123(64.1%) | 69(35.9%) | | |

**Table 4.4: Socio-Demographic Characteristics and Completion of Immunisations Among Mothers of Under Five Children in Ajeromi-Ifelodun LGA, June 2024. (Con't)**

| Socio-demographic characteristics | Immunisation not completed | Immunisation completed | $X^2$ | P-value |
|---|---|---|---|---|
| **Child gender** | | | | |
| Male | 319(91.1%) | 31(8.9%) | 0.02 | 0.88 |
| Female | 406(91.4%) | 38(8.6%) | | |
| **Partner educational level** | | | | |
| University graduate | 415(89.4%) | 49(10.6%) | 4.81 | 0.03 |
| None university graduate | 308(93.9%) | 20(6.1%) | | |
| **Partner Occupation** | | | | |
| Skilled | 191(92.3%) | 16(7.7%) | 6.48 | 0.04 |
| Employed | 334(93.3%) | 24(6.7%) | | |
| Unemployed | 201(87.4%) | 29(12.6%) | | |
| **Postnatal care received** | | | | |
| Yes | 667(92.1%) | 57(7.9%) | 3.24 | 0.07 |
| No | 24(82.8%) | 5(17.2%) | | |
| **Registered birth** | | | | |
| Yes | 679(91.1%) | 66(8.9%) | 0.81 | 0.37 |
| No | 53(94.6%) | 3(5.4%) | | |
| **Immunisation card available** | | | | |
| Yes | 717(91.5%) | 67(8.5%) | 0.22 | 0.64 |
| No | 15(88.2%) | 2(11.8%) | | |
| **Immunisation card seen** | | | | |
| Yes | 680(93.9%) | 44(6.1%) | 57.51 | 0.00 |
| No | 52(68.4%) | 24(31.6%) | | |

**Field Survey, 2024**

Table 4.5 shows the factors influencing immunisation completion among mothers in Ajeromi Ifelodun LGA. The results revealed that respondents less than 30 years are 43% less likely to complete the immunisation schedule of their children than those aged 40 and above.

Similarly, respondents who are university graduates are 2.31 times more likely to complete the immunisation schedule of their children than those who are not university graduates at an unadjusted OR (OR = 2.31, 95% CI 1.39-3.84), While mothers who gave birth in public hospitals are 53% less likely to complete the immunisation schedules compared to those delivered in other places at both an adjusted OR and an unadjusted OR (AOR = 0.01, 95% CI 0.28-0.81).

**Table 4.5: Determinants of Immunisation Completion among Mothers of Under-Five Children in Ajeromi Ifelodun LGA, June 2024**

| Determinants of Immunisation Completion | OR | 95% CI | p-value | AOR | 95% CI | p-value |
|---|---|---|---|---|---|---|
| **Mothers Age** | | | | | | |
| <30 years | 0.53 | 0.21-1.34 | 0.18 | | | |
| 30-39 years | 0.56 | 0.22-1.44 | 0.23 | | | |
| 40 years and above | 1 | | | | | |
| **Marital status** | | | | | | |
| Single | 2.11 | 0.63-7.04 | 0.22 | | | |
| Married | 0.78 | 0.27-2.26 | 0.64 | | | |
| Once married | 1 | | | | | |
| **Religion** | | | | | | |
| Christianity | 1.63 | 0.98-2.69 | 0.06 | | | |
| Others | 1 | | | | | |
| **Place of delivery** | | | | | | |
| Public hospital | 0.47 | 0.28-0.78 | 0.004 | 0.47 | 0.28-0.81 | 0.01 |
| Others | 1 | | | 1 | | |
| **Partner educational level** | | | | | | |
| University graduate | 1.82 | 1.06-3.12 | 0.03 | 1.66 | 0.81-3.37 | 0.17 |
| No university graduate | 1 | | | 1 | | |

**Field Survey, 2024**

**Discussion of Findings**

The study aimed to assess the factors associated with childhood immunisation uptake by mothers of under-five in Ajeromi-Ifelodun Local Government Area, Lagos State. The major effective public health intervention currently available for reducing the mortality and morbidity from infectious diseases is Childhood immunisation [3]

**The background characteristics of the mothers in Ajeromi-Ifelodun LGA**

The study focused on mothers of children within the first 5 years of life and their uptake of routine immunisation (RI). The mean age of the mothers in this study is 29.51 ± 5.34. The largest proportion of respondents was aged 25-29 years, this falls within the reproductive age of women in sub-Saharan Africa of 15-45years and corresponds with the findings that the mean age of mothers at first birth in south-west, Nigeria was 24.4[15]. The least being those less than 20 years of age which corresponds with the fact that individuals within these ages are adolescents who are probably in school and single too. Hence, they constituted mostly of the single mothers, which depicts that they got pregnant out of wedlock.

The respondents were mostly married, this corroborates with past studies, and the society here scowls at motherhood outside marriage, and encourages couples to parent their children together[6], hence the data showing that less than 5.0% are either divorced or separated. The data also revealed that the majority of the respondents identified as either Christians or Muslims, these are the two dominant religions in the region, with only a few practising traditional religion and others.

The study revealed that half of the study participants had secondary education which is the minimum requirement in the region. However, 41.2% were tertiary institution graduates with only 1.7% being unschooled. The literacy level of the mothers could potentially impact and determine if the child will complete his or her routine immunisation[6]. Also, most of their

partners had good educational levels, with more than 50% having tertiary education. This could also significantly impact the uptake and completion of childhood immunisation. Thus, the educational level of the mothers and their exposure to media could be a determinant factor if the child will be under-vaccinated or fully vaccinated[12].

Study respondents were predominantly skilled workers and self-employed individuals. This is consistent with the fact that most women in the region are housewives who engage in skills that would enable them to manage the home effectively. Only a few mothers are professional, as female education to the peak is not always encouraged. However, a large percentage are employed and work to assist the family, with only a few indicating as unemployed or unskilled, most of which are likely to be single mothers under the age of 20 years.

From the study report, most of the children were aged 6 months and below, which implies that most parents are aware of the importance of immunisation and take it seriously, but going on to complete it is the issue hence the reason for this study. The children were mostly female and first in their birth order.

**The prevalence of completion childhood immunisation among under five**

The finding of this study demonstrates that most of the children completed the Bacillus Calmette-Guerin (BCG) vaccine, Oral Polio vaccine (OPV0), and Hepatitis B (HepB) vaccines. These vaccines are administered at birth, thus the rate of completion indicates that most health facilities are very intentional, and equipped to administer these vaccines at birth. This complements the finding that over ninety per cent of births in this study took place in a health facilities. This supports the finding that children who were not born in a health facility are likely to be incompletely immunised. Another study reported that children born in health facilities are more likely to receive all vaccines at birth compared to those born elsewhere[12]. However, some

studies in the Northern part of the country showed otherwise, by reporting a far lower birth antigens immunisation coverage in the region [5].

The next routine immunisation is administered at 6 weeks and the percentage completion is higher for penta, opv1 and pcv1 than ipv1 and rota1 had a lower completion. Which could be due to vaccine stock out. The next set of vaccines is taken at 10 weeks, vaccines like penta2, pcv2, and opv2 were mostly reported to be largely complete, while rota2 was not, this could be due to reasons like vaccine stock out, mothers forgetting the date of the vaccination or the requirement to pay before its administration. The mothers forgetting the date of the vaccination could result in defaulting and incomplete immunisation [14]. Also, it has been reported that payments are made in some facilities before the administration of vaccines even in public facilities. This could discourage immunisation uptake for their children [17].

However, the trend of completion decreased afterwards with meningitis being the least with less than 50% completion, while vitamin A1 had the most completion of 98.3%. This result is consistent with reports that after 10 weeks there was a decreased uptake of immunisation. This could be due to the unavailability of the vaccines, lack of awareness, forgetfulness of mothers, and return to work thus the need to encourage maternity leave for up to 6 months postpartum. Thus, the need to include prompts to help remind mothers of vaccination schedules. Similar studies on this vaccine administration revealed a higher administration of vaccines at birth than those administered later on like measles vaccine, yellow fever and meningitis[14].

Furthermore, the prevalence of immunisation completion among under-5 is reported in this study to be 8.6%. This is lower than reports in the United States of America, which found that only 41.7% of U.S. children received all vaccines on time for all recommended doses in the combined 7-vaccine series by age 19 months [1]. Also, other reports in Africa and Nigeria showed that our

findings are lower compared to these earlier studies conducted elsewhere in Africa which revealed that more than half (54.5%) of children were fully vaccinated[8], as well as another similar study in Nigeria which reported that about 30% of the under-5 were fully inoculated [6]. This could be due to the fact that a lot of the children are below the age of vaccine completion. Comparable to previous studies [10], it was observed that a large proportion of under-five children were under-immunised with a number of missed doses. Factors like inaccessibility to a health facility, financial constraint, maternal literacy level and place of residence were associated factors which influence immunisation uptake. If these factors are addressed it could help improve vaccine compliance generally.

**The barriers to the uptake of childhood immunisation**

The result revealed several perceived barriers to the uptake of childhood immunisation. The most perceived barrier is reported as inadequate staffing. The next perceived barrier is vaccine stock-out, this aligns with findings from a study in Rwanda where the mothers stated vaccine stockout as a barrier to the completion of childhood RI [26]. Also, family or peer influence is another perceived barrier, while cultural and religious belief was not left out, this corroborates the findings of[6] that the education given by religious organisations on immunisation impacts the full vaccination of children by their mothers. However, spouse resistance, lack of confidence in the quality of the vaccine as well and untrained staff were the least on the list of perceived barriers with untrained staff being as low as 1%.

**The perception of mothers towards childhood immunisation**

The perception of mothers towards childhood immunisation varies as reported in this study with most (78.7%) mothers having a good perception towards childhood immunisation. This is consistent with the study in the Atakumosa-west local government area on maternal knowledge,

attitude and ception of routine immunisation programs[4]. A small proportion of mothers exhibited a poor perception of childhood immunisation. This is comparable to findings in another study in Osun state Nigeria, which revealed that 16.3% of the respondents didn't have a good perception. Hence, mothers with negative perceptions were more unlikely to have their children complete their immunisation schedule [10]. Thus, there is a dire need for more education and accurate information on childhood immunisation, its significance, vaccine safety and efficacy. This will help ensure comprehensive knowledge of mothers of routine vaccines and the schedule [14].

**The perceived factors associated with the completion of childhood immunisation**

There are many factors associated with the completion of childhood immunisation. However, the few considered in this study are very relevant to the subject. Most of the mothers revealed that lack of awareness was a major factor associated with their failure to complete their child's immunisation schedule. This corroborates the findings that poor knowledge of childhood immunisation is strongly associated with incompletion of childhood immunisation [16]. Thus, limited knowledge or awareness among mothers about routine immunisation, its significance and the vaccination schedule has been closely associated with incomplete vaccination and, in some cases, the failure to vaccinate altogether[8]. It is therefore essential to raise awareness about the routine immunisation of children, educate mothers on its importance, and persuade them to ensure their child's timely completion of the vaccination schedule as recommended.

The absence of health workers was reported as a factor by a large proportion of mothers. This could be due to the regular strikes in the health sector to protest for their entitlements or revote poor wages, and this could lead to vaccination postponement which is a factor in childhood immunisation completion [16]. Hence, the government should try to see to it that the health

workers are paid all their dues and on time to prevent strikes which disrupt the immunisation of the children thus endangering their health and development.

More than a quarter of the respondents indicated that they often do not remember the vaccination schedule, thus identifying it as a factor associated with the non-completion of their child's vaccination. This corroborates the findings in a study on "A Community Survey of the Vaccination Status of Under-Five Children in a Community in Southern Nigeria" which revealed that mothers often forget the vaccination schedule of their children due to the space between early vaccination schedules and the later ones [14]. Consequently, most of the respondents indicated an interest in the health facility sending reminders and prompts to enable them to remember their child's vaccination schedule and come to immunise their child when due.

Finally, financial constraints were another factor stated by some of the respondents to be the culprit in the completion of the childhood immunisation as scheduled. This could lead to failure in the uptake of the routine immunisation especially for mothers living far from the vaccination location, which could be a major impediment to timely vaccine uptake and could lead to increased missed doses. Thus, there is a need to ensure that every health facility is equipped to vaccinate children [11, 10]. Also, the study by [17] reported that children from rich households are more likely to be fully vaccinated than those from poor households (2024), thus corroborating the fact that financial constraints could be a barrier, hence female empowerment could help prevent this and empower mothers to properly provide for their children.

Most of the study respondents denied delaying vaccination, while one-fifth of the respondents admitted to delaying vaccination, siting mostly travelling at the time of the vaccination, child illness during the time of vaccination, lack of transport fare, lack of clear information about vaccination, relocation, fear of side effects and distance from the vaccination site. One or more

of these could result in defaulting from immunisation and could potentially influence the completion of childhood immunisation [16]. Child illness at the time of scheduled immunisation has been reported as a usual reason why immunisation could be delayed, which could result in the incompletion of RI [7].

A study in East Africa reported that distance from the vaccination site could result in parents defaulting to routine immunisation uptake of their children which could potentially result in incompletion [8]. Also, some of the respondents admitted that they usually fail to recall appointments, with over fifty per cent conceding to receiving reminders from health facilities while the rest said they don't. They all want the health facility to send out reminders to them before their next appointment to enable them to come when scheduled.

Furthermore, the finding of this study showed a statistically significant association between birth order and place of birth was significant. The finding of this study reveals that children who are first and second-born are more likely to be fully vaccinated than their younger ones because mothers are likely to get too involved in the care of other children and forget the vaccination schedule. This corroborates the findings in a study that the birth order of the child is significantly associated with immunisation completion of under-five children [13].

Also, children born in health facilities are more likely to be fully vaccinated than those born in other places [12]. This could be due to the perception of the mothers about vaccines, the availability of vaccines at the place of birth or the level of awareness of the mothers about vaccines and their benefits.

**The factors influencing the completion of childhood immunisation**

The finding of this study shows that several factors were influencing the completion of childhood immunisation in the study area, maternal marital status, maternal educational level,

place of delivery, child age, paternal educational level, paternal occupation, as well as those whose immunisation card was seen were all significantly associated with childhood immunisation completion. This is in line with previous studies in sub-Saharan Africa which showed that maternal educational level, marital status, place of delivery, distance from health facility and partner's educational level were all significantly associated with the full completion of childhood immunisation in the sub-Saharan African countries [19].

The study showed that mother's marital status significantly influenced the completion of their children's immunisation than those who were currently married. The study also disclosed that single mothers were more likely to ensure full completion of their children's immunisation than those who were currently married. This is

The study found that children of mothers who were fourth, fifth, or higher in the birth order were more likely to complete their vaccination schedule than those who were first, second, and third in the birth order. This is in contrast to findings in an earlier study in Indonesia, which revealed that firstborn children were more likely to complete their routine immunisation than those who were fourth or higher in the birth order [18].

The study also discovered that maternal educational level was significantly associated with full childhood vaccination. This is in line with an earlier study in sub-Saharan Africa, which revealed that educated mothers have a higher likelihood of fully vaccinating their children than uneducated mothers [19,20].

Also, the study showed that mothers practising Christianity had higher odds of completing their child's routine immunisation than those of other religions. This is in line with preceding studies in Nigeria, which reveal that religion could influence a person's perspective, thus, it's the sole

determinant of vaccine hesitancy [23]. Thus, studies show that Christians have higher odds of completing routine vaccination when compared to other religions [24].

Furthermore, the study observed that mothers who earn more than 50,000 were more likely to complete their children's routine immunisation when compared to mothers who earn less than 50,000 and those who have no income. This corroborates the finding by Allan and colleagues in Kenya, which found that inequalities in full vaccination significantly affect more children from poorer households than those whose parents are financially comfortable [21].

The study also revealed that maternal characteristics such as maternal age influenced the completion of the RI. This is in line with preceding studies in Afghanistan, which reported maternal age as one of the main determinants for full completion of vaccination [22].

Moreover, the place of delivery was also revealed by the study to be significantly associated with the completion of the RI. This finding corroborates the study by [25], which showed that children of mothers who had their babies in a healthcare facility were twice as likely to complete their RI compared to those who didn't (2019). This could be because health facilities promote these vaccines during antenatal clinic visits and postnatal visits. Also, some of the vaccines like OPV, Hep, and BCG are administered soon after delivery at the health facilities, thus ensuring the uptake of these immunisations by the children delivered there.

The findings of this study showed that several factors were influencing the completion of childhood RI; these factors were found to be significantly associated with the completion of childhood RI at a non-adjusted OR, such as the mother's educational level, place of delivery, birth order, partner's educational attainment, and occupation. However, the mother's educational level, place of delivery, and Partner's occupation significantly influenced the completion of RI at the adjusted OR.

Mothers' educational level was found to be significantly associated with the completion of childhood RI at a non-adjusted and adjusted OR. Mothers who were university graduates were 1.90 times more likely to complete their child's immunisation schedule at an adjusted OR than those who were non-university graduates (AOR=1.90, 95% CI 1.01-3.59; p=0.047). This is consistent with studies that revealed mothers with lesser educational attainment are unlikely to complete their children's RI [27,30].

The Place of delivery was discovered to be strongly associated with the completion of childhood RI at a non-adjusted and adjusted OR. Babies born in public hospitals were 53% less likely to complete their RI when compared with those given birth to in other facilities (AOR=0.47, 95% CI 0.28-0.81; p=0.01). This could be due to the availability of vaccines, vaccinators, vaccine awareness, or all as at the time of delivery[29]. A previous study in North central Nigeria reveals that hospital delivery was associated with early vaccination[28], thus, babies born outside the hospital are not likely to complete their RI.

Similarly, the birth order of children had a significant influence on the completion of the RI. Children who were 1st to 3rd born were 3.38 times more likely to complete their RI compared to children who are 4th or above in the birth order at an unadjusted OR (OR=3.28, 95% CI 1.46-7.35; p=0.004). This is consistent with the findings of [30] who found that children of higher birth order of 4th and above were at a greater risk of incomplete RI (2018). This could be due to the parents being more readily available to attend to the child's health needs as a result of a lesser number of children being cared for.

Furthermore, partners' occupation was found to be associated with the completion of the RI at a non-adjusted and adjusted OR. Children of mothers whose partners were employed were found

to be 57% less likely to complete their RI than those whose partners were unemployed at an adjusted OR (AOR=0.43, 95% CI 0.23-0.79; p=0.01).

## Endnotes


1. Freeman, R. E., Thaker, J., Daley, M. F., Glanz, J. M., & Newcomer, S. R. (2022). Vaccine timeliness and prevalence of undervaccination patterns in children ages 0–19 months, US, National Immunisation Survey-Child 2017. *Vaccine*, *40*(5), 765-773.
2. Fite, R. O., & Hailu, L. D. (2019). Immunisation coverage of 12 to 23-month-old children in Ethiopia. *Journal of Public Health and Epidemiology*, *11*(1), 31-37.
3. Bangura, J. B., Xiao, S., Qiu, D., Ouyang, F., & Chen, L. (2020). Barriers to childhood immunisation in sub-Saharan Africa: a systematic review. *BMC public health*, *20*, 1-15.
4. Adedire, E. B., Ajumobi, O., Bolu, O., Nguku, P., & Ajayi, I. (2021). Maternal knowledge, attitude, and perception about childhood routine immunisation program in Atakumosa-west Local Government Area, Osun State, South-western Nigeria. ***The Pan African Medical Journal*, *40*(Suppl 1).**
5. Ayodele, A. M., Fasasi, M. I., Uche, O. R., Ikemdinachi, N. G., & Ugochukwu, U. H. (2024). Factors associated with full childhood vaccination coverage among young mothers in Northern Nigeria. ***The Pan African Medical Journal*, *47*. https://doi.org/10.11604/pamj.2024.47.4.37517**
6. Omobowale, M. O., Amodu, F. A., Falase, O. S., Olajide, T. H., & Amodu, O. K. (2024). Contextualizing post-day-one childhood immunisation in-take drop-off rate in Nigeria: An assessment of working mothers in Ibadan. *Gates Open Research*, *8*(48), 48.
7. Ullah, K., Saleem, J., Zakar, R., Ishaq, M., Khattak, F. A., Majeed, F., Sadiqa, H.A., & Fischer, F. (2024). Exploring the reasons for defaulting from childhood immunisation: a qualitative study in Pakistan. *BMC Public Health*, *24*(1), 408.

8. Mulugeta, G. T., Gemeda, D. H., Dimore, A. L., Getu, T. Y., & Gelaw, A. Z. H. (2024). Factors Associated with Non-and Incomplete Vaccination Among Children Aged 12-23 Months in Gindhir Rural District. *Southeast Ethiopia: A Multinomial Analysis, J Vaccines Vaccin Stud*, *3*(1), 101.

9. Olusoji, I. J., Opeymi, O., Adesoji, A. K., Olanrewaju, O., Aderibigbe, M., & Dasola, A. R. (2024). Factors Affecting Mothers' Adherence to Childhood Immunisation Schedules in Ifelodun LGA, Osun-State, Nigeria: Public Health Implications.

**10.** Salako, J., Bakare, D., Uchendu, O. C., Bakare, A. A., Graham, H., & Falade, A. G. (2024). Factors associated with immunisation status among children aged 12-59 months in Lagelu local government area, Ibadan: A cross-sectional study. ***The Pan African Medical Journal*, *47*. https://doi.org/10.11604/pamj.2024.47.35.37013**

11. Mohammed, Y., Reynolds, H. W., Waziri, H., Attahiru, A., Mikailu, F., Adewole, A. O., ... & Nguku, P. (2024). Exploring the Landscape of Routine Immunisation in Nigeria: A Scoping Review of Barriers and Facilitators.

12. Ahmed, L. Q., Adebowale, A. S., & Palamuleni, M. E. (2024). Bayesian spatial analysis of incomplete vaccination among children aged 12–23 months in Nigeria. *Scientific Reports*, *14*(1), 1-16. https://doi.org/10.1038/s41598-024-57345-y

13. Kuuyi, A., & Kogi, R. (2024). Factors contributing to immunisation coverage among children less than 5 years in Nadowli-Kaleo District of Upper West Region, Ghana. *PLOS Global Public Health*, *4*(8), e0002881.

**14.** Ochei, O., Ntaji, M. I., Adesoye, O. O., Oserada, N. O., Ordiah, S. N., Osaekete, K. I., & Oshadiya, O. C. (2023). A Community Survey of the Vaccination Status of Under- Five

Children in a Community in Southern Nigeria. ***Nigerian Journal of Medicine*, *32*(1), 8-14.**

15. Olowolafe TA, Adebowale AS, Fagbamigbe AF, Bolarinwa OA, Akinyemi JO (2023) Shifts in age pattern, timing of childbearing and trend in fertility level across six regions of Nigeria: Nigeria Demographic and Health Surveys from 2003–2018. PLoS ONE 18(1): e0279365. doi:10.1371/**journal.pone.0279365**
16. Asnake M, Lamessa D, Ayantu K, Zemedu A (2021). Determinants of Incomplete Childhood Vaccination among Children Aged 12-23 Months in Gambela Region, Southwest Ethiopia: A Case-Control Study. Ethiop J Health Sci. 31(1):63. doi:http://dx.doi.org/ 10.4314/ejhs.v31i1.8
17. Williams, S. V., Akande, T., & Abbas, K. (2024). Systematic review of social determinants of childhood immunisation in low- and middle-income countries and equity impact analysis of childhood vaccination coverage in Nigeria. *PLOS ONE*, *19*(3), e0297326. https://doi.org/10.1371/journal.pone.0297326
18. Efendi, F., Pradiptasiwi, D. R., Krisnana, I., Kusumaningrum, T., Kurniati, A., Sampurna, M. T. A., & Berliana, S. M. (2020). Factors associated with complete immunisations coverage among Indonesian children aged 12–23 months. *Children and Youth Services Review*, *108*, 104651.
19. Fenta, S. M., Biresaw, H. B., Fentaw, K. D., & Gebremichael, S. G. (2021). Determinants of full childhood immunisation among children aged 12–23 months in sub-Saharan Africa: a multilevel analysis using Demographic and Health Survey Data. *Tropical medicine and health*, *49*, 1-12.

20. Afolabi, R. F., Salawu, M. M., Gbadebo, B. M., Salawu, A. T., Fagbamigbe, A. F., & Adebowale, A. S. (2021). Ethnicity as a cultural factor influencing complete vaccination among children aged 12-23 months in Nigeria. *Human Vaccines & Immunotherapeutics*, *17*(7), 2008-2017.
21. Allan, S., Adetifa, I. M., & Abbas, K. (2021). Inequities in childhood immunisation coverage associated with socioeconomic, geographic, maternal, child, and place of birth characteristics in Kenya. *BMC infectious diseases*, *21*(1), 553.
22. Aalemi, A. K., Shahpar, K., & Mubarak, M. Y. (2020). Factors influencing vaccination coverage among children age 12–23 months in Afghanistan: Analysis of the 2015 Demographic and Health Survey. *PloS one*, *15*(8), e0236955.
23. Tiwana, M. H., & Smith, J. (2024). Faith and vaccination: a scoping review of the relationships between religious beliefs and vaccine hesitancy. *BMC Public Health*, *24*(1), 1806.
24. Jillian, O., & Kizito, O. (2020). Socio-cultural factors associated with incomplete routine immunisation of children _ Amach Sub-County, Uganda. *Cogent medicine*, *7*(1), 1848755.
25. Tamirat, K. S., & Sisay, M. M. (2019). Full immunisation coverage and its associated factors among children aged 12–23 months in Ethiopia: further analysis from the 2016 Ethiopia demographic and health survey. *BMC public health*, *19*, 1-7.
26. Mercy Nwankwo, C., & Elisabeth, O. (2020). Factors influencing incomplete immunisation among under-five-year-old children at CHUK hospital, Nyarugenge district, Rwanda. International Journal of Community Medicine and Public Health | October 2020 | Vol 7 | Issue 10 Page 3793

27. Verulava, T., Jaiani, M., Lordkipanidze, A., Jorbenadze, R., & Dangadze, B. (2019). Mothers' knowledge and attitudes towards child immunisation in Georgia. *The Open Public Health Journal*, *12*, 232-237.

28. Ibraheem, R., Abdulkadir, M., Akintola, M., & Adeboye, M. (2019). Determinants of timely presentation for birth dose vaccination at an immunisation centre in North-central Nigeria. *Annals of global health*, *85*(1), 20.

29. Okenwa, U. J., Dairo, M. D., Uba, B., & Ajumobi, O. (2019). Maternal reasons for non-receipt of valid Hepatitis B birth dose among mother-infant pairs attending routine immunisation clinics, South-east, Nigeria. *Vaccine*, *37*(46), 6894-6899.

30. Sheikh, N., Sultana, M., Ali, N., Akram, R., Mahumud, R. A., Asaduzzaman, M., & Sarker, A. R. (2018). Coverage, timelines, and determinants of incomplete immunisation in Bangladesh. *Tropical medicine and infectious disease*, *3*(3), 72.

# Chapter Five

# Conclusion

## Summary of Findings

Childhood immunisation is considered one of the most effective interventions in reducing under-five mortality. Despite efforts to improve childhood immunisation coverage in Nigeria, it has remained below the acceptable level. The attention of stakeholders in the health sector is focused on making policies that will improve the acceptance and uptake of childhood immunisation. This necessitated this study to assess the factors associated with childhood immunisation uptake by mothers of under-five children in the Ajeromi-Ifelodun Local Government Area, Lagos State. The study determined the prevalence of completion childhood immunisation, examined the barriers to the uptake of childhood immunisation, assessed the perception of mothers towards childhood immunisation, and identified the factors associated with the completion of childhood immunisation by mothers under five in Ajeromi-Ifelodun L.G.A Lagos State. The study was a cross-sectional research design. A multi-stage cluster sampling technique was used to select 246 participants for this study. The prevalence of immunisation completion among under-fives in the study population was less than ten percent. The finding of this study identified inadequate staffing as the most perceived barrier to the completion of childhood immunisation in the study population. The main factors associated with the completion of childhood immunisation in this study were lack of awareness, the absence of health workers, forgetting the appointment date, and financial constraints. Also, the finding of this study revealed that children who are born in health facilities were more likely to complete their RI.

## Conclusion

The results of this study demonstrate that mothers generally have a good understanding of the RI program for children and have favorable opinions and views about it. Knowledge of the immunisation program and VPDs was positively related with greater levels of education, having attended prenatal care, and giving birth in a health facility. Improving vaccine coverage rates in Osun and other regions of Nigeria requires further research into the causes and effects of low vaccination rates among mothers, as well as strategies to dispel myths and increase understanding.

## Contribution to Knowledge

This study has contributed to the body of knowledge in public health and child survival by:

1. Identifying key socio-demographic and behavioral factors influencing the uptake of childhood immunisation among mothers of under-five children in Ajeromi-Ifelodun LGA, Lagos State.
2. The study adds to existing literature by presenting up-to-date data on the prevalence of childhood immunisation completion in a densely populated urban LGA in Nigeria
3. Providing empirical data on immunisation coverage, barriers, and facilitators specific to an urban, high-density setting in Nigeria, which is often under represented in national data.
4. Highlighting gaps in awareness and access, which can inform future public health policies, education campaigns, and interventions tailored to urban low-income communities.
5. It highlights key barriers to immunisation uptake such as misinformation, cultural beliefs, maternal education, and health facility accessibility.

6. Recommending targeted interventions, including health education and community engagement strategies that can improve immunisation uptake and reduce vaccine hesitancy in similar contexts.
7. The research contributes to understanding how maternal perceptions and attitudes affect vaccination behavior, offering evidence that perception directly correlates with immunisation decisions

**Intervention:**
Community based health education programme target at mothers of under five children.

1. Health talk and group discussion during antenatal and postnatal clinic visit
2. Community outreach sessions in collaboration with ward health committees and community leaders
3. Distribution of information, education and communication (IEC) materials such as posters and leaflets in English and Yoruba for better comprehension.
4. Use of reminder systems (e.g Mobile phone, text message and immunisation cards) to improve adherence to immunisation schedules, also to track defaulters' community.
5. Training of health workers and volunteers facilitated and improved the immunisation coverage.
6. Community engagemet and stakeholder involvement, where the religious leaders, traditional rulers, and women leaders were actively involved and engaged in immunisation campaign. Their influence within the community enhances trust, and promotes positive social norms around child vaccination.
7.

Evaluation of Intervention

- Pre-intervention survey: Structured questionnaires were administered at baseline to assess knowledge, attitude and practices of mothers
- Post-intervention survey: Conducted after three months to determine changes in awareness, perceptions and immunisation completeion rates among under-five children.
- Indicators measured: Proportion of fully immunised children, maternal knowledge scores, attitude change indices and service utilisation.

**Recommendations**

Local Government

1. The LGA health authority should increase the number of fixed and outreach immunisation points to improve immunisation voverage.
2. Ensure availabiltyof vaccines in the health centres to reduce stock-out
3. Regular training and motivation of health workers to improve interaction between the mothers and health workers

Health Workers

1. Engage community influencer to dispel myths, misconceptions, and fears that discourage vaccine uptake.
2. Intervention should be focus on mothers with low education, low income and those living in hard-to-reach area.
3. Health facilities should be encouraged to send reminder to mothers before the next routine immunisation (RI) to prompt them about their next vaccination schedule.
4. Further research is needed to explore deeper socio-cultural influences and to replicate the study across other L.G.A in Lagos State

# Bibliography


1. Aalemi, A. K., Shahpar, K., & Mubarak, M. Y. (2020). Factors influencing vaccination coverage among children age 12–23 months in Afghanistan: Analysis of the 2015 Demographic and Health Survey. *PloS one*, *15*(8), e0236955.
2. Abdulraheem, I., & Onajole, A. (2011). Reasons for incomplete vaccination and factors for missed opportunities among rural Nigerian children. *Journal of Public Health and Epidemiology*, *3*, 194-203. Retrieved from http://www.academicjournals.org/journal/JPHE
3. Abdulrasheed, N., Lawal, L., Mogaji, A. B., Abdulkareem, A. O., Shuaib, A. K., Adeoti, S. G., ... & Abdul-Rahman, T. (2023). Recurrent diphtheria outbreaks in Nigeria: A review of the underlying factors and remedies. Immunity, Inflammation and Disease, 11(11), e1096.
4. Abós, B., Bailey, C., & Tafalla, C. (2022). Adaptive immunity. In Principles of Fish Immunology: From Cells and Molecules to Host Protection (pp. 105-140). Cham: Springer International Publishing.
5. Galadima Abubakar Nasiru, Nor Afiab Mohd Zulkefli, Norlisa, Salmiah Md Said & Norisa Ahmad. Factors Influencing Childhood Immunisation Uptake in Africa: a systematic review. Published; 28 July, 2021. BMC Public Health 21, Article number: 1474(2021)
6. Adedire, E. B., Ajumobi, O., Bolu, O., Nguku, P., & Ajayi, I. (2021). Maternal knowledge, attitude, and perception about childhood routine immunisation program in Atakumosa-west Local Government Area, Osun State, South-western Nigeria. *The Pan African Medical Journal*, *40*(Suppl 1).
7. Adedire, E. B., Ajumobi, O., Bolu, O., Nguku, P., & Ajayi, I. (2021). Maternal knowledge, attitude, and perception about childhood routine immunisation program in Atakumosa-west Local Government Area, Osun State, South-western Nigeria. *The Pan African Medical Journal*, *40*(Suppl 1).
8. Adedokun ST, Uthman OA, Adekanmbi VT, Wiysonge CS. Incomplete childhood immunisation in Nigeria: a multilevel analysis of individual and contextual factors. BMC Public Health 2017; 17:236 https://dx.doi.org/10.1186%2Fs12889-017-4137-7

9. Adeyanju, G. C., & Betsch, C. (2024). Vaccination decision-making among mothers of children 0–12 months old in Nigeria: A qualitative study. *Human Vaccines & Immunotherapeutics*, *20*(1), 2355709.

10. Adongo, A. A., Dapaah, J. M., Azumah, F. D., & Onzaberigu Nachinaab, J. The influence of sociodemographic behavioural variables on health-seeking behaviour and the utilisation of public and private hospitals in Ghana. *International Journal of Sociology and Social Policy*, *42*(5/6), 2022, 455-472.

11. Afolabi, R. F., Salawu, M. M., Gbadebo, B. M., Salawu, A. T., Fagbamigbe, A. F., & Adebowale, A. S. (2021). Ethnicity as a cultural factor influencing complete vaccination among children aged 12-23 months in Nigeria. *Human Vaccines & Immunotherapeutics*, *17*(7), 2008-2017.

12. Agbede, G. T., Emezirinwune, D., Adedokun, T., & Idowu-Collins, P. (2024). Vaccine hesitancy in Nigeria: overcoming cultural, linguistic and religious obstacles. *Information Impact: Journal of Information and Knowledge Management*, *15*(1), 153-168.

13. Ahmed, L. Q., Adebowale, A. S., & Palamuleni, M. E. (2024). Bayesian spatial analysis of incomplete vaccination among children aged 12–23 months in Nigeria. *Scientific Reports*, *14*(1), 1-16. https://doi.org/10.1038/s41598-024-57345-y

14. Ahmed, L. Q., Adebowale, A. S., & Palamuleni, M. E. (2024). Bayesian spatial analysis of incomplete vaccination among children aged 12–23 months in Nigeria. *Scientific Reports*, *14*(1), 1-16. https://doi.org/10.1038/s41598-024-57345-y

15. Ajzen, I. (1991). The theory of planned behavior. Organisational behavior and human decision processes, 50(2), 179-211.

16. Ajzen,T., & Fishbein, M .(1980). Understanding attitude and predicting social behaviour. Englewood Cliffs,NJ: Prentic Hall

17. Akinola Ayoola Fatiregun; Laura NIC Lochlain Kaborie, Lessane; Dosumu, Modupeola; Isere, Elvis; Yetunde; Onyibe, Rosemary; Boatang, Kofi; Banda, Richard; Braka, Fioma. "Missed Opportunities for Vaccination among Children, aged 0-23 months visiting Health Facilities in South West Nigeria, December, 2019. Published Aug, 2021, Public Library of Science, e-ISSN1932 6203.

18. Al Fayez, N., Nassar, M. S., Alshehri, A. A., Alnefaie, M. K., Almughem, F. A., Alshehri, B. Y., ... & Tawfik, E. A. (2023). Recent Advancement in mRNA Vaccine Development and Applications. Pharmaceutics, 15(7), 1972.
19. Alderson, M. R., LaForce, F. M., Sobanjo-ter Meulen, A., Hwang, A., Preziosi, M. P., & Klugman, K. P. (2019). Eliminating meningococcal epidemics from the African meningitis belt: the case for advanced prevention and control using next-generation meningococcal conjugate vaccines. *The Journal of infectious diseases*, *220*(Supplement_4), S274-S278.
20. Aleem, A., Ab, A. S., & Slenker, A. K. (2021). Emerging variants of SARS-CoV-2 and novel therapeutics against coronavirus (COVID-19).
21. Alexander-Miller, M. A. (2020). Challenges for the newborn following influenza virus infection and prospects for an effective vaccine. Frontiers in immunology, 11, 568651.
22. Alkhawaldeh, A., ALBashtawy, M., Rayan, A., Abdalrahim, A., Musa, A., Eshah, N., ... & Khraisat, O. (2023). Application and use of Andersen's behavioral model as theoretical framework: a systematic literature review from 2012–2021. *Iranian journal of public health*, *52*(7), 1346.
23. Allan, S., Adetifa, I. M., & Abbas, K. (2021). Inequities in childhood immunisation coverage associated with socioeconomic, geographic, maternal, child, and place of birth characteristics in Kenya. *BMC infectious diseases*, *21*(1), 553.
24. Almutairi, W. M., Alsharif, F., Khamis, F., Sallam, L. A., Sharif, L., Alsufyani, A., ... & Alqasimi, R. (2021). Assessment of mothers' knowledge, attitudes, and practices regarding childhood vaccination during the first five years of life in Saudi Arabia. *Nursing reports*, *11*(3), 506-516.
25. Alyafei, A., & Easton-Carr, R. (2024). The health belief model of behavior change. In *StatPearls [Internet]*. StatPearls Publishing.
26. *American Journal of Public Health, 97*(2), 259–266. http://doi.org/10.2105/AJPH.2005.076661

27. American Red Cross (2002). *Measles Initiative to Vaccinate 14 Million Children in Kenya During One-week Campaign*. Nairobi: American Red Cross. [Online], Available: http:// www.redcross.org/press/intl/in_pr/020614measles.html [04/18/08 10: 12 AM].
28. American Red Cross (2003). *Zambia Mass Measles Vaccination Campaign First on Measles Initiative's 2003 Schedule*. Washington: American Red Cross. [Online], Available: http:// www.measlesinitiative.org/030606press.html [04/18/08 09:25 AM].
29. American Red Cross (2004). *Measles Initiative Partners Fight the Two Most Deadly Childhood Diseases in Africa Testing an Integrated Approach to Reach Every Child*. Washington: American Red Cross. [Online], Available: http://www.redcross.org/pressrelease/ 0,1077,0_314_3818,00.html [04/18/08 11:20 AM].
30. and UNICEF estimates of immunisation from https://www.who.int/immunisation/
31. Andersen, R., & Newman, J. F. (1973). Societal and individual determinants of medical care utilisation in the United States. *Health and Society*, *51*(1), 95-124. http://doi.org/ 10.2307/3349613
32. Anderson, R. M., & May, R. M. (1991). Infectious diseases of humans: dynamics and control. Oxford university press.
33. Angsantikul, P., Fang, R. H., & Zhang, L. (2017). Toxoid vaccination against bacterial infection using cell membrane-coated nanoparticles. Bioconjugate chemistry, 29(3), 604-612.
34. Antai, D. Migration and child immunisation in Nigeria: individual- and community-level contexts. BMC Public Health 10, 116 (2010). https://doi.org/10.1186/1471-2458-10-116
35. Asim, M., Alkadi, M. M., Asim, H., & Ghaffar, A. (2019). Dehydration and volume depletion: how to handle the misconceptions. World journal of nephrology, 8(1), 23.
36. Asnake M, Lamessa D, Ayantu K, Zemedu A (2021). Determinants of Incomplete Childhood Vaccination among Children Aged 12-23 Months in Gambela Region, Southwest Ethiopia: A Case-Control Study. Ethiop J Health Sci. 31(1):63. doi:http://dx.doi.org/ 10.4314/ejhs.v31i1.8
37. Asnake M, Lamessa D, Ayantu K, Zemedu A (2021). Determinants of Incomplete Childhood Vaccination among Children Aged 12-23 Months in Gambela Region, Southwest Ethiopia: A Case-Control Study. Ethiop J Health Sci. 31(1):63. doi:http://dx.doi.org/ 10.4314/ejhs.v31i1.8

38. Attitudes and Beliefs towards Rotavirus Vaccination in a Sample of Italian Women: A Cross-Sectional Study. Vaccines, 11(6), 1041.
39. Awasthi, A., Pandey, C. M., Singh, U., Kumar, S., & Singh, T. B. (2015). Maternal determinants of immunisation status of children aged 12-23 months in urban slums of Varanasi, India. *Clinical Epidemiology and Global Health*, *3*(3), 110-116. http://doi.org/ 10.1016/j.cegh.2014.07.004
40. Ayodele, A. M., Fasasi, M. I., Uche, O. R., Ikemdinachi, N. G., & Ugochukwu, U. H. (2024). Factors associated with full childhood vaccination coverage among young mothers in Northern Nigeria. *The Pan African Medical Journal*, *47*. https://doi.org/10.11604/pamj.2024.47.4.37517
41. Ayodele, A. M., Fasasi, M. I., Uche, O. R., Ikemdinachi, N. G., & Ugochukwu, U. H. (2024). Factors associated with full childhood vaccination coverage among young mothers in Northern Nigeria. *The Pan African Medical Journal*, *47*. https://doi.org/10.11604/pamj.2024.47.4.37517
42. Babalola S. Maternal reasons for non-immunisation and partial immunisation in northern Nigeria . J Paediatr Child Health 2011; 47:276 . https://doi . org/10 . 1111/ j.1440-1754.2010.01956.x
43. Badran, E. F., Qasem, Z., Alqutob, R., Khaled, M. W., Aldabbas, A. M., Mansour, A. A., ... & Salhout, S. I. (2024). Understanding Parental Intentions for COVID-19 Child Vaccination: A Cross-Sectional Study From Jordan Using Theory of Planned Behavior. *Journal of Multidisciplinary Healthcare*, 2729-2740.
44. Badurdeen, S., Marshall, A., Daish, H., Hatherill, M., & Berkley, J. A. (2019). Safety and immunogenicity of early Bacillus Calmette-Guérin vaccination in infants who are preterm and/or have low birth weights: a systematic review and meta-analysis. JAMA pediatrics, 173(1), 75-85.
45. Bae, C., & Bourget, D. (2021). Tetanus.[Updated 2021 May 12]. StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing.
46. Bailey, A., & Sapra, A. (2020). MMR Vaccine.
47. Balasundaram, P., & Sakr, M. (2021). Understanding and Application of CDC Immunisation Guidelines.

48. Bangura, J. B., Xiao, S., Qiu, D., Ouyang, F., & Chen, L. (2020). Barriers to childhood immunisation in sub-Saharan Africa: a systematic review. *BMC public health*, *20*, 1-15.
49. Bangura, J. B., Xiao, S., Qiu, D., Ouyang, F., & Chen, L. (2020). Barriers to childhood immunisation in sub-Saharan Africa: a systematic review. *BMC public health*, *20*, 1-15.
50. Bashiri, S., Koirala, P., Toth, I., & Skwarczynski, M. (2020). Carbohydrate immune adjuvants in subunit vaccines. Pharmaceutics, 12(10), 965.
51. Bbaale, E. (2015). Factors influencing childhood immunisation in Uganda. *Journal of Health Population and Nutrition, 31*(1), 118-129. http://doi.org/10.3329/jhpn.v31i1.14756
52. Bender, R. G., Shen, J., Aravkin, A., Fouda, A. A. B., Bwaka, A. M., Galles, N. C., ... & Kyu, H. H. (2023). Meningococcal A conjugate vaccine coverage in the meningitis belt of Africa from 2010 to 2021: a modelling study. *EClinicalMedicine*, *56*.
53. Bharati, P. (2014). Women autonomy, nutritional and immunisation status of their children. *Anthropology*, *2*(2), 118-124. http://doi.org/10.4172/2332-0915.1000118
54. Bhattacharya, S., Bohara, V. S., Sevda, S., & Kumar, S. (2024). Vaccine and vaccine types. In Bioreactor Design Concepts for Viral Vaccine Production (pp. 73-82). Academic Press.
55. Blanchard-Rohner, G., Caprettini, B., Rohner, D., & Voth, H. J. (2021). Impact of COVID-19 and intensive care unit capacity on vaccination support: Evidence from a two-leg representative survey in the United Kingdom. *Journal of virus eradication*, *7*(2), 100044.
56. Boulanger, A. (2023, February 6). *Everything you need to know about vaccinations*. Healthline. https://www.healthline.com/health/vaccinations.
57. Bovay, A., Fuertes Marraco, S. A., & Speiser, D. E. (2021). Yellow fever virus vaccination: an emblematic model to elucidate robust human immune responses. Human Vaccines & Immunotherapeutics, 17(8), 2471-2481.
58. Braka, F., Adamu, U., Siddique, A., Bolu, O., Damisa, E., Banda, R., ... & Shuaib, F. (2023). The role of polio emergency operations centers: perspectives for future disease control initiatives in Nigeria. *The Pan African Medical Journal*, *45*(Suppl 2), 8.

59. Briciu, V., Topan, A., Calin, M., Dobrota, R., Leucuta, D. C., & Lupse, M. (2023, January). Comparison of COVID-19 severity in vaccinated and unvaccinated patients during the Delta and Omicron wave of the pandemic in a Romanian tertiary infectious diseases hospital. In *Healthcare* (Vol. 11, No. 3, p. 373). MDPI.

60. Brown, V. B., Oluwatosin, O. A., & Ogundeji, M. O. (2017). Impact of training intervention on immunisation providers' knowledge and practice of routine immunisation in Ibadan, south-western Nigeria: a primary health care experience. *The Pan African Medical Journal*, *26*(216).

61. Bugya, Z., Prechl, J., Szénási, T., Nemes, É., Bácsi, A., & Koncz, G. (2021). Multiple levels of immunological memory and their association with vaccination. Vaccines, 9(2), 174.

62. Bullen, M., Heriot, G. S., & Jamrozik, E. (2023). Herd immunity, vaccination and moral obligation. Journal of Medical Ethics, 49(9), 636-641.

63. Bullen, M., Heriot, G. S., & Jamrozik, E. (2023). Herd immunity, vaccination and moral obligation. *Journal of medical ethics*, *49*(9), 636-641.

64. Caceres, M. M. F., Sosa, J. P., Lawrence, J. A., Sestacovschi, C., Tidd-Johnson, A., Rasool, M. H. U., ... & Fernandez, J. P. (2022). The impact of misinformation on the COVID-19 pandemic. *AIMS public health*, *9*(2), 262.

65. Canavan, M. E., Sipsma, H. L., Kassie, G. M., & Bradley, E. H. (2014). Correlates of complete childhood vaccination in East African countries, *9*(4), 1-7. http://doi.org/10.1371/ journal.pone.0095709

66. Cantrell, M. E., Sylvestre, É., Wharton, H. C., Scheidegger, R., Curchod, L., Gute, D. M., ... & Pickering, A. J. (2023). Hands are frequently contaminated with fecal bacteria and enteric pathogens globally: A systematic review and meta-analysis. ACS Environmental Au, 3(3), 123-134.

67. Capurro, G., Maier, R., Tustin, J., Jardine, C. G., & Driedger, S. M. (2022). "They're trying to bribe you and taking away your freedoms": COVID-19 vaccine hesitancy in communities with traditionally low vaccination rates. *Vaccine*, *40*(50), 7280-7287.

68. Carabalí-Isajar, M. L., Rodríguez-Bejarano, O. H., Amado, T., Patarroyo, M. A., Izquierdo, M. A., Lutz, J. R., & Ocampo, M. (2023). Clinical manifestations and immune response to tuberculosis. World Journal of Microbiology and Biotechnology, 39(8), 206.
69. Centers for Disease Control and Prevention, Ten Great Public Health Achievements, United States, in the 20th Century [Internet]. (800-232-4636) TTY: (888) 232-6348.
70. Chandler, R. E. (2020). Optimizing safety surveillance for COVID-19 vaccines. Nature reviews immunology, 20(8), 451-452.
71. Chavda, V. P., Soni, S., Vora, L. K., Soni, S., Khadela, A., & Ajabiya, J. (2022). mRNA-based vaccines and therapeutics for COVID-19 and future pandemics. Vaccines, 10(12), 2150.
72. Chidiebere ODI, Uchenna E, Kenechi OS. Maternal sociodemographic factors that influence full child immunisation uptake in Nigeria. S Afr J Child Health.2014;8(4):138–42. https:// doi.org/10.7196/SAJCH.661
73. Chidiebere ODI, Uchenna E, Kenechi OS. Maternal sociodemographic factors that influence full child immunisation uptake in Nigeria. S Afr J Child Health.2014;8(4):138–42. https:// doi.org/10.7196/SAJCH.661
74. Clemente-Suárez, V. J., Hormeño-Holgado, A., Jiménez, M., Benitez-Agudelo, J. C., Navarro-Jiménez, E., Perez-Palencia, N., ... & Tornero-Aguilera, J. F. (2020). Dynamics of population immunity due to the herd effect in the COVID-19 pandemic. *Vaccines*, *8*(2), 236.
75. Cockcroft A, Usman MU, Nymucherera OF, Emori H, Duke B, Umar NI, Andersson N. Why children are not vaccinated against measles: a cross-sectional study in two Nigerian states. Arch Public Health. 2014;72:48http://www.archpublichealth.com/content/72/1/48
76. Comfort Z. Olorunsaiye and Hannah Degge(2016)- Variation in the Uptake of Routine Immunisation in Nigeria: Examining Determinant of Inequalities Access. https://doi.org/ 10.1080/2376200.2016.1206780 July, Page 19-29/published online: 22 July2016
77. Cooper, S., Schmidt, B. M., Sambala, E. Z., Swartz, A., Colvin, C. J., Leon, N., & Wiysonge, C. S. (2021). Factors that influence parents' and informal caregivers' views and practices regarding routine childhood vaccination: a qualitative evidence synthesis. Cochrane Database of Systematic Reviews, (10).
78. coverage: 2019 revision. WHO. Available monitoring_surveillance/data/nga.pdf

79. Covián, C., Fernández-Fierro, A., Retamal-Díaz, A., Díaz, F. E., Vasquez, A. E., Lay, M. K., ... & Kalergis, A. M. (2019). BCG-induced cross-protection and development of trained immunity: implication for vaccine design. Frontiers in immunology, 10, 504051.
80. Crawford, S. E., Ramani, S., Tate, J. E., Parashar, U. D., Svensson, L., Hagbom, M., ... & Estes, M. K. (2017). Rotavirus infection. Nature Reviews Disease Primers, 3(1), 1-16.Dansereau, E., Miangotar, Y., Squires, E., Mimche, H., UND group Alexis Ngarmbatedjimal Haroun Koumakoi Djimet Seli, IFORD group Hénoque Blaise Nguendo Yongsi Julien Guy Ewos Bomba Léopold Cyriaque Donfack Mbasso Mariane Kenmegni Omgba Patrice Tanang Tchouala Vivien Meli Meli, & El Bcheraoui, C. (2017). Challenges to implementing Gavi's health system strengthening support in Chad and Cameroon: results from a mixed-methods evaluation. *Globalisation and health*, *13*, 1-12.
81. De Oliveira, M. F. S., Martinez, E. Z., & Rocha, J. S. Y. (2014). Factors associated with vaccination coverage in children < 5 years in Angola. *Revista de Saúde Pública*, *48*(6), 906-915. http://doi.org/10.1590/S0034-8910.2014048005284
82. Decker, M. D., & Edwards, K. M. (2021). Pertussis (whooping cough). The Journal of Infectious Diseases, 224(Supplement_4), S310-S320.
83. Dhir, S. K., Dewan, P., & Gupta, P. (2021). Maternal and Neonatal Tetanus Elimination: Where are We Now?. Research and Reports in Tropical Medicine, 247-261.
84. Di Martino, G., Mazzocca, R., Camplone, L., Cedrone, F., Di Giovanni, P., & Staniscia, T.
85. Di Pietro, G. M., Biffi, G., Castellazzi, M. L., Tagliabue, C., Pinzani, R., Bosis, S., & Marchisio, P. G. (2022). Meningococcal disease in pediatric age: a focus on epidemiology and prevention. International Journal of Environmental Research and Public Health, 19(7), 4035.
86. Domingo, C., Fraissinet, J., Ansah, P. O., Kelly, C., Bhat, N., Sow, S. O., & Mejía, J. E. (2019). Long-term immunity against yellow fever in children vaccinated during infancy: a longitudinal cohort study. The Lancet Infectious Diseases, 19(12), 1363-1370.
87. Dr Gbemisola January 31, 2021. Childhood Immunisation update. Current EPI schedule in Nigeria. CHILDHOOD IMMUNISATION – UPDATE – Ask The Paediatricians Foundation https://ask the paediaticians.com/2021/01/childhood immunisation-update/31 jan 2021

88. Krutz, J. E. (2021). Patient education: Vaccines for infants and children age 0 to 6 years (Beyond the Basics). https:www.uptodate.com

89. Duru, J. I., Usman, S., Adeosun, O., Stamidis, K. V., & Bologna, L. (2019). Contributions of volunteer community mobilisers to polio eradication in Nigeria: the experiences of non-governmental and civil society organisations. *The American Journal of Tropical Medicine and Hygiene*, *101*(4 Suppl), 74.

90. Ebot, J. O. (2015). "Girl Power!": The relationship between women's autonomy and children's immunisation coverage in Ethiopia. *Journal of Health, Population and Nutrition*, 1-9. http://doi.org/10.1186/s41043-015-0028-7

91. Efendi, F., Pradiptasiwi, D. R., Krisnana, I., Kusumaningrum, T., Kurniati, A., Sampurna, M. T. A., & Berliana, S. M. (2020). Factors associated with complete immunisations coverage among Indonesian children aged 12–23 months. *Children and Youth Services Review*, *108*, 104651.

92. Estivariz, C. F., Kovacs, S. D., & Mach, O. (2023). Review of use of inactivated poliovirus vaccine in campaigns to control type 2 circulating vaccine derived poliovirus (cVDPV) outbreaks. Vaccine, 41, A113-A121.

93. Etana, B., & Deressa, W. (2012). Factors associated with complete immunisation coverage in children aged 12-23 months in Ambo Woreda, Central Ethiopia. *BMC Public Health*, *12*(1), 566. http://doi.org/10.1186/1471-2458-12-566

94. Eze, O. V., Meyer, J. C., & Campbell, S. M. (2025). Poliomyelitis in Nigeria: Impact of Vaccination Services and Polio Intervention and Eradication Efforts. *Vaccines*, *13*(3), 232.

95. Faniyan, O., Opara, C., Oyinade, A., Botchway, P., & Soyemi, K. (2017). Vaccine financing in Nigeria: are we making progress towards self-financing/sustenance?. *The Pan African Medical Journal*, *27*(Suppl 3), 9.

96. Favin, M., Steinglass, R., Fields, R., Banerjee, K., & Sawhney, M. (2012). Why children are not vaccinated: A review of the grey literature. *International Health*, *4*(4), 229-238. https:// doi.org/10.1016/j.inhe.2012.07.004

97. Federal Ministry of Health. Comprehensive EPI multi-year plan 2016 - 2020. National P r i m a r y H e a l t h C a r e D e v e l o p m e n t A g e n c y . A v a i l a b l e f r o m h t t p : /

/ www.africanchildforum.org/clr/policy%20per%20country/2018%20Update/Nig eria/ nigeria_comprehensivemultiyearp_2016-2020.pdf

98. Federal Ministry of Health. Comprehensive EPI multi-year plan 2016 - 2020. National P r i m a r y H e a l t h C a r e D e v e l o p m e n t A g e n c y . Av a i l a b l e f r o m h t t p : / / www.africanchildforum.org/clr/policy%20per%20country/2018%20Update/Nig eria/ nigeria_comprehensivemultiyearp_2016-2020.pdf
99. Fenta, S. M., Biresaw, H. B., Fentaw, K. D., & Gebremichael, S. G. (2021). Determinants of full childhood immunisation among children aged 12–23 months in sub-Saharan Africa: a multilevel analysis using Demographic and Health Survey Data. *Tropical medicine and health*, *49*, 1-12.
100. Fenta, S. M., Biresaw, H. B., Fentaw, K. D., & Gebremichael, S. G. (2021). Determinants of full childhood immunisation among children aged 12–23 months in sub-Saharan Africa: a multilevel analysis using Demographic and Health Survey Data. *Tropical medicine and health*, *49*, 1-12.
101. Finlay, K. A., Trafimow, D., & Moroi, E. (2006). The importance of subjective norms on intentions to perform health behaviors. *Journal of Applied Social Psychology*, *29*(11), 2381-2393.
102. Fite, R. O., & Hailu, L. D. (2019). Immunisation coverage of 12 to 23-month-old children in Ethiopia. *Journal of Public Health and Epidemiology*, *11*(1), 31-37.
103. Fite, R. O., & Hailu, L. D. (2019). Immunisation coverage of 12 to 23-month-old children in Ethiopia. *Journal of Public Health and Epidemiology*, *11*(1), 31-37.
104. Freeman, R. E., Thaker, J., Daley, M. F., Glanz, J. M., & Newcomer, S. R. (2022). Vaccine timeliness and prevalence of undervaccination patterns in children ages 0–19 months, US, National Immunisation Survey-Child 2017. *Vaccine*, *40*(5), 765-773.
105. Freeman, R. E., Thaker, J., Daley, M. F., Glanz, J. M., & Newcomer, S. R. (2022). Vaccine timeliness and prevalence of undervaccination patterns in children ages 0–19 months, US, National Immunisation Survey-Child 2017. *Vaccine*, *40*(5), 765-773.
106. Frenkel, L. D. (2021, September). The global burden of vaccine-preventable infectious diseases in children less than 5 years of age: implications for COVID-19 vaccination.

How can we do better?. In *Allergy and asthma proceedings* (Vol. 42, No. 5, pp. 378-385). OceanSide Publications, Inc.

107. Galadima, A. N., Zulkefli, N. A. M., Said, S. M., & Ahmad, N. (2021). Factors influencing childhood immunisation uptake in Africa: a systematic review. *BMC Public Health*, *21*, 1-20.

108. Galagali, P. M., Kinikar, A. A., & Kumar, V. S. (2022). Vaccine hesitancy: obstacles and challenges. *Current pediatrics reports*, *10*(4), 241-248.

109. Gaudino, S. J., & Kumar, P. (2019). Cross-talk between antigen presenting cells and T cells impacts intestinal homeostasis, bacterial infections, and tumorigenesis. Frontiers in immunology, 10, 422031.

110. Gavi (2013). GAVI aims to improve access to vaccines in Nigeria through supply chains project. https://www.gavi.org/news/media-room/gavi-aims-improve-access-vaccines-nigeria-through-supply-chains-project

111. Gavi (2024). The fight against pneumonia in five charts. https://www.gavi.org/vaccineswork/fight-against-pneumonia-5-charts

112. Geneti, L., Shallo, S. A., Yebasa, M. A., & Daba, D. B. (2024). Health workers' knowledge and practices toward vaccine cold chain management and its associated factors in a resource-limited setting of Sheger, Oromia, Ethiopia: a multicenter cross-sectional study. *BMC pediatrics*, *24*(1), 786.

113. Ghattas, M., Dwivedi, G., Lavertu, M., & Alameh, M. G. (2021). Vaccine technologies and

114. Gianchecchi, E., Cianchi, V., Torelli, A., & Montomoli, E. (2022). Yellow fever: origin, epidemiology, preventive strategies and future prospects. Vaccines, 10(3), 372.

115. Gidado, S., Nguku, P., Biya, O., Waziri, N. E., Mohammed, A., Nsubuga, P., … Sabitu, K. (2014). Determinants of routine immunisation coverage in Bungudu, Zamfara State, Northern Nigeria, May 2010. *The Pan African Medical Journal, 18 Suppl1*(9). http://doi.org/ 10.11694/pamj.supp.2014.18.1.4149

116. Gilsdorf, J. R. (2021). Hib vaccines: their impact on Haemophilus influenzae type b disease. The Journal of infectious diseases, 224(Supplement_4), S321-S330.

117. González-Block, M. Á., Arroyo-Laguna, J., Rodríguez-Zea, B., Pelcastre-Villafuerte, B. E., Gutiérrez-Calderón, E., Díaz-Portillo, S. P., ... & Sarti, E. (2021). The importance of confidence, complacency, and convenience for influenza vaccination among key risk groups in large urban areas of Peru. *Human vaccines & immunotherapeutics*, *17*(2), 465-474.

118. González-Silva, M., & Rabinovich, N. R. (2021). Some lessons for malaria from the Global Polio Eradication Initiative. Malaria Journal, 20(1), 210.

119. Gooding, E., Spiliotopoulou, E., & Yadav, P. (2019). Impact of vaccine stockouts on immunisation coverage in Nigeria. Vaccine, 37(35), 5104–5110.

120. Gostin, L. O., Monahan, J. T., Kaldor, J., DeBartolo, M., Friedman, E. A., Gottschalk, K., ... & Yamin, A. E. (2019). The legal determinants of health: harnessing the power of law for global health and sustainable development. *The lancet*, *393*(10183), 1857-1910.

121. Guerra, F. M., Bolotin, S., Lim, G., Heffernan, J., Deeks, S. L., Li, Y., & Crowcroft, N. S. (2017). The basic reproduction number (R0) of measles: a systematic review. *The Lancet Infectious Diseases*, *17*(12), e420-e428.

122. Guo, Y., Tian, X., Wang, X., & Xiao, Z. (2018). Adverse effects of immunoglobulin therapy. Frontiers in immunology, 9, 362740.

123. Gupta, S., & Pellett, S. (2023). Recent developments in vaccine design: From live vaccines to recombinant toxin vaccines. Toxins, 15(9), 563.

124. Haider, S. M. S., Alvi, S. A., Khan, H., Majeed, R., Syed, T., Anwar, A., & Hashmi, A. A. (2023). Common Side Effects of Pfizer COVID-19 Vaccine: An Experience From Pakistan. Cureus, 15(6).

125. Hamson, E., Forbes, C., Wittkopf, P., Pandey, A., Mendes, D., Kowalik, J., ... & Mugwagwa, T. (2023). Impact of pandemics and disruptions to vaccination on infectious diseases epidemiology past and present. *Human Vaccines & Immunotherapeutics*, *19*(2), 2219577.

126. Hansen, C. A., & Barrett, A. D. (2021). The present and future of yellow fever vaccines. Pharmaceuticals, 14(9), 891.
127. Hasan, T., Lynch, M., King, C., Wehbe, C., Plymoth, M., Islam, M. S., ... & Sheel, M. (2024). Vaccine-Preventable Disease Outbreaks Among Healthcare Workers: A Scoping Review. *Clinical Infectious Diseases*, *79*(2), 555-561.
128. Health Reform Foundation of Nigeria. (2008). *Nigerian health review 2007: Primary health care in Nigeria: 30 years after Alma-Ata.* Abuja, Nigeria: Mmm-nat Educational Window Consultant Ltd.
129. Healthcare ( Base)- 2019 March :7(1):23 Published Online 2019 February 1 Doi: 10.3390/healthcare 7010023 PMCID: PMC 6473815/PIMID: 3071313
130. Hotta, C., Ogawa, T., & Shirasawa, H. (2019). Surveillance of immunity acquired from poliovirus immunisation including vaccination with the Sabin strain-derived inactivated vaccine. Human Vaccines & Immunotherapeutics.
131. https://pubmed.ncbi.nim.nih.gov/31792552/
132. Ibraheem R, Abdulkadir M, Akintola M, Adeboye M. Determinants of timely presentation for birth dose vaccination at an immunisation Centre in North-Central Nigeria. Ann Glob Health. 2019;85(1):20. https://doi.org/10.5334/aogh.725
133. Ibraheem, R., Abdulkadir, M., Akintola, M., & Adeboye, M. (2019). Determinants of timely presentation for birth dose vaccination at an immunisation centre in North-central Nigeria. *Annals of global health*, *85*(1), 20.
134. Ingle, Erin A., Priyanka Shrestha, Aparna Seth, Mathias S. Lalika, Jacinta I. Azie, and Rena C. Patel. "Interventions to vaccinate zero-dose children: a narrative review and synthesis." *Viruses* 15, no. 10 (2023): 2092.
135. Itimi K, Dienye PO, Ordinioha B. Community participation and childhood immunisation coverage: A comparative study of rural and urban communities of Bayelsa State, South-South Nigeria. Niger Med J 2012; 53: 21–25. https://dx.doi.org/10.4103%2F0300-1652.99826
136. Jillian, O., & Kizito, O. (2020). Socio-cultural factors associated with incomplete routine immunisation of children _ Amach Sub-County, Uganda. *Cogent medicine*, *7*(1), 1848755.

137. Karnad, D. R., & Gupta, V. (2021). Intensive care management of severe tetanus. Indian Journal of Critical Care Medicine: Peer-reviewed, Official Publication of Indian Society of Critical Care Medicine, 25(Suppl 2), S155.
138. Kaufmann JR, Feldbaum H. Diplomacy and the polio immunisation boycott in Northern Nigeria. Health Aff (Millwood). 2009 Jul-Aug;28(4):1091-101. doi:10.1377/hlthaff.28.4.1091. PMID: 19597208
139. Kayser, V., & Ramzan, I. (2021). Vaccines and vaccination: history and emerging issues. *Human vaccines & immunotherapeutics*, *17*(12), 5255-5268.
140. Kim, S. S., Frimpong, J. A., Rivers, P. A., & Kronenfeld, J. J. (2007). Effects of maternal and provider characteristics on up-to-date immunisation status of children aged 19 to 35 months.
141. Kiros, G. & White, J.M. (2004). Migration, Community Context, and Child Immunisation in Ethiopia. *Social Science & Medicine*, 59: 2603–16.
142. Konwea, P. E., David, F. A., & Ogunsile, S. E. (2018). Determinants of compliance with child immunisation among mothers of children under five years of age in Ekiti State, Nigeria. *Journal of Health Research*, *32*(3), 229-236.
143. Kuan, R., Muskat, K., Peters, B., & Arlehamn, C. S. L. (2020). BCG vaccine efficacy, immune correlates of protection and antigen-specific T cell responses. Journal of internal medicine, 288(6), 651.
144. Kuuyi, A., & Kogi, R. (2024). Factors contributing to immunisation coverage among children less than 5 years in Nadowli-Kaleo District of Upper West Region, Ghana. *PLOS Global Public Health*, *4*(8), e0002881.
145. Kuuyi, A., & Kogi, R. (2024). Factors contributing to immunisation coverage among children less than 5 years in Nadowli-Kaleo District of Upper West Region, Ghana. *PLOS Global Public Health*, *4*(8), e0002881.
146. kwataghibe NN, Ogunsola EA, Broerse J, Popoola OA, Agbo AI, DielemanMA. Exploring factors influencing immunisation utilisation in Nigeria-A mixed methods study. Front Public Health. 2019;7:392. https://doi.org/10.3389/fpubh.2019.00392.
147. Lam, E., Rosen, J. B., & Zucker, J. R. (2020). Mumps: an update on outbreaks, vaccine efficacy, and genomic diversity. *Clinical Microbiology Reviews*, *33*(2), 10-1128.

148. Lamichhane, A., & Radhakrishnan, S. (2024). Diphtheria
149. Laupèze, B., Del Giudice, G., Doherty, M. T., & Van der Most, R. (2021). Vaccination as a preventative measure contributing to immune fitness. npj Vaccines, 6(1), 93.
150. Lauria, A. M., & Zabbo, C. P. (2019). Pertussis (Whooping Cough). StatPearls. Treasure Island: StatPearls Publishing.
151. Lauria, A. M., & Zabbo, C. P. (2024). Pertussis.[Updated 2022 Oct 7]. *StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing*.
152. Lazarevic, I., Banko, A., Miljanovic, D., & Cupic, M. (2024). Hepatitis B Surface Antigen Isoforms: Their Clinical Implications, Utilisation in Diagnosis, Prevention and New Antiviral Strategies. Pathogens, 13(1), 46.
153. Lei, D., Miller, T., Carr, J., Buttery, J., Nold-Petry, C. A., Nold, M. F., & Malhotra, A. (2022). Timing of the First Dose of the Hepatitis B Vaccine in Preterm Infants. Vaccines, 10(10), 1656.
154. Li, Q., Wang, Y., Sun, Q., Knopf, J., Herrmann, M., Lin, L., ... & Shi, Y. (2022). Immune response in COVID-19: what is next?. Cell Death & Differentiation, 29(6), 1107-1122.
155. Lindstrand, A., Cherian, T., Chang-Blanc, D., Feikin, D., & O'Brien, K. L. (2021). The world of immunisation: achievements, challenges, and strategic vision for the next decade. *The Journal of Infectious Diseases*, *224*(Supplement_4), S452-S467.
156. Luca, S., & Mihaescu, T. (2013). History of BCG vaccine. Maedica, 8(1), 53-58.
157. Luies, L., & Du Preez, I. (2020). The echo of pulmonary tuberculosis: mechanisms of clinical symptoms and other disease-induced systemic complications. Clinical microbiology reviews, 33(4), 10-1128.
158. Machingaidze, S., Wiysonge, C. S., & Hussey, G. D. (2015). Strengthening the expanded programme on immunisation in Africa: Looking beyond 2015. *PLoS Medicine, 10*(3), 1-5. http://doi.org/10.1371/journal.pmed.1001405
159. MacNeil, J. R., Bennett, N., Farley, M. M., Harrison, L. H., Lynfield, R., Nichols, M., ... & Cohn, A. C. (2015). Epidemiology of infant meningococcal disease in the United States, 2006-2012. Pediatrics, 135(2), e305-e311.

160. Mahachi, K., Kessels, J., Boateng, K., Baptiste, A. E. J., Mitula, P., Ekeman, E., ... & Gabrielli, A. F. (2022). Zero-or missed-dose children in Nigeria: contributing factors and interventions to overcome immunisation service delivery challenges. *Vaccine*, *40*(37), 5433-5444.

161. Maina, L. C., Karanja, S., & Kombich, J. (2013). Immunisation coverage and its determinants among children aged 12-23 months in a peri-urban area of Kenya. *Pan African Medical Journal 14*(3), 1-7. http://doi.org/10.11604/pamj.2013.14.3.2181

162. Malave Sanchez, M., Saleeb, P., Kottilil, S., & Mathur, P. (2021, August). Oral Polio Vaccine to protect against COVID-19: Out of the box strategies?. In Open Forum Infectious Diseases (Vol. 8, No. 8, p. ofab367). US: Oxford University Press.

163. Malik, J. A., Ahmed, S., Yaseen, Z., Alanazi, M., Alharby, T. N., Alshammari, H. A., & Anwar, S. (2022). Association of SARS-CoV-2 and polypharmacy with Gut–Lung Axis: from pathogenesis to treatment. ACS omega, 7(38), 33651-33665.

164. Mameli, C., Cocchi, I., Fumagalli, M., & Zuccotti, G. (2019). Influenza vaccination: effectiveness, indications, and limits in the pediatric population. Frontiers in pediatrics, 7, 317.

165. Marinho, P. S., Cunha, A. J., Amim Junior, J., & Prata-Barbosa, A. (2017). A review of selected Arboviruses during pregnancy. Maternal Health, Neonatology and Perinatology, 3, 1-9.

166. Marshall, J. S., Warrington, R., Watson, W., & Kim, H. L. (2018). An introduction to immunology and immunopathology. Allergy, Asthma & Clinical Immunology, 14, 1-10.

167. Matthews, P. C., Ocama, P., Wang, S., El-Sayed, M., Turkova, A., Ford, D., ... & Hamid, S. (2023). Enhancing interventions for prevention of mother-to-child-transmission of hepatitis B virus. JHEP Reports, 5(8), 100777.

168. Mehta, P., & Reddivari, A. K. R. (2022). Hepatitis. In StatPearls [Internet]. StatPearls Publishing.

169. Mekonnen, Z. A., Gelaye, K. A., Were, M. C., & Tilahun, B. (2020). Timely completion of vaccination and its determinants among children in northwest, Ethiopia: a multilevel analysis. *BMC public health*, *20*, 1-13.

170. Mercy Nwankwo, C., & Elisabeth, O. (2020). Factors influencing incomplete immunisation among under-five-year-old children at CHUK hospital, Nyarugenge district, Rwanda. International Journal of Community Medicine and Public Health | October 2020 | Vol 7 | Issue
171. Ministry of Finance, Planning and Economic Development, (2007). *Infant Mortality in Uganda 2000-2005.* Kampala, Ministry of Finance, Planning and Economic Development.
172. Ministry of Health, (2007). *Annual Health Development Report for Uganda, 2005/2007*.
173. modified lactic acid bacteria: an overview on the gut-vagina axis. Cellular and Molecular Life Sciences, 78, 1191-1206.
174. Mohammed Ruhul Amin and Sartini Saman 03 June 2021-Reasons why it is important to complete all the vaccine on time.
175. Mohammed, I., Iliyasu, G., & Habib, A. G. (2017). Emergence and control of epidemic meningococcal meningitis in sub-Saharan Africa. *Pathogens and global health*, *111*(1), 1-6.
176. Mohammed, Y., Reynolds, H. W., Waziri, H., Attahiru, A., Mikailu, F., Adewole, A. O., ... & Nguku, P. (2024). Exploring the Landscape of Routine Immunisation in Nigeria: A Scoping Review of Barriers and Facilitators.
177. Mohammed, Y., Reynolds, H. W., Waziri, H., Attahiru, A., Mikailu, F., Adewole, A. O., ... & Nguku, P. (2024). Exploring the Landscape of Routine Immunisation in Nigeria: A Scoping Review of Barriers and Facilitators.
178. Moncion, K., Young, K., Tunis, M., Rempel, S., Stirling, R., & Zhao, L. (2019). Effectiveness of hand hygiene practices in preventing influenza virus infection in the community setting: A systematic review. Canada communicable disease report= Releve des maladies transmissibles au Canada, 45(1), 12-23.
179. Mulugeta, G. T., Gemeda, D. H., Dimore, A. L., Getu, T. Y., & Gelaw, A. Z. H. (2024). Factors Associated with Non-and Incomplete Vaccination Among Children Aged 12-23 Months in Gindhir Rural District. *Southeast Ethiopia: A Multinomial Analysis, J Vaccines Vaccin Stud*, *3*(1), 101.
180. Mulugeta, G. T., Gemeda, D. H., Dimore, A. L., Getu, T. Y., & Gelaw, A. Z. H. (2024). Factors Associated with Non-and Incomplete Vaccination Among Children Aged 12-23

Months in Gindhir Rural District. *Southeast Ethiopia: A Multinomial Analysis, J Vaccines Vaccin Stud*, *3*(1), 101.

181. Najjar, M., Albuaini, S., Fadel, M., & Mohsen, F. (2023). Covid-19 vaccination reported side effects and hesitancy among the Syrian population: a cross-sectional study. *Annals of Medicine*, *55*(2), 2241351.

182. Nasir, U. N., Bandyopadhyay, A. S., Montagnani, F., Akite, J. E., Mungu, E. B., Uche, I. V., & Ismaila, A. M. (2016). Polio elimination in Nigeria: a review. Human vaccines & immunotherapeutics, 12(3), 658-663.

183. Nasir, U. N., Bandyopadhyay, A. S., Montagnani, F., Akite, J. E., Mungu, E. B., Uche, I. V., & Ismaila, A. M. (2016). Polio elimination in Nigeria: a review. *Human vaccines & immunotherapeutics*, *12*(3), 658-663.

184. National Institute of Allergy and Infectious Diseases. Understanding How Vaccines Work (cdc.gov). http://www.niaid.nih.gov/topics/vaccines/

185. National Population Commission (NPC) [Nigeria] and ICF. (2019). *Nigeria Demographic and Health Survey 2018*. NPC and ICF

186. National Population Commission. Nigeria demographic and health survey 2013. Available from http://www.dhsprogram.com/pubs/pdf/FR293/FR293.pdf

187. National Primary Health Care Development Agency, (NPHCDA, 2019). Immunisation, foundation of Primary Health Care system in Nigeria. Immunisation, foundation of Primary Health Care system in Nigeria (vanguardngr.com) https://www.vanguardngr.com/2019/12/ immunisation -foundation-of-primary-health-care system

188. National Primary Health Care Development Agency. (2012). *National Guidelines for the Development of Primary Health Care System in Nigeria* (Fourth Revised Edition). National Primary Health Care Development Agency, Federal Republic of Nigeria.

189. Ngozi N. Akwataghibe, Elijah A, Ogunsola, Jacqueline E.W.Broeose, Oluwafemi A. Popoola, Adannah I. Agbo and Marjolein A. Dieleman., 20 Dec 2019 . Exploring Factors Influencing Immunisation Utilisation in Nigeria – As Mixed Method Study, Frontiers in public health.7,392. Front, public health,20 Dec 2019 sec.pubic health policy volume 7-2019 https://doi.org/10.3389/fpubh.2019.00392

190. Nnaji, C. A., Owoyemi, A. J., Amaechi, U. A., Wiyeh, A. B., Ndwandwe, D. E., & Wiysonge, C. S. (2021). Taking stock of global immunisation coverage progress: the gains, the losses and the journey ahead. *International Health*, *13*(6), 653-657.

191. Nomhwange, T., Jean Baptiste, A. E., Ezebilo, O., Oteri, J., Olajide, L., Emelife, K., ... & Tomori, O. (2021). The resurgence of yellow fever outbreaks in Nigeria: a 2-year review 2017–2019. *BMC infectious diseases*, *21*, 1-12.

192. Nurmi, J., & Jaakola, J. (2023). Losing trust: Processes of vaccine hesitancy in parents' narratives. *Social Science & Medicine*, *331*, 116064.

193. Nuwarda, R. F., Ramzan, I., Weekes, L., & Kayser, V. (2022). Vaccine hesitancy: contemporary issues and historical background. *Vaccines*, *10*(10), 1595.

194. Nwaiwu, A. U., Musekiwa, A., Tamuzi, J. L., Sambala, E. Z., & Nyasulu, P. S. (2021). The incidence and mortality of yellow fever in Africa: a systematic review and meta-analysis. BMC infectious diseases, 21, 1-11.

195. Obasohan PE, Mustapha MA, Makada A, Obasohan DN. Evaluating the reasons for partial and non-immunisation of children in Wushishi local government area, Niger State, Nigeria: methodological comparison Afr JReprod Health 2018; 22:113:https://doi.org/10.29063/ ajrh2018/v22i4.12

196. Ochei, O., Ntaji, M. I., Adesoye, O. O., Oserada, N. O., Ordiah, S. N., Osaekete, K. I., & Oshadiya, O. C. (2023). A Community Survey of the Vaccination Status of Under-Five Children in a Community in Southern Nigeria. *Nigerian Journal of Medicine*, *32*(1), 8-14.

197. Ochei, O., Ntaji, M. I., Adesoye, O. O., Oserada, N. O., Ordiah, S. N., Osaekete, K. I., & Oshadiya, O. C. (2023). A Community Survey of the Vaccination Status of Under-Five Children in a Community in Southern Nigeria. *Nigerian Journal of Medicine*, *32*(1), 8-14.

198. Ogden, S. A., Ludlow, J. T., & Alsayouri, K. (2019). Diphtheria Tetanus Pertussis (DTaP) Vaccine.

199. Ogunniyi, T. J. (2024). Revealing the challenges and efforts of routine immunisation coverage in Nigeria. *Health Science Reports*, *7*(8), e70000.

200. OIDP, May, 6 2022. Five important Reasons to Vaccinate Your Child. Headquarters. Office of infectious Disease and HIV/AIDS Policy.U.S. Department of Health and Human Services 330 C Street, SW. Suit L 100 Washington, D. C. 20024

201. Okenwa UJ, Dairo MD, Uba B, Ajumobi O. Maternal reasons for non-receipt of valid hepatitis B birth dose among mother-infant pairs attending routine immunisation clinics, south - east, Nigeria . Vaccine . 2019;37(46):6894 – 9 . https://doi . org/10 . 1016/ j.vaccine.2019.09.056.

202. Okenwa, U. J., Dairo, M. D., Uba, B., & Ajumobi, O. (2019). Maternal reasons for non-receipt of valid Hepatitis B birth dose among mother-infant pairs attending routine immunisation clinics, South-east, Nigeria. *Vaccine*, *37*(46), 6894-6899.

203. Oladokun RE, Adedokun BO, Lawoyin TO. Children not receiving adequate immunisation in Ibadan, Nigeria: what reasons and beliefs do their mothers have? Niger J Clin Pract. 2010;13(2):173–8

204. Olaniyan, A., Isiguzo, C., & Hawk, M. (2021). The Socioecological Model as a framework for exploring factors influencing childhood immunisation uptake in Lagos state, Nigeria. *BMC Public Health*, *21*(1), 867.

205. Olowolafe TA, Adebowale AS, Fagbamigbe AF, Bolarinwa OA, Akinyemi JO (2023) Shifts in age pattern, timing of childbearing and trend in fertility level across six regions of Nigeria: Nigeria Demographic and Health Surveys from 2003–2018. PLoS ONE 18(1): e0279365. doi:10.1371/journal.pone.0279365

206. Olowolafe TA, Adebowale AS, Fagbamigbe AF, Bolarinwa OA, Akinyemi JO (2023) Shifts in age pattern, timing of childbearing and trend in fertility level across six regions of Nigeria: Nigeria Demographic and Health Surveys from 2003–2018. PLoS ONE 18(1): e0279365. doi:10.1371/journal.pone.0279365

207. Olufadewa, I., Bamidele, D., Olufadewa, T., Adesina, M., & Oladele, R. (2024). Combating recurrent measles outbreaks in Nigeria: Short-term and long-term strategies. *Journal of Medicine, Surgery, and Public Health*, *3*, 100123.

208. Olugbade, O. T., Adeyemi, A. S., Adeoti, A. H., Ilesanmi, O. S., Gidado, S. O., Waziri, N. E., & Aworh, M. K. (2019). Measles outbreaks and Supplemental Immunisation

Activities (SIAs): the Gwagwalada experience, Abuja 2015. *The Pan African Medical Journal*, *32*(Suppl 1), 10.

209. Olusoji, I. J., Opeymi, O., Adesoji, A. K., Olanrewaju, O., Aderibigbe, M., & Dasola, A. R. (2024). Factors Affecting Mothers' Adherence to Childhood Immunisation Schedules in Ifelodun LGA, Osun-State, Nigeria: Public Health Implications.
210. Olusoji, I. J., Opeymi, O., Adesoji, A. K., Olanrewaju, O., Aderibigbe, M., & Dasola, A. R. (2024). Factors Affecting Mothers' Adherence to Childhood Immunisation Schedules in Ifelodun LGA, Osun-State, Nigeria: Public Health Implications.
211. Olutuase, V. O., Iwu-Jaja, C. J., Akuoko, C. P., Adewuyi, E. O., & Khanal, V. (2022). Medicines and vaccines supply chains challenges in Nigeria: a scoping review. *BMC Public Health*, *22*, 1-15.

212. Omobowale, M. O., Amodu, F. A., Falase, O. S., Olajide, T. H., & Amodu, O. K. (2024). Contextualizing post-day-one childhood immunisation in-take drop-off rate in Nigeria: An assessment of working mothers in Ibadan. *Gates Open Research*, *8*(48), 48.
213. Omobowale, M. O., Amodu, F. A., Falase, O. S., Olajide, T. H., & Amodu, O. K. (2024). Contextualizing post-day-one childhood immunisation in-take drop-off rate in Nigeria: An assessment of working mothers in Ibadan. *Gates Open Research*, *8*(48), 48.
214. Onwujekwe, O., Ezumah, N., Mbachu, C., Obi, F., Ichoku, H., Uzochukwu, B., & Wang, H. (2019). Exploring effectiveness of different health financing mechanisms in Nigeria; what needs to change and how can it happen?. *BMC health services research*, *19*, 1-13.

215. Ophori EA, Tula MY, Azih AV, Okojie R, Ikpo PE. Current trends of immunisation in Nigeria: prospect and challenges. Trop Med Health. 2014;42(2):67-75. doi:10.2149/tmh.2013-13
216. Ophori EA, Tula MY, Azih AV, Okojie R, Ikpo PE. Current trends of immunisation in Nigeria: prospect and challenges. Trop Med Health. 2014;42(2):67-75. doi:10.2149/tmh.2013-13
217. Osain, M. (2011). The Nigerian health care system: Need for integrating adequate medical intelligence and surveillance systems. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3249694/

218. Oyadiran, O. T., Usman, S. A., Osoba, M. E., Olukorode, S. O., & Lucero-Prisno III, D. E. (2021). Towards effective and efficient COVID-19 vaccination in Nigeria. *Journal of global health reports*, *5*, e2021023.

219. Oyefara John Lekan: Mothers characteristics and immunisation status of under-five children in Ojo Local Government Area, Lagos State, Nigeria August 2014: SAGE Open 4(3) DOI:10:1177/2158244014545474

220. Oyefara, J. L. (2014). Mothers' characteristics and immunisation status of under-five children in Ojo Local Government Area, Lagos State, Nigeria. *SAGE Open*, *4*(3). http://doi.org/10.1177/2158244014545474

221. Oyo-Ita, A., Oduwole, O., Arikpo, D., Effa, E. E., Esu, E. B., Balakrishna, Y., ... & Meremikwu, M. M. (2023). Interventions for improving coverage of childhood immunisation in low-and middle-income countries. *Cochrane Database of Systematic Reviews*, (12).

222. Patterson, B., & Wood, R. (2019). Is cough really necessary for TB transmission?. Tuberculosis, 117, 31-35.
223. Platform for infectious diseases: Current progress, challenges, and opportunities. Vaccines, 9(12), 1490.
224. Packham, A., Taylor, A. E., Karangwa, M. P., Sherry, E., Muvunyi, C., & Green, C. A. (2024). Measles vaccine coverage and disease outbreaks: A systematic review of the early impact of COVID-19 in low and lower-middle income countries. *International Journal of Public Health*, *69*, 1606997.
225. Pathakumari, B., Liang, G., & Liu, W. (2020). Immune defence to invasive fungal infections: A comprehensive review. Biomedicine & Pharmacotherapy, 130, 110550.
226. Pavia, G., Branda, F., Ciccozzi, A., Romano, C., Locci, C., Azzena, I., ... & Scarpa, F. (2024). Integrating digital health solutions with immunisation strategies: Improving immunisation coverage and monitoring in the post-COVID-19 era. *Vaccines*, *12*(8), 847.
227. Pittet, L. F., & Posfay-Barbe, K. M. (2021). Vaccination of immune compromised children—an overview for physicians. *European journal of pediatrics*, *180*, 2035-2047.
228. Pollard, A. J., & Bijker, E. M. (2021). A guide to vaccinology: from basic principles to new developments. Nature Reviews Immunology, 21(2), 83-100.
229. Rabaan, A. A., Mutair, A. A., Alhumaid, S., Garout, M., Alsubki, R. A., Alshahrani, F. S., ... & Ahmed, N. (2022). Updates on measles incidence and eradication: emphasis on the immunological aspects of measles infection. Medicina, 58(5), 680.
230. Rahman, M., & Obaida-Nasrin, S. (2010). Factors affecting acceptance of complete immunisation coverage of children under five years in rural Bangladesh. *Salud Publica de Mexico*, *52*(2), 134-140. http://doi.org/10.1590/S0036-36342010000200005
231. Randolph, H. E., & Barreiro, L. B. (2020). Herd immunity: understanding COVID-19. *Immunity*, *52*(5), 737-741.
232. Rasmussen, A. L. (2020). Vaccination is the only acceptable path to herd immunity. *Med*, *1*(1), 21-23.
233. Rastogi, I., Jeon, D., Moseman, J. E., Muralidhar, A., Potluri, H. K., & McNeel, D. G. (2022). Role of B cells as antigen presenting cells. Frontiers in immunology, 13, 954936.
234. Richard, O. (2023). Fraud, corruption and counterfeits in the Nigerian pharmaceutical industry. Univ Portsm.

235. Richter, G. (2023, April 3). Why do mRNA Vaccines Cause Strongest Immune Response in Younger Individuals. https://drexel.edu/news/archive/2023/March/Why-do-mRNA-Vaccines-Cause-Strongest-Immune-Response-in-Younger-Individuals

236. Rodrigues, C. M., & Plotkin, S. A. (2020). Impact of vaccines; health, economic and social perspectives. Frontiers in microbiology, 11, 1526.

237. Rodrigues, C. M., & Plotkin, S. A. (2020). Impact of vaccines; health, economic and social perspectives. *Frontiers in microbiology*, *11*, 1526.

238. Rodrigues, C. M., & Plotkin, S. A. (2020). Impact of vaccines; health, economic and social perspectives. *Frontiers in microbiology*, *11*, 1526.

239. Rodrigues, F., Ziade, N., Jatuworapruk, K., Caballero-Uribe, C. V., Khursheed, T., & Gupta, L. (2023). The impact of social media on vaccination: a narrative review. *Journal of Korean Medical Science*, *38*(40).

240. Rohokale, R., & Guo, Z. (2023). Development in the concept of bacterial polysaccharide repeating unit-based antibacterial conjugate vaccines. ACS infectious diseases, 9(2), 178-212.

241. Romano', L., & Zanetti, A. R. (2022). Hepatitis B vaccination: A historical overview with a focus on the Italian achievements. Viruses, 14(7), 1515.

242. Sabirovna, R. S. (2021). To study the effects of viral diseases on the human body and their effective treatment. International Journal of Current Research and Review, 13(1), 52-55.

243. Sadiq, A., & Khan, J. (2024). Rotavirus in developing countries: molecular diversity, epidemiological insights, and strategies for effective vaccination. Frontiers in Microbiology, 14, 1297269.

244. Sadiq, M., Croucher, S., & Dutta, D. (2023). COVID-19 vaccine Hesitancy: a content analysis of Nigerian YouTube videos. *Vaccines*, *11*(6), 1057.

245. Salako, J., Bakare, D., Uchendu, O. C., Bakare, A. A., Graham, H., & Falade, A. G. (2024). Factors associated with immunisation status among children aged 12-59 months in Lagelu local government area, Ibadan: A cross-sectional study. *The Pan African Medical Journal*, *47*. https://doi.org/10.11604/pamj.2024.47.35.37013

246. Salako, J., Bakare, D., Uchendu, O. C., Bakare, A. A., Graham, H., & Falade, A. G. (2024). Factors associated with immunisation status among children aged 12-59 months in Lagelu local government area, Ibadan: A cross-sectional study. *The Pan African Medical Journal*, *47*. https://doi.org/10.11604/pamj.2024.47.35.37013

247. Samaila, A., Abdulkadir, B., Kabir, K., Aliyu, S., & Umar, Z. (2018). Pathogenesis and management of tetanus. UMYU Journal of Microbiology Research (UJMR), 3(1), 16-23.

248. Scharff, D. P., Mathews, K. J., Jackson, P., Hoffsuemmer, J., Martin, E., & Edwards, D. (2010). More than Tuskegee: understanding mistrust about research participation. *Journal of health care for the poor and underserved*, *21*(3), 879-897.

249. Seiwert, C. (2019). Immune System. Human Biology.

250. Sheikh, N., Sultana, M., Ali, N., Akram, R., Mahumud, R. A., Asaduzzaman, M., & Sarker, A. R. (2018). Coverage, timelines, and determinants of incomplete immunisation in Bangladesh. *Tropical medicine and infectious disease*, *3*(3), 72.

251. Shen, A. K., Fields, R., & McQuestion, M. (2014). The future of routine immunisation in the developing world: challenges and opportunities. *Global Health, Science and Practice*, *2*(4), 381 94. http://doi.org/10.9745/GHSP-D-14-00137

252. Singh, K., Haney, E., & Olorunsaiye, C. (2013). Maternal autonomy and attitudes towards gender norms: Associations with childhood immunisation in Nigeria. *Maternal and Child Health Journal, 17*(5), 837-841. http://doi.org/10.1007/s10995-012-1060-5

253. Sinuraya, R. K., Nuwarda, R. F., Postma, M. J., & Suwantika, A. A. (2024). Vaccine hesitancy and equity: lessons learned from the past and how they affect the COVID-19 countermeasure in Indonesia. *Globalisation and Health*, *20*(1), 11.

254. Song, M. Y., Blake-Hepburn, D., Karbasi, A., Fadel, S. A., Allin, S., Ataullahjan, A., & Ruggiero, E. D. (2024). Public health partnerships with faith-based organisations to support vaccination uptake among minoritised communities: A scoping review. *PLOS Global Public Health*, *4*(6), e0002765.

255. Statistica.com. Literacy rate in Nigeria in 2018, by zone and gender. https:// www.statista.com/statistics/1124745/literacy-rate-in-nigeria-by-zone-and-gend er/

256. Stefanetti, G., Borriello, F., Richichi, B., Zanoni, I., & Lay, L. (2022). Immunobiology of carbohydrates: implications for novel vaccine and adjuvant design against infectious diseases. Frontiers in Cellular and Infection Microbiology, 11, 808005.

257. Stein-Zamir, C., Shoob, H., Abramson, N., Brown, E. H., & Zimmermann, Y. (2023). Pertussis outbreak mainly in unvaccinated young children in ultra-orthodox Jewish groups, Jerusalem, Israel 2023. Epidemiology & Infection, 151, e166.

258. Streatfield, K., Singarimbun, M., & Diamond, I. (1990). Maternal Education and Child Immunisation. *Demography*, 27: 447–55.

259. Svallfors, S., Båge, K., Ekström, A. M., Elimian, K., Gayawan, E., Litorp, H., & Kågesten, A. (2024). Armed conflict, insecurity, and attitudes toward women's and girls' reproductive autonomy in Nigeria. *Social Science & Medicine*, *348*, 116777.

260. Tagbo BN, Eke CB, Omotowo BI, Onwuasigwe CN, Onyeka EB, and Mildred UO. (2014) Vaccination coverage and its determinants in children aged 11 - 23 months in an urban district of Nigeria. World Journal of Vaccines, 4, 175-183. http://dx.doi.org/10.4236/wjv.2014.44020

261. Taghinezhad-S, S., Keyvani, H., Bermúdez-Humarán, L. G., Donders, G. G., Fu, X., & Mohseni, A. H. (2021). Twenty years of research on HPV vaccines based on genetically

262. Tamirat, K. S., & Sisay, M. M. (2019). Full immunisation coverage and its associated factors among children aged 12–23 months in Ethiopia: further analysis from the 2016 Ethiopia demographic and health survey. *BMC public health*, *19*, 1-7.

263. Tan, M., Bhadoria, A. S., Cui, F., Tan, A., Van Holten, J., Easterbrook, P., ... & Hutin, Y. (2021). Estimating the proportion of people with chronic hepatitis B virus infection eligible for hepatitis B antiviral treatment worldwide: a systematic review and meta-analysis. The lancet Gastroenterology & hepatology, 6(2), 106-119.

264. Tereziu, S., & Minter, D. A. (2018). Pneumococcal vaccine.

265. Tesema, G. A., Tessema, Z. T., Tamirat, K. S., & Teshale, A. B. (2020). Complete basic childhood vaccination and associated factors among children aged 12–23 months in East Africa: a multilevel analysis of recent demographic and health surveys. *BMC Public Health*, *20*, 1-14.

266. The health belief model-Sph.bu.edu-Boston university https://sphweb bumc.bu.edu.otit 3 Nov 2022

267. Thomas Cherian, and Carsten Mantel 2020. National Programme on Immunisation. National immunisation programmes - PubMed (nih.gov) Bundesgesundheitsbatt Gesundheitsschutz.2020 Jan

268. Tiwana, M. H., & Smith, J. (2024). Faith and vaccination: a scoping review of the relationships between religious beliefs and vaccine hesitancy. *BMC Public Health*, *24*(1), 1806.

269. Tiwana, M. H., & Smith, J. (2024). Faith and vaccination: a scoping review of the relationships between religious beliefs and vaccine hesitancy. *BMC Public Health*, *24*(1), 1806.

270. Tobin-West CI, Alex-Hart BA. Identifying barriers and sustainable solutions to childhood immunisation in Khana local government area of Rivers State, Nigeria Int Q Community Health Educ 2011-2012; 32:149–158. http://dx.doi.org/https://doi.org/10.2190/IQ.32.2.e

271. Travieso, T., Li, J., Mahesh, S., Mello, J. D. F. R. E., & Blasi, M. (2022). The use of viral vectors in vaccine development. npj Vaccines, 7(1), 75.

272. Trotter, C. L., Lingani, C., Fernandez, K., Cooper, L. V., Bita, A., Tevi-Benissan, C., ... & Stuart, J. M. (2017). Impact of MenAfriVac in nine countries of the African meningitis belt, 2010–15: an analysis of surveillance data. The Lancet infectious diseases, 17(8), 867-872.

273. Truelove, S. A., Keegan, L. T., Moss, W. J., Chaisson, L. H., Macher, E., Azman, A. S., & Lessler, J. (2020). Clinical and epidemiological aspects of diphtheria: a systematic review and pooled analysis. *Clinical Infectious Diseases*, *71*(1), 89-97.

274. Turaiche, M., Grigoras, M. L., Bratosin, F., Bogdan, I., Bota, A. V., Cerbu, B., ... & Marincu, I. (2022). Disease progression, clinical features, and risk factors for pneumonia in unvaccinated children and adolescents with measles: a re-emerging disease in Romania. International Journal of Environmental Research and Public Health, 19(20), 13165.

275. Ullah, K., Saleem, J., Zakar, R., Ishaq, M., Khattak, F. A., Majeed, F., Sadiqa, H.A., & Fischer, F. (2024). Exploring the reasons for defaulting from childhood immunisation: a qualitative study in Pakistan. *BMC Public Health*, *24*(1), 408.

276. Ullah, K., Saleem, J., Zakar, R., Ishaq, M., Khattak, F. A., Majeed, F., Sadiqa, H.A., & Fischer, F. (2024). Exploring the reasons for defaulting from childhood immunisation: a qualitative study in Pakistan. *BMC Public Health*, *24*(1), 408.

277. UN News. Polio is no longer endemic in Nigeria – UN health agency. Available from https:// www.un.org/africarenewal/news/polio-no-longer-endemic-nigeria-%E2%80%9 3-un-health-agency

278. UNICEF (2021). COVID-19 vaccines shipped by COVAX arrive in Nigeria. https://www.unicef.org/nigeria/press-releases/covid-19-vaccines-shipped-covax-arrive-nigeria

279. Urich, A. (2017). *The health belief model*. Pressbooks. Varghese, T., Kang, G., & Steele, A. D. (2022). Understanding rotavirus vaccine efficacy and effectiveness in countries with high child mortality. Vaccines, 10(3), 346.

280. Velavan, T. P., Pollard, A. J., & Kremsner, P. G. (2020). Herd immunity and vaccination of children for COVID-19. *International Journal of Infectious Diseases*, *98*, 14.

281. Verulava, T., Jaiani, M., Lordkipanidze, A., Jorbenadze, R., & Dangadze, B. (2019). Mothers' knowledge and attitudes towards child immunisation in Georgia. *The Open Public Health Journal*, *12*, 232-237.

282. Visca, D., Ong, C. W. M., Tiberi, S., Centis, R., D'ambrosio, L., Chen, B., ... & Goletti, D. (2021). Tuberculosis and COVID-19 interaction: a review of biological, clinical and public health effects. Pulmonology, 27(2), 151-165.

283. Voorman, A., Hoff, N. A., Doshi, R. H., Alfonso, V., Mukadi, P., Muyembe-Tamfum, J. J., ... & Rimoin, A. W. (2017). Polio immunity and the impact of mass immunisation campaigns in the Democratic Republic of the Congo. *Vaccine*, *35*(42), 5693-5699.

284. WHO (2023) Influenza (seasonal).

285. WHO (2020) History of the Measles Vaccine. https://www.who.int/news-room/spotlight/history-of-vaccination/history-of-measles-vaccination

286. WHO (2023) Poliomyelitis. https://www.who.int/news-room/fact-sheets/detail/poliomyelitis

287. WHO (2023) Yellow Fever. https://www.who.int/news-room/fact-sheets/detail/yellow-fever

288. WHO (2023). Meningitis. https://www.who.int/news-room/fact-sheets/detail/meningitis

289. WHO (2024) Hepatitis B.

290. WHO (2024) Measles. https://www.who.int/news-room/fact-sheets/detail/measles

291. WHO (2024) Vaccines and Immunisation.

292. WHO (2024). *Immunisation coverage*. https://www.who.int/teams/immunisation-vaccines-and-biologicals/immunisation-analysis-and-insights/global-monitoring/immunisation-coverage.

293. WHO ,14 July 2022 https://www.who.int( Therapentics and COVID-19 :living guideline 14 July 2022 https://ins.who.int/handle/10665/359774

294. WHO, 2020 Polio Eradication - A Battle I Fought with Undiluted Passion, Professor Oyewale Tomori Published: 25 Aug, 2020 https://www.afro.who.int/news/polio eradication a battle fault with undiluted passion says professor oyewale tomori amjorlayer who made this feat possible

295. WHO/UNICEF Joint news release. Global measles deaths plunge by 48% over past six years. WHO Media centre. Available at h t tp : / / w ww . w h o .i n t / mediacentre/news/ releases/2006/pr11/ en/ .Accessed 6/04/2016.)

296. Williams, S. V., Akande, T., & Abbas, K. (2024). Systematic review of social determinants of childhood immunisation in low- and middle-income countries and equity impact analysis of childhood vaccination coverage in Nigeria. *PLOS ONE*, *19*(3), e0297326. https://doi.org/10.1371/journal.pone.0297326

297. Williams, S. V., Akande, T., & Abbas, K. (2024). Systematic review of social determinants of childhood immunisation in low- and middle-income countries and equity impact analysis of childhood vaccination coverage in Nigeria. *PLOS ONE*, *19*(3), e0297326. https://doi.org/10.1371/journal.pone.0297326

298. World Health Organisation (2023) Tuberculosis.

299. World Health Organisation. Nigeria: WHO

300. World Bank (2006). *Disease and Mortality in Sub-Saharan Africa.* Washington, World Bank Headquarters.

301. World Health Organisation (2023) Tetanus. https://www.who.int/news-room/fact-sheets/ detail/tetanus

302. World Health Organisation (2024) Diphtheria. https://www.who.int/news-room/fact-sheets/ detail/diphtheria

303. World Health Organisation. (2015). *National immunisation coverage scorecards estimates for 2014.* Retrieved from http://www.who.int/immunisation/global_vaccine_action_plan/ WHA_Scorecards _2014.pdf

304. World Health Organisation. Emergencies, preparedness, response: Smallpox vaccines. Available from www. Who.int/csr/disease/smallpox/vaccines/en [Accessed Nov 2017]
305. World Health Organisation. Expanded Programme on Immunisation. Geneva, Switzerland, 1976. Available from www.doh.gov.ph>expanded–programme-onimmunisation.
306. World Health Organisation. Global eradication of poliomyelitis: report of the sixth meeting of the Technical Consultative Group for poliomyelitis eradication. Geneva, 2001. Available from www.who.int/vaccinesdocuments/
307. World Health Organisation. Health topics: Immunisation. Available from www.who.int/topics/immunisaton/en.
308. World Health Organisation. Immunisation surveillance, assessment and monitoring. Vaccine preventable diseases 2012. Available a t h t tp : / / w ww . w h o .i n t / immunisation_monitoring/ diseases/en/ accessed 16/3/16.
309. World Health Organisation: WHO. (2024, August 13). *Breaking barriers, building bridges: the collaborative effort to reach every child in Nigeria*. https://www.who.int/news-room/feature-stories/detail/breaking-barriers-building-bridges-collaborative-effort-nigeria
310. World Immunisation Week (2013). Available at www.who.int/mediacenter/news/releases/200 6/prll/en/ Accessed 05/05/2016.
311. Yadav, M. (2022). Innate Immunity. In An Interplay of Cellular and Molecular Components of Immunology (pp. 27-59). CRC Press.
312. Yeasmin, S., Hasan, S. T., Chisti, M. J., Khan, M. A., Faruque, A. S. G., & Ahmed, T. (2022). Factors associated with dehydrating rotavirus diarrhea in children under five in Bangladesh: An urban-rural comparison. Plos one, 17(8), e0273862.
313. Younus, M. M., & Al-Jumaili, A. A. (2021). An overview of COVID-19 vaccine safety and post-marketing surveillance systems. Innovations in Pharmacy, 12(4).
314. Zhao, L., Tran, H., Risk, M., & Nair, G. (2024). Risk of blood clots after COVID-19 vaccination and infection: a risk-benefit analysis. *Research square*, rs-3.
315. Zimmerman, T., Shiroma, K., Fleischmann, K. R., Xie, B., Jia, C., Verma, N., & Lee, M. K. (2023). Misinformation and COVID-19 vaccine hesitancy. *Vaccine*, *41*(1), 136-144.

## INFORMED CONSENT

**TITLE OF STUDY: FACTORS ASSOCIATED WITH THE UPTAKE OF CHILDHOOD IMMUNISATION BY MOTHERS OF UNDER FIVE IN AJEROMI-IFELODUN LOCAL GOVERNMENT AREA LAGOS STATE**

**PRINCIPAL INVESTIGATOR:** MILLER AFOLABI WILLIAMS

**PURPOSE OF STUDY**

My name is Miller Afolabi Williams, a PhD of public health student at the Faculty of Public Health, Lead City University, Ibadan. I am conducting a study on the FACTORS ASSOCIATED WITH THE UPTAKE OF CHILDHOOD IMMUNISATION BY MOTHERS OF UNDER-FIVE IN AJEROMI-IFELODUN LOCAL GOVERNMENT AREA LAGOS STATE

The primary objective of this study is to understand the knowledge levels and practices related to childhood immunisation among mothers of under-five children in the Ajeromi-Ifelodun Local Government Area. Additionally, the research aims to identify the factors that influence the uptake of childhood immunisation by mothers in this locality.

**RESEARCH PROCEDURE**

Your involvement in this study is valuable. If you agree to participate, you will be required to respond to a structured questionnaire. The questionnaire will cover aspects such as your demographic information, knowledge of childhood immunisation, practices related to immunisation for your under-five children, and factors influencing the uptake of childhood immunisation. Completing the questionnaire is estimated to take approximately 20 minutes of your time.

**RISKS AND BENEFITS**

There are minimal or no risks if you take part in this study. There are also no incentives but the information you provide will help you improve your health and that of your loved ones.

**COMPENSATION**

There is no monetary compensation or incentive for this study. Participation is voluntary.

**CONFIDENTIALITY**

As stated above, your comments will be anonymous. Every effort will be made by the researcher to preserve your confidentiality. Only the research team will have access to the answered questionnaires. Confidentiality and privacy will be maintained by keeping all materials under lock and key. Your name will not be recorded.

**CONTACT INFORMATION**

If you have questions at any time about this study, as the result of participating in this study, you may contact

Miller Afolabi Williams

PUBLIC HEALTH DEPARTMENT,

LEAD CITY UNIVERSITY, TOLL GATE, IBADAN,

+2347064658364/+2348053520474

afolabi.miller@gmail.com

OR

Chairman LCU Institutional Review Board. Lead City University Ibadan Oyo State through lcu.hrec@lcu.edu.ng

**VOLUNTARY PARTICIPATION**

Your participation in this study is voluntary. It is up to you to decide whether or not to take part in this study. If you decide to take part in this study, you will be asked to sign a consent form. After you sign the consent form, you are still free to withdraw at any time and without giving a reason. Withdrawing from this study will not affect the relationship you have, if any, with the researcher. If you withdraw from the study before data collection is completed, your data will be returned to you or destroyed.

---

**CONSENT**

I have read and understand the provided information and have had the opportunity to ask questions. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving a reason and without cost. I understand that I will be given a copy of this consent form. I voluntarily agree to take part in this study.

Participant's signature/thumbprint _____ Date _____

Participants Name: _____

Investigator's signature _____ Date _____

Investigator's Name: _____

Witness Name: (If necessary) _____

Signature or thumbprint: _____

**QUESTIONNAIRE**

**FACULTY OF PUBLIC HEALTH**

**LEAD CITY UNIVERSITY, IBADAN**

# FACTORS ASSOCIATED WITH THE UPTAKE OF CHILDHOOD IMMUNISATION BY MOTHERS OF UNDER-FIVE IN AJEROMI-IFELODUN LOCAL GOVERNMENT AREA LAGOS STATE



**Dear Respondent**

I am a Postgraduate student of the above-named department and school. Conducting a study on factors associated with the uptake of childhood immunisation by mothers of under-five in Ajeromi-Ifelodun Local Government Area Lagos State.

I humbly solicit your consent and honest response to this questionnaire which is strictly for academic purposes, all information supplied will be treated with utmost confidentiality and you do not need to put your name on the instrument thank you.

**Miller Afolabi Williams**

**Section A – DEMOGRAPHIC**

Socio-demographic characteristics

Instruction: Kindly tick (√) or fill in the space which best represents your response(s) to the questions.

1. Sex: (1) Male ( ) (2) Female ( )
2. Age _____ (at last birthday)
3. Marital status: Single ( ) Married ( ) Divorce ( ) Separated ( ) Widow ( )
4. Religion: (1) Christian ( ) (2)Muslim ( ) (3)Traditional ( ) (4) Others (specify)_____
5. Occupation: (1) Professional ( ) (2) Skilled ( ) (3) Unskilled ( ) (4) Employed ( ) (5) Unemployed ( ) (6) Self-employed
6. Level of education: (1) No Education ( ) (2) Primary ( ) (3) Secondary ( ) (4) Tertiary ( ) (5) Others specify_____
7. How much money do you earn in a month (1) ₦10,000 – ₦20,000 (2) ₦21,000 – ₦30,000 (3) ₦31,000 – ₦40,000 (4) ₦41,000 – ₦50,000 (5) More than ₦50,000 (6) No Income
8. Partner educational level: (1) No Education ( ) (2) Primary ( ) (3) Secondary ( ) (4) Tertiary ( ) (5) Others (Specify)_____
9. Partner Occupation (1) Professional ( ) (2) Skilled ( ) (3) Unskilled ( ) (4) Employed ( ) (5) Self-employed ( ) (6) Unemployed ( )

**SECTION B - INFORMATION OF THE CHILD**

10.Age (in months) _____
11.Sex (1) Male ( ) (2) Female ( )

12.What is the position of the child among your children_____

13.Place of birth: (1) General hospital ( ) (2) Private hospital ( ) (3) Primary Health Care Center (6) Church ( ) (7) Other places (Specify)_____

14.Types of delivery (1) Caesarean section (**CS**) ( ) (2) Vaginal delivery ( ) (3) Labor induction ( ) (4) Vacuum extraction( )

15.Registration of birth: (1) Yes ( ) (2) No ( )

16.Immunisation card available: (1) Yes ( ), (2) No ( )

17.Immunisation card seen: (1) Yes ( ), (2) No ( )

18.Did you receive postnatal care (1) Yes ( ) (2) No ( )

19.Types of immunisation received by the child

| Contact | Age of Child | Types of vaccine | Yes | No |
|---|---|---|---|---|
| 1st | At Birth | BCG | | |
| | | $OPV_0$ | | |
| | | Hepatitis B | | |
| 2nd | 6 weeks | Pentavalent 1 | | |
| | | $OPV_1$ | | |
| | | $PCV_1$ | | |
| | | $IPV_1$ | | |
| | | Rota virus vaccine1 | | |
| 3rd | 10 weeks | Pentavalent 2 | | |
| | | PCV2 | | |
| | | $OPV_2$ | | |
| | | Rota virus vaccine2 | | |

| | | | | |
|---|---|---|---|---|
| 4th | 14 weeks | Pentavalent 3 | | |
| | | PCV3 | | |
| | | IPV3 | | |
| | | OPV3 | | |
| | | Rota virus vaccine 3 | | |
| | 6 weeks | Vitamin A 1st dose | | |
| 5th | 9 months | Measles Vaccine1 | | |
| | | Yellow fever Vaccine | | |
| | | Meningitis Vaccine | | |
| | 12 months | Vitamin A 2nd dose | | |
| 6th | 15 months | Measles Vaccine2 | | |

Please read the under-listed and indicate by ticking (√) in one of the columns appropriate

20. Has your child received his/her Immunisation up to date (1) yes ( ) (2) No ( )
(3) I don't know ( )

21. If your answer is yes to question 20, what encourages you to take your child for immunisation?

I. Health facility close to my house (YES ) (NO)
II. Immunisation is free (YES ) (NO)
III. Health workers are friendly (YES ) (NO)
IV. Time is not wasted (YES ) (NO)
V. Vaccines are always available (YES ) (NO)

22. If your answer to question 20 is no, why has your child not received the immunisation?

(1) Not informed ( ) (2) No awareness ( ) (3) No means of transportation ( )
(4) Not remembered ( ) (5) Vaccine not available ( ) (6) Date of appointed still ahead ( )

**SECTION C - BARRIERS TO THE UPTAKE OF CHILDHOOD IMMUNISATION**

Please read the under-listed carefully and indicate by ticking (√) in the appropriate column.

23. Type of health facilities close to your place of residence **(choose the closest: only one)** (1) General hospital ( ) (2) Private hospital ( ) (3) Primary Health Care Centre ( ) (4) Convalescent home ( )

24. What is the walking distance from your house to the facility, where your child received immunisation : (1) 10 minutes distance ( ) (2) 20 minutes distance ( ) (3) 30 minutes distance ( ) (4) others (specify)_____

25. Do you think inadequate health worker staffing is a significant to effective immunisation services? (1) Yes ( ) (2) No ( )

26. Have you experienced vaccine stockouts (getting to the health facility and being told they had no vaccine) at health facilities in your area? (1) Yes ( ) (2) No ( )

27. Are there religious or cultural beliefs in your community that discourage or prevent immunisation? (1) Yes ( ) (2) No ( )

28. Do you face resistance from your spouse regarding immunizing your children? (1) Yes ( ) (2) No ( )

29.Do you have confidence in the quality and safety of vaccines used for childhood immunisation? (1) Yes ( ) (2) No ( )

30. Do you believe that the health workers in the health facility that you patronise are sufficiently trained to administer vaccines? (1) Yes ( ) (2) No ( )

31. Do the opinions of your peers and family members influence your decision to immunise your child? (1) Yes ( ) (2) No ( )

**SECTION D - PERCEPTION OF MOTHERS TOWARDS**

**CHILDHOOD IMMUNISATION**

**The abbreviation below include the following**

SA=Strongly Agree, A=Agree, N=Non, D=Disagree, SD=Strongly Disagree

| | Perception | SA | A | N | D | SD |
|---|---|---|---|---|---|---|
| 32 | Childhood immunisation is an effective way to prevent Diseases | | | | | |
| 33 | I trust that the vaccines provided during childhood immunisation are safe for my child | | | | | |
| 34 | Immunizing my child is important for their overall well-being. | | | | | |
| 35 | The information I receive about vaccines from the vaccine program is reliable and trustworthy | | | | | |
| 36 | Newly approved vaccines carry more risks than older ones | | | | | |
| 37 | I am well-informed about the benefits of childhood immunisation. | | | | | |
| 38 | I am confident in managing and understanding any side effects that may occur after my child's immunisation. | | | | | |
| 39 | I have confidence in the quality and safety of vaccines being used | | | | | |
| 40 | Do you think an awareness campaign about childhood immunisa:on is effec:ve in your community | | | | | |
| 41 | Do you think a child should be immunised just once | | | | | |

**SECTION E – OTHER FACTORS ASSOCIATED WITH THE COMPLETION OF CHILDHOOD IMMUNISATION**

42. Did you ever delay your child's vaccination (1) Yes ( ) (2) No ( )

43. If question 42 is yes, what are the main reasons (1) Child illness ( ), (2) lack of clear Information ( ), (3) fear of side effects ( ), (4) Distance from the vaccination site ( ), (5) Relocation ( ), (6) Travelled within the period of vaccination ( ), (7) lack of money for transportation ( )

44. Are you aware that immunisation services are available at primary health care near you (1) Yes ( ) (2) No ( )

45. Do you sometimes forget the appointment date of your child's immunisation? (1) Yes ( ) (2) No ( )

46. (If your answer to the above question is yes) Do you receive any prompt or reminder from the health facility where you usually receive immunisation? (1) Yes ( ) (2) No ( )

47. If question 45 is yes, do you think the clinic should remind you about the next appointment of your child's immunisation by the clinic staff (1) Yes ( ) (2) No ( )

48. Does the absence of health workers from the clinic prevent your child from taking immunisations (1) Yes ( ) (2) No ( )

49. Have financial constraints ever prevented you from attending the clinic for your child's immunisation (1) Yes ( ) (2) No ( )

# Lead City University (LCU)

*Motto: Knowledge for Self-reliance*

*Lagos - Ibadan Expressway, Toll Gate Area, Ibadan, Oyo State, Nigeria*

*Email: lcu.hrec@lcu.edu.ng*


NHREC

## University Research Ethics Committee

**PROJECT TITLE:** **FACTORS ASSOCIATED WITH THE UPTAKE OF CHILDHOOD IMMUNIZATION BY MOTHERS OF UNDER FIVE IN AJEROMI-IFELODUN LOCAL GOVERNMENT AREA, LAGOS STATE.**

**PROJECT NUMBER:** **LCU-REC/23/313**

### APPROVAL LETTER

The above-named proposal has been adequately reviewed; the protocol and safety guidelines satisfy the conditions of *LCU-REC* policies regarding experiments that use human subjects. Therefore, the study under its reviewed state is hereby approved by the LCU-Research Ethics Committee.

**Prof. Olusola Ladokun** .....

*Name of LCU-REC Chairman*

**Dr. Folahanmi Akinsolu** .....

*Name of LCU-REC Secretary*

**This approval is given with the investigator's Declaration as stated below;**

**By signing below I agree/certify that:**

1. I have reviewed this protocol submission in its entirety and that I am fully cognizant of, and in agreement with all submitted statements.

2. I will conduct this research study in strict accordance with all submitted statements except where a change may be necessary to eliminate apparent immediate hazard to a given research subject.
   - I will notify the LCU-REC promptly of any change in research procedures necessitated in the interest of the safety of a given research subject.
   - I will request and obtain LCU-REC approval of any proposed modification to the research protocol or informed consent document(s) prior to implementing such modifications.