

University of Applied Sciences

Faculty of Life Sciences

Health Sciences Degree

ACHIEVING MATERNAL AND CHILD ACCESS TO ESSENTIAL VACCINES IN SUB-SAHARAN
AFRICA: AN ASSESSMENT OF THE DIMENSIONS OF ACCESS TO ESSENTIAL VACCINES IN
NIGERIA

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Abstract

Introduction: One of the ways of reducing unnecessary expenditure on healthcare caused by communicable diseases, is by reducing the vulnerability of the population to infectious diseases. Several studies have found vaccines to be cost effective, but to ensure that vaccines get to the populations that need them, it will be necessary to understand the factors (dimensions) that determine access to essential vaccines. **Objective:** This project seeks to evaluate maternal and child access to essential vaccines in terms of the dimensions of access. The aim is to identify the dimensions (dimensions of access) that affect mother and child access to essential vaccines in Nigeria, and how these factors play role in vaccine uptake. The findings from this project will give us better understanding of the determinants of access to essential vaccines and how they interrelate. **Method:** The research method is systematic review of literature, it includes studies that primarily explored the different dimensions of access. The findings from the systematic review were further complemented using semi structured interviews with healthcare professionals. **Results:** The identified dimensions of access include; availability and accommodation, effectiveness, approachability (of health facility and workers), acceptability (of vaccines and services), affordability, appropriateness or relevance, physical accessibility and information/communication. Information/communication was found to have the highest impact on access, followed by acceptability. Irrespective of availability and effectiveness of the vaccines, the acceptability of the vaccines may be poor, due to lack of “trust” and proper information. The identified dimensions of access alone, do not clearly explain the dynamics surrounding access to essential vaccines, instead “the people’s ability to interact with the dimensions of access” also play a vital role. Other factors were also identified to influence access, and they include; insecurity, trust, sociocultural factors, quality of care, safety of vaccine, prioritization and vaccine hesitancy. **Conclusion:** The problems of vaccine access in Nigeria vary from one region to the other, but in all of the regions, the dimensions of access found to have the most impact on vaccine uptake were; information/communication. To ensure effective vaccine access in Nigeria, a continuous system of communicating the health and economic value of vaccines should be encouraged, as opposed to occasional immunization programs. These interventions should not be directed at care givers alone, but should include community leaders, religious leaders and the youth, thereby promoting trust and acceptability of vaccines and services.

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Abbreviations:

SDGs: Sustainable Development Goals

WHO: World Health Organization

GVAP: Global Vaccine Action Plan

CDC: Center for Disease Control

WTO: World Trade Organization

UN: United Nations

NGOs: Non-governmental organizations

BCG: Bacilli Calmette Guerine

DTP: Diphtheria Tetanus toxoid and Pertussis

RI: Routine Immunization

SIA: Supplementary Immunization Activities

OPV: Oral Polio Vaccine

LGAs: Local Government Areas

UNICEF: The United Nations Children's Fund

PMNCH: Partnership for maternal, newborn and child health

RED: Reaching Every District

EU-SIGN: European Union Support to Immunization Governance in Nigeria

PHCUOR: Primary Health Care Under One Roof

N-Stop: Nigeria stop polio

NPHCDA: Nigeria Primary Health Care Development Agency

PRISMA: Preferred Reporting Items for Systematic reviews and Meta-Analysis

PICO: Population-Intervention-comparison and Outcome

PIO: Population-Intervention and Outcome

DHS: Demographic health survey

GPS: Global position system

JAP: Journalists against polio

PHCIPT: Primary health care immunization provider training

IPD: Immunization plus days

OPV: Oral Polio Vaccine

SOP: Standard Operating procedure

HIV: Human Immunodeficiency Virus

TV: Television

IPV: Intermittent Polio Vaccine

SPHCDB: State Primary Healthcare Development Bored

CHAI: Clinton Health Access Initiative

FMC: Federal medical center

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1.0 Introduction

1.1 Brief History of vaccines

It is well known that the sciences of vaccinology and of immunology were established about two centuries ago by Edward Jenner's scientific studies of prevention of smallpox through inoculation with cowpox virus (Hilleman, 2000). Edward Jenner, was a country doctor living in Berkeley (Gloucestershire), England, who in 1796 performed the world's first vaccination (Turner, 1982). Taking pus from a cowpox lesion on a milkmaid's hand, Jenner inoculated an eight-year-old boy, James Phipps. Six weeks later Jenner variolated two sites on Phipps's arm with smallpox, yet the inoculated boy was unaffected by this as well as subsequent exposures to small pox (Barquet & Domingo, 1997).

Based on this and twelve more of such experiments and sixteen additional case histories he had collected since the 1770s, Jenner published a volume that quickly became a classic text in the annals of medicine: *Inquiry into the Causes and Effects of the Variolae Vaccine*. This discovery “that the cow-pox protects the human constitution from the infection of smallpox” laid the foundation for modern vaccinology (Stern & Markel, 2005). Jenner was armed with a wealth of older knowledge of the ancient Chinese practice of preventing severe natural smallpox by inoculating pus from smallpox patients into a healthy subject.

Since the discovery by Jenner, Vaccines referred only to cowpox inoculation for smallpox, until the brilliant French Chemist, Louis Pasteur developed what he referred to as a rabies vaccine in 1885 (Stern & Markel, 2005). What Pasteur produced led to the expansion in the definition of vaccines, he actually created a rabies antitoxin that acted as a post infection antidote only due to the long incubation period of the rabies germ, he expanded the term vaccines beyond its Latin association with cows and cowpox to cover all inoculating agents (Hansen, 1998).

The modern era of vaccinology started about 1950 as a continuum following remarkable advances made during the 1940s and World War II (Hilleman, 2000; Stern & Markel, 2005). In present day definition, the World Health Organization defines vaccine as “a biological preparation that improves immunity to a particular disease.

A vaccine typically contains an agent that resembles a disease-causing microorganism and is often made from weakened or killed forms of the microbe, its toxins or one of its surface proteins. The agent stimulates the body's immune system to recognize the agent as foreign, which is then destroyed, and "remembered", so that the immune system easily recognizes and destroys these microorganisms when it later encounters them (WHO, 2016b)

1.2 Essential vaccines

The general principle for establishing an essential drug list was first conceived in 1977 by the WHO Expert Committee on the Selection of essential drugs in Geneva from (“The selection of essential drugs,” 1977). The criteria used to select essential drugs include disease prevalence, treatment facilities, safety, efficacy, quality, availability, and cost factors. Vaccines have also been included in the list.

For some time, WHO has provided advice to countries on the use of vaccines, first through the guidelines developed in the establishment of the Expanded Program on Immunization (EPI) and published in WHO publications” and through position papers since 1998 (Milstien & Lambert, 2002). Over the past decade, immunization programs have included new and underused vaccines to the original six, which include; diphtheria, tetanus, pertussis, measles, polio, and tuberculosis given to young children. These new inclusions are vaccines against hepatitis B, Haemophilus influenza type b (Hib) disease, mumps, pneumococcal disease, rotavirus, rubella, and in countries where needed; yellow fever and Japanese encephalitis (Maurice & Davey, 2009)

A detailed list of vaccines considered to be essential for children and for mothers before, during and or after pregnancy as recommended by the World Health Organization (WHO) are shown on Table 1.

<i>Recommendations for all</i>
BCG vaccine
diphtheria vaccine
Haemophilus influenzae type b vaccine
hepatitis B vaccine
HPV vaccine
measles vaccine
pertussis vaccine
pneumococcal vaccine
poliomyelitis vaccine
rotavirus vaccine
rubella vaccine
tetanus vaccine

<i>Recommendations for some high-risk populations</i>
cholera vaccine
hepatitis A vaccine
meningococcal meningitis vaccine
rabies vaccine
typhoid vaccine
<i>Recommendations for certain regions</i>
Japanese encephalitis vaccine
yellow fever vaccine
tick-borne encephalitis vaccine
<i>Recommendations for immunization programs with certain characteristics</i>
influenza vaccine (seasonal)
mumps vaccine
varicella vaccine

Table 1: List of vaccines considered essential for mothers and children by WHO

When considering the concept of essential vaccines, it may be helpful to invoke the economic concept of a public good, which is a benefit which is non-excludable and non-rivalrous in consumption; that is everyone benefits from its use, therefore preventing the spread of communicable diseases from one population to another on a global scale (Kaul & Faust, 2001). It is this concept that guides and pushes forward the agenda of essential vaccines.

1.3 Economic Importance of Vaccines and Immunization

Over the years, several methods have been used to determine whether investing in vaccines and immunization is worthwhile, including cost analysis, cost-benefit analysis, cost-effectiveness analysis, and cost-utility analysis. About 162 published economic evaluations of vaccines, have been carried out from 1969 to 1998. They are always consistent with the finding that immunization is an excellent investment - highly cost-effective and usually cost-saving (Hinman, 1999).

Since World War II, vaccination has had a major impact on global health (Bloom et al., 2005; Hilleman, 2000; Milstien & Lambert, 2002; Stern & Markel, 2005) This is evident by the successes that have been recorded since then and includes; “the wiping out of smallpox in 1979

after a worldwide immunization campaign, which had killed two million people per year until the late 1960s, the number of polio cases fell from over 300,000 per year in the 1980s to just 2,000 in 2002, two-thirds of developing countries have eradicated neonatal tetanus, since the launch of the World Health Organization's Expanded Program on Immunization (EPI) in 1974, the number of reported measles deaths has dropped from 6 million to less than 1 million per year, Whooping cough cases have fallen from 3 million per year to less than a quarter of a million, Diphtheria cases have declined from 80,000 in 1975 to less than 10,000 today" (Bloom et al., 2005).

In all, Immunization prevents about 2.5 million child deaths each year, but despite these successes, millions of children in developing countries, about 20% of all children born every year, are unable to get the complete immunizations scheduled for their first year of life (Maurice & Davey, 2009).

1.4 The concept of access to essential vaccines

Improving the health of mothers and children is a priority globally. 5.9 million children and more than 300 000 women died in 2015 from maternal causes (WHO, 2016a). A large number of these diseases could have been prevented or treated by access to appropriate and affordable medicines and vaccines (Mihigo et al., 2016). Over one million of vaccine preventable deaths occur in Africa annually, although a great progress has been made in African countries since the global launch of the expanded program on immunization in 1974, more than six million children remain incompletely vaccinated (Wysonge et al., 2016).

Vaccine access is among the priorities of the Sustainable Development Goals (SDGs), as stated in the SDG number 3. In the month of May 2012, African countries along with the other member states of the world Health Assembly endorsed the Global Vaccine Action Plan (GVAP), this is an agenda aimed at making vaccines accessible to avert millions of deaths caused by diseases that can be prevented by vaccines. These vaccines are referred to as lifesaving vaccines and should be readily available to all pregnant women and children (CDC, 2016; WHO, 2015c). The list is a comprehensive list of basic essential vaccines and the vaccines can be chosen and used according to the needs of the patient (indications) or based on requirements in the country or region.

The United Nations define Access as 'having medicines continuously available and affordable at public or private health facilities or medicine outlets that are within one hour's

walk from the homes of the population’ (UN, 2003). Access to healthcare at a general level is also defined as “*entailing the ability to secure a specified set of healthcare services, at a specified level of quality, subject to a specified maximum level of personal inconvenience and cost, while in possession of specified amount of information*” (Oliver & Mossialos, 2004). It is in the context of these definitions, that this research, seeks to carry out an evaluation of the access to essential vaccines by mother and child in terms of personal and organizational barriers, affordability, physical accessibility and acceptability of these essential vaccines.

In most African countries, there lies a barrier in getting these essential vaccines in good therapeutic condition to the population in need of them, these problems include and are not limited to; persistent problems with leadership and planning, vaccine stock management, supply chain capacity and quality, provider-parent communication, cultural/religious beliefs and financial sustainability (Oku et al., 2016; Sundaram et al., 2016; Wiysonge et al., 2016).

1.5 Access to essential vaccines and Herd immunity

The emphasis and concern placed on vaccine access has a lot to do with not only achieving individual immunity but also considering the concept of achieving community level immunity known as “Herd immunity” (Anderson & May, 1985).

Within a given population, the risk of uninfected individuals being infected with infectious diseases is simultaneously increased when one individual is infected (Metcalf, Ferrari, Graham, & Grenfell, 2015). The infected person increases the exposure of the uninfected people to the infection, but at the same time reduces the number of susceptible individuals that can be infected, because the infected or exposed individual will develop individual immunity (Gonçalves, 2008; Metcalf et al., 2015).

If the proportion of the population that is immune either by vaccination or natural infection, exceeds the ‘herd immunity threshold’, which is a threshold proportion of the population that must be susceptible for the pathogen to successfully spread, the susceptible individuals enjoy benefits from “indirect protection” from the immunized people that surround them (Anderson & May, 1985; Gonçalves, 2008; Metcalf et al., 2015).

1.6 Access to essential vaccines in Nigeria

As at 2013, the WHO estimates that Nigeria has a population of about 174 million people, with 44% of the population under 15 years old (WHO, 2015a). With the introduction of the Expanded Program on Immunization (EPI) in 1979(WHO, 2015b), Nigeria had initially recorded but not sustained successes. The peak of achieving an optimum level of immunization coverage was attained in early 1990s, with the country achieving a universal childhood immunization coverage of 81.5%. But since

after that period of success, Nigeria has experienced gradual but consistent fall in immunization coverage (Ophori, Tula, Azih, Okojie, & Ikpo, 2014).

Nigeria, in the past few years has experienced some worsening of child mortality. The infant mortality rate evaluated at 100 per 1000 in 2003, was measured at 87 in 1990 (PMNCH, 2017). The high infant mortality rate was found to have been associated with a number of reasons among which one includes poor immunization coverage recorded years after the launch of EPI, according to the figures of the national immunization survey, by 1998, the national data showed decreasing coverage for all antigens, and this figure further decreased in 2002-2003 with children 12-23 months of age vaccinated with Pol3 vaccine to be only 29%, evident from both card or history from Nigeria demographic health survey data, while cards seen alone was as low as 11% (WHO and UNICEF, 2016).

The primary vision of EPI in Nigeria is to improve the health of Nigerian children by eradicating all the six killer diseases, which are polio, measles, diphtheria, whooping cough, tuberculosis, and yellow fever (Ophori et al., 2014), access to these vaccines by children who need them has however been a problem requiring urgent attention. Variations have been experienced in nationwide coverage of routine immunization (Gunnala et al., 2016; Ophori et al., 2014). Several articles have pointed out issues associated with access to routine immunization as the cause of these irregularities in immunization coverage (Eboreime, Abimbola, & Bozzani, 2015; Gunnala et al., 2016; Ophori et al., 2014)

1.7 Efforts made so far to improve access to essential vaccines

To overcome the barriers to achieving the target of the expanded program on immunization, both national government and international non-governmental organizations, have made several efforts which include use of immunization campaigns and “outreach” operations that seek out populations not adequately covered by routine immunization programs. A few of such efforts being made to improve vaccine access include;

1. “The Reaching Every District” (RED) strategy, launched in 2002, is designed to strengthen immunization delivery at the district level, by encouraging district-level immunization officials to adopt the principles of “good immunization practice”, such as the identification and resolution of local problems, the organization of regular outreach vaccine delivery services, and the involvement of communities in ensuring adequate functioning of immunization services (Maurice & Davey, 2009).
2. Integration of immunization activities with other services provided by the health system. Any contact of a health worker with a child or mother at is also an opportunity to check immunization status and, if need be, to administer vaccines. At the same time, other outreach activities are carried out, such as antimalaria, mosquito nets distribution etc. (Maurice & Davey, 2009).
3. GAVI Alliance (formerly known as the "Global Alliance for Vaccines and Immunization") : Provide financial support for immunization to enabled many low-income countries to strengthen their routine

vaccine delivery systems and promote the use of underused vaccines, such as hepatitis B, Hib, and yellow fever (Maurice & Davey, 2009).

4. An effort of interest worth mentioning is the European Support to Immunization Governance in Nigeria (EU-SIGN). “The strategic aim of European Union-Support for Immunization Governance in Nigeria (EU-SIGN) is to strengthen health sector governance through the entry point of Routine Immunization (RI). To this end, EU-SIGN works to extend the policy of Primary Health Care Under One Roof (PHCUOR) from the Federal to the State and Local Governance Area (LGA) levels while strengthening Routine Immunization (RI) and reducing maternal and under-five’s burden of disease” (EU-SIGN, 2015).
5. N-stop: Nigeria stop Polio transmission program (Gammino et al., 2014), developed by the NPHCDA
6. Polio Eradication and Endgame Strategic Plan 2013–2018

1.8 Current state of research

A large number of papers have discussed access to vaccines, for example (Chokshi & Kesselheim, 2008; Eboime et al., 2015; Gunnala et al., 2016; Mittal, 2008; Smith, Lipsitch, & Almond, 2011), to mention just a few. These papers have been able to discuss access to vaccines extensively and could identify both supply and demand side aspects of access that play important roles in the uptake of routine immunization. This research on the other hand intends to further explore access based on the framework of access and its dimensions as proposed by (Gulliford et al., 2002) and (Levesque et al., 2013).

Some aspects of dimensions of access have been discussed under a broader topic of supply side and demand aspects of access, but without sole focus on vaccines for mother and child under 5 years of age. For this reason, this research is aimed at analyzing access based on the various identified dimensions, this will help to understand access to essential vaccines at a micro level and to evaluate how these dimensions inter relate to determine access.

1.9 Significance and contribution of this research to the field

This research will help to understand essential vaccine access on a micro level. The components of access to essential vaccines will be analyzed on the level of dimensions, as opposed to the broad classification of the factors affecting access into; the supply and demand side factors. This research will identify these dimensions of access and analyze how these factors are interdependent in determining access to routine vaccination. The research will identify salient factors that may be found useful in making decision towards achieving a sustainable supply and uptake of immunization in Nigeria.

2.0 Research objective: Hypothesis, Questions and Aims

2.1 Research Hypothesis

In this research, the hypothesis is: Analyzing access on the level of dimensions can provide better understanding of salient problems of access to essential vaccines, that are peculiar to countries of sub-Saharan Africa (Nigeria)

2.2 Research Questions

1. What dimensions of access play vital role in maternal and child access to essential vaccines?
2. How do these dimensions interact to play a role in access to essential vaccines?
3. Would the study of access to essential vaccines in the level of dimensions of access help to better enhance routine immunization uptake by mother and child?

2.3 Aims/Objective

1. To identify the dimensions of access that play role in maternal and child access to essential vaccines
2. To analyze the interdependencies of these dimensions of access to essential vaccines and how they play a role in maternal and child access to essential vaccines.
3. Based on findings, make recommendations on how to improve on access to essential vaccines.
4. To provide recommendations for future research

3.0 Theoretical conceptualization of access and the dimensions of access.

Access is a complex concept which has evolved over time to address the ever-increasing health policy concerns (Gold, 1998; Gulliford et al., 2002; Levesque, Harris, & Russell, 2013). The conceptual framework for the study of access was explained by Aday and Anderson, as “proceedings from health policy objectives through the characteristics of the health care system and of the populations at risk (inputs) to the outcomes or outputs: actual utilization of health care services” (Aday & Anderson, 1974). They explained how the various healthcare system characteristics and the population characteristics are interrelated. In their framework for the study of access, 5 categories of interrelated variables were identified as shown in figure 1. In their discussion of access, they could identify aspects of both supply and demand sides of access and how they interrelate.

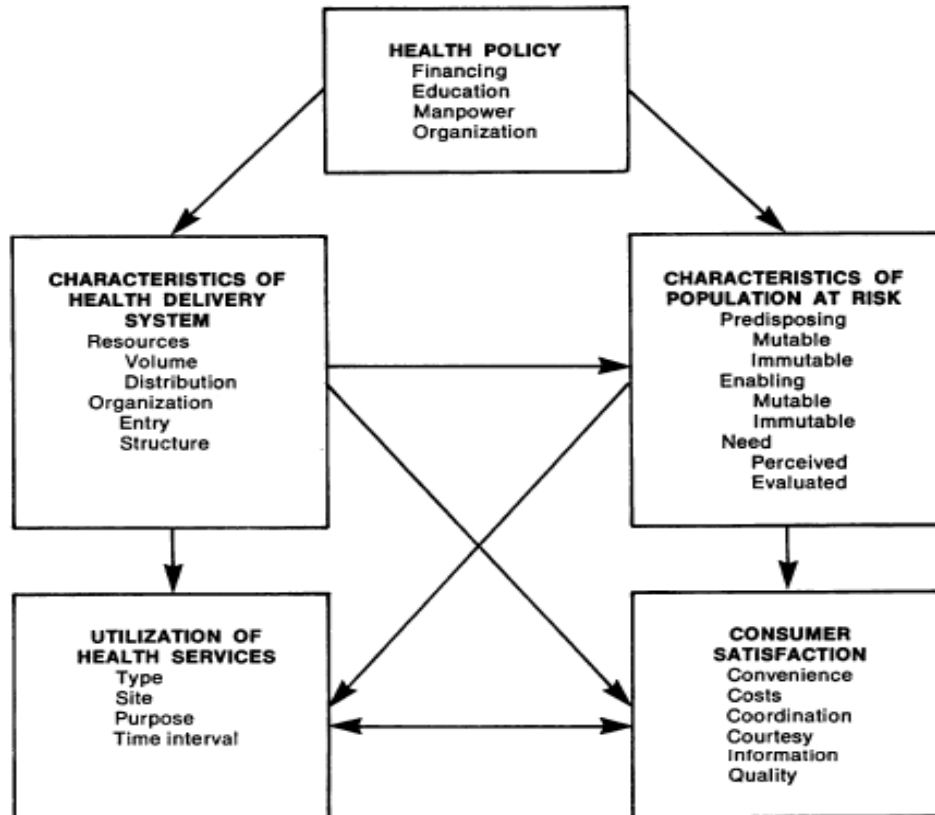


Figure 1: Frame work for the study of access. adopted from Aday and Anderson 1974

1. Health Policy (financing, education, manpower, organization)
2. Characteristics of health delivery system (resources, volume, distribution, entry, structure)
3. Characteristics of the population at risk:
 - predisposing (mutable, immutable),
 - enabling (mutable, immutable),
 - need (perceived, evaluated)
4. Utilization of health services (type, site, purpose, time interval)
5. Consumer satisfaction (convenience, costs, coordination, courtesy, information, quality)

Gulliford et al, went further to explain and expand on Aday and Anderson’s concept of access by classifying the aspects of access into four dimensions, which include; 1) Service availability. 2) utilization of services and barriers to access (financial barriers, Personal barriers and organizational barriers). 3)Relevance, effectiveness and access. 4) Equity and access. This concept explained that “If services are available and there is an adequate supply of services, then

the opportunity to obtain health care exists, and a population may “have access” to services. The extent to which a population “gains access” also depends on financial, organizational and sociocultural barriers that limit the utilization of services. Thus, access measured in terms of utilization is dependent on the affordability, physical accessibility and acceptability of services and not merely adequacy of supply” (Gulliford et al., 2002).

Another valuable conceptualization was by Mooney, when he described Utilization as a function of both supply and demand, while access is a function of supply. “Thus, an individual's utilization of health care facilities will depend not only on access (i.e., supply) but also on his or her perception of the benefits of care. Since individuals will differ in their perception of benefits (or which more later) even if they have equal *access* to health care it does not follow that they will have equal utilization” (Mooney, 1983). This concept has similarities with the concept by Levesque et al, because Mooney considered both the supply and the ability of the people to perceive need and actually engage to utilize healthcare they have access to or that is supplied to them. Penchasky et al, on the other hand took into consideration of Personal, financial and organizational barriers that may affect utilization. They said utilization is dependent on the affordability, physical accessibility and acceptability of services and not merely on the adequacy of supply (Penchansky & Thomas, 1981).

A similar conceptualization, identifying the people’s ability to interact with dimensions of access was by Levesque et al, in this concept access is viewed as “the opportunity to identify healthcare needs, to seek healthcare services, to reach, to obtain or use health care services, and to actually have a need for services fulfilled”(Levesque et al., 2013). They explained the dynamic and comprehensive nature of access to care, explaining the different variables that can have impact on access from a multilevel perspective, here factors related to health systems, institutions, organizations and providers are considered together with factors at the individual, household, community, and population levels. This framework could identify 5 dimensions of access along with five corresponding abilities of populations interact with the dimensions of accessibility to generate access, here the dimensions of access were conceptualized into; 1) Approachability; 2) Acceptability; 3) Availability and accommodation; 4) Affordability; 5) Appropriateness. And the five corresponding abilities of populations interact with the dimensions of accessibility to generate access include: 1) Ability to perceive; 2) Ability to seek; 3) Ability to reach; 4) Ability to pay; and 5) Ability to engage (Levesque et al., 2013)

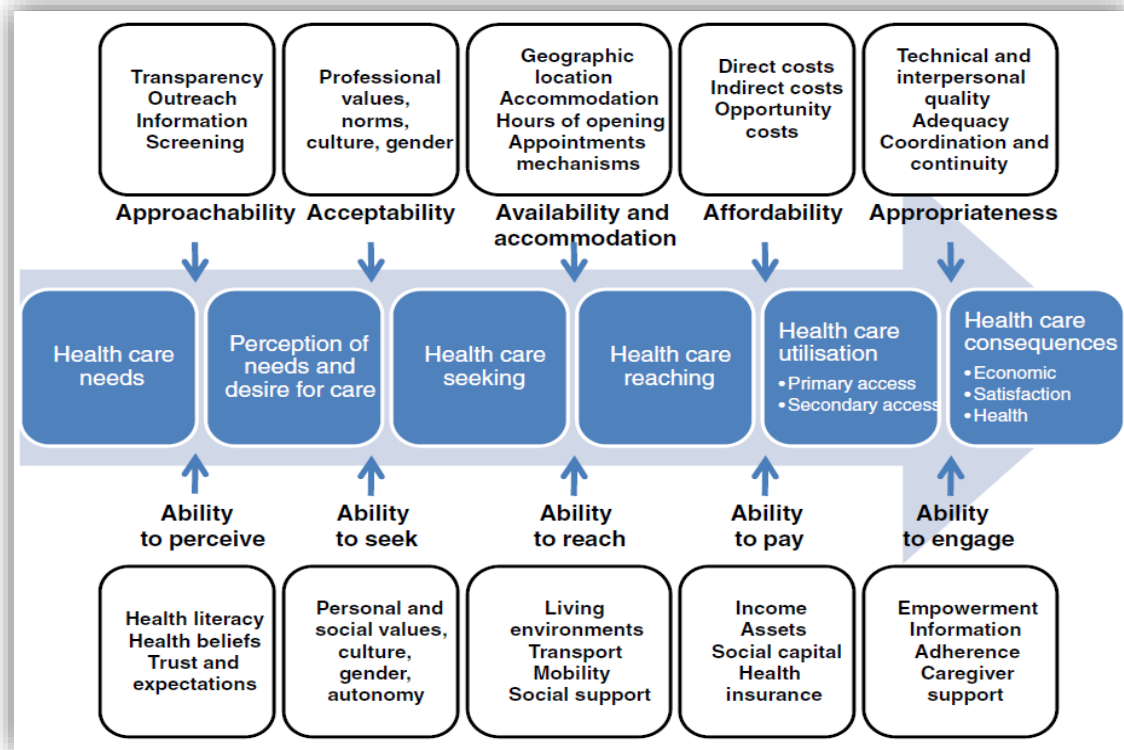


Figure 2: A conceptual framework for access to healthcare. Figure adopted from (Levesque et al., 2013)

The Dimensions of access and identified by (Aday & Anderson, 1974; Gulliford et al., 2002; Levesque et al., 2013; Mooney, 1983) are compile as shown in the table 2.

Authors and identified dimensions of access and other factors			
(Mooney, 1983)	(Gulliford et al., 2002)	(Levesque et al., 2013)	(Aday & Anderson, 1974)
Access is a function of supply	Availability	Approachability, with Ability to perceive	Health Policy (financing, education, manpower, organization)

Utilization is a function of supply and demand	Utilization of services and barriers to access (financial, personal, and organizational barriers)	Acceptability, with ability to seek	Characteristics of health delivery system (resources, volume, distribution, entry, structure)
Demand a function of Perception of need	Relevance, effectiveness of access	Availability and accommodation, with ability to reach	Characteristics of the population at risk (predisposing (mutable, immutable), enabling (mutable, immutable), need (perceived, evaluated)
	Equity of access	Affordability, with ability to pay	Utilization of health services (type, site, purpose, time interval)
		Appropriateness, with ability to engage	Consumer satisfaction (convenience, costs, coordination, courtesy, information, quality)

Table 2: Names of authors and identified dimensions of access and other factors.

4.0 Methodology

This research was carried out using a systematic review of literature, which was complemented by qualitative semi structured interviews with healthcare professionals.

4.1 Rationale for the chosen methods

A systematic review was chosen, because of the nature of the topic. Secondly, there is a vast number of papers, which have discussed essential vaccine access in Africa and hence it would be relevant to review and synthesize the collective results of these studies, which would in turn be useful in answering the proposed research questions.

The interviews were conducted to complement findings from the systematic review. “The framework method” was considered suitable for the interviews, because it is well adapted to Semi-structured interviews. Lastly the method of data generation during the interview was deductive method, with themes gotten from the systematic review.

4.2 Systematic Literature review

This was a secondary analysis of literature with focus on the dimensions of access and their roles in maternal and child uptake of essential vaccines. The review protocol involving the research question, objectives and search strategies were predefined before conducting the review. Several steps were involved in conducting the actual systematic review ranging from the search of the literature, selection, assessment and analysis of the identified studies in the related field of research.

Using the preferred reporting items for systematic review and meta-analysis (PRISMA) guidelines (Liberati, 2009), the systematic review was carried out according to the recommended requirements, using the PRISMA check list (table 19 and 20 in appendix) to build up the research structure. A visual representation of the study search and selection process was elaborated using PRISMA flow chart (Figure 3)

In the research protocol prior to the review search, the inclusion and exclusion criteria were predetermined based on the questions the research intends to answer. As guide, the review questions were defined by the PICO components: population, intervention, comparison and outcome(s). The literature search was designed to identify all potentially relevant original research that may address the question. Search terms related to some or all of the PICO components are entered into literature database. All steps of the literature search, were documented to provide transparent reporting of the process (O’Connor, Anderson, Goodell, & Sargeant, 2014).

As a prerequisite to check validity and reliability of the studies included in the review, the risk of bias in the studies used were assessed using the specific domain-based Cochrane collaboration. This

helped to ensure that studies used for the review are of approved standards and conducted with high level of transparency (Higgins et al., 2011; Hofmeyr & Cochrane Collaboration, 2008).

4.2.1 Inclusion and exclusion criteria

The inclusion and exclusion criteria were determined by the components of PICO (Population, Intervention, Comparator, Outcome) and other factors as shown in table 3. Since there is no comparator, the PICO was modified to exclude the outcome becoming “PIO”

	Inclusion criteria	Details
1	Population	Studies on mothers, caregivers or parents with children between 0-5 years of age Studies on Children between 0-5 years of age were included Studies based on Routine Immunization of children less than 5 years
2	Intervention	Studies that cover the topic of mother’s vaccination to protect both mother and child against infectious diseases or topics that cover Child vaccination against infectious diseases
3	Outcome	Papers that the outcome is focused on complete access to vaccination or incomplete access to vaccination and influencing factors. Papers that address any of dimensions of access and how it affects vaccination with effective essential vaccines Studies that talk about complete or incomplete vaccination resulting due to any of the mentioned dimensions of access or any of the accompanying population factors that affect vaccination.
4	Type of study	Qualitative and Quantitative Randomized and Non-randomized studies that discuss access or any of the mentioned dimensions of access
5	Year of study	Studies done between within 5 years before March 14 20017
6	Language of study	Only studies done in English language were included
7	Place of study	Studies done in Nigeria were included

Table 3: Inclusion criteria

The exclusion criteria were also predetermined by the modified PICO, “PIO” along with other factors as shown in table 4

	Exclusion criteria	Details
1	Population	Studies done in population other than mothers with children between 0-5 Years old, Studies done in population other than children between 0-5 Years old
2	Intervention	Studies that do not discuss vaccination, immunization or both

3	Outcome	Papers that do not address access to vaccines by mother and child Vaccination in mothers that are not aimed at protecting child Studies that do not address factors that affect access to vaccines or the dimensions of access to vaccines by mother and child
4	Type of study	Other Systematic reviews
5	Year of studies	Studies done more than 5 years ago from March 14, 2017 or after March 14 217
6	Language of study	Any language other than English language
7	Place of study	Studies done outside of Nigeria

Table 4: Exclusion criteria

4.2.2 Search database

The search databases used for this research was PubMed (MEDLINE).

4.2.3 Search terms and strategy

The search key terms were based on the research questions to be answered. The PICO as modified above was also a guiding factor during the search. The search includes the following:

- child OR
- infant OR
- “mother-child” OR
- “maternal child” OR
- “mother-infant” OR
- “maternal infant” AND
- access OR
- accessibility OR
- utilization OR
- supply OR
- demand AND
- vaccines OR
- vaccination OR
- “essential vaccines” OR
- “childhood vaccination” OR
- “infant Vaccination” OR
- immunization OR
- “childhood immunization” OR
- “infant immunization” OR
- “routine immunization” OR
- “routine vaccination” AND

- Nigeria.

The filters applied included; full text, 5 years (between March 2012 and March 2014), humans, English language, the date of search was 14.03.2016.

For detailed information on how the search was conducted on electronic data base, the search key terms and combinations, refer to table 12 in appendix.

4.2.4 Study Identification and Selection

After applying the search key terms in table, based on the inclusion and exclusion criteria, the studies were selected as illustrated by the schematic diagram (figure 3). In the search data base “PubMed (MEDLINE)” the studies to either undergo full text review or to be excluded from the review, were identified and selected in a stepwise manner and then documented on two spread sheets; the table of full text review and the table of exclusion. Based on the title and the abstract of the studies, papers that do not meet the Inclusion criteria as dictated by the modified “PICO” were documented on the exclusion form 1 in appendix.

On the other hand, in papers where the title and abstract were in accord with the inclusion criteria, were documented on the table for full text review. The table of full text studied (see appendix table 14) was screened to select the final papers included in the in the study.

4.2.5 Assessing the validity of included studies

To assess the validity, reliability and risk of bias in the included studies, strategies specified for both qualitative and quantitative, randomized and non-randomized studies were utilized to ensure that only papers that meet the inclusion criteria were included in the final review. It is important to note that the review does not involve trials alone, but also other researches such as empirical analysis and reports. The evaluation of the validity of the included studies is an essential component of a systematic review (Higgins et al., 2011), to ensure the accuracy of the research findings, the Cochrane tool for assessing the risk of bias was used to evaluate randomized studies, while a modified version, was used for non-randomized studies.

The Cochrane Collaboration’s tool for assessing risk of bias covers aspects of possible bias in the included papers. It is a two-part tool, addressing the six specific domains; sequence generation, allocation concealment, blinding, incomplete outcome data, selective outcome reporting and ‘other issues’ (Higgins et al., 2011). “Within each entry, the first part of the tool involves describing what was reported to have happened in the study. The second part of the tool involves assigning a judgement relating to the risk of bias for that entry. This is achieved by answering a pre-specified question about the adequacy of the study in relation to the entry, such that a judgement of ‘Yes’ indicates low risk of bias, ‘No’ indicates

high risk of bias, and ‘Unclear’ indicates unclear or unknown risk of bias” (Higgins et al., 2011). This tool is as shown in form 2 in appendix.

For non-randomized control trials, the domains; random allocation (sequence generation), allocation of concealment and blinding were not considered, as they do not apply to such studies.

Validation of studies which utilized qualitative methods, was done by the technique proposed by Lincoln and Guba (1985) in their Naturalistic Inquiry was used to validate the findings. In this perspective, aspects of qualitative validation include;

1. Credibility: confidence in the 'truth' of the findings. The techniques used in establishing credibility include;
 - Prolonged engagement
 - Persistent observation
 - Triangulation
 - Peer debriefing
 - Negative case analysis
 - Member checking
2. Transferability: showing that the findings have applicability in other contexts. The technique for establishing transferability includes;
 - Thick description, as opposed to peripheral description
3. Dependability: showing that the findings are consistent and could be repeated. The technique here involves;
 - Audit inquiry
4. Confirmability: a degree of neutrality or the extent to which the findings of a study are shaped by the respondents and not researcher bias, motivation, or interest. The techniques for establishing confirmability include;
 - Confirmability audit
 - Audit trail
 - Triangulation
 - Reflexibility

(Lincoln & Guba, 1985)

To assess the 4 parameters above, the tool for assessing the validity of qualitative studies was used. (See form 3 in appendix)

For studies or reports that the above-mentioned validation principles do not apply, other factors such as credible source of data, interpretation of the secondary data, size of sample, statistical analysis and interpretation of results were evaluated for accuracy.

4.2.6 Data extraction process

The data extraction form was designed to collect all the information needed to address the review questions (Kitchenham, 2008). It was then used to collect data items specified in the review protocol. The data extraction form was then tested using 2 randomly selected papers (table 13 in appendix)

4.2.7 Synthesis of results and findings

The synthesis of the results was carried out based on the dimensions of access and on the people's ability to interact with the dimensions of access mentioned in table 5. The synthesis was done in a qualitative manner and reported stepwise to cover all the findings.

4.3 Semi structured Healthcare provider/professional interviews

Here the instrument for data collection was semi-structured interview guide, which was audio taped. The healthcare providers were purposively selected, and data analysis was carried out using the framework method of analysis.

The framework method was considered suitable, because it is well adapted to Semi-structured interviews and our method of data generation is deductive rather than inductive, and the findings of the systematic review provided the themes needed for data collection in the interviews.

Three health professionals, who chose to remain anonymous were interviewed (a state team leader for Clinton Health Access Initiative (CHAI), a consultant Pediatrician at Federal Medical Center Keffi and the Secretary to a State Primary Healthcare Development Board (SPHCDB). Questions were asked based on the results of the findings of the systematic reviews. These questions, were explorative and aimed at further clarifying the problems around the dimensions of access and people's ability to interact with access. The interviews were tape recorded and notes were taken down. The interviews lasted between 20 to 35 minutes.

Applying the framework method as described by (Gale, Heath, Cameron, Rashid, & Redwood, 2013), the interviews were analyzed as follows;

1. **Transcription:** The recorded interview was first transcribed verbatim, transcripts were first read as a general overview, for clarity and to comprehend the transcript. The notes taken down during the interview supplemented the transcribed text
2. **Familiarization with the interviews:** The second stage is familiarization with the data, which was carried out listening to tapes, reading the transcripts and the notes taken during interviews.
3. **Coding:** Since this is a purely deductive interview, this part was not necessary, since the codes have been predefined by the specific areas of interest (The dimensions of access).
4. **Developing a working/analytical framework:** This stage was also not necessary, because we have already generated our framework of interest
5. **Applying the analytical framework:** The transcripts were then indexed into different categories or themes
6. **Charting data into framework matrix:** Data were then charted and summarized into the frameworks. This was done with care to still retain the meaning and original content of the data
7. **Interpreting the data:** the summarized data was finally interpreted.

5.0 Result

The identified dimensions of access and the people’s ability to interact with these dimensions, were summarized and modified in table 5 to comprehensively cover the dimensions of access that were identified in table 2.

	Identified Dimensions of access		Identified People`s ability to interact with the Dimensions of access
1	Availability of essential vaccines, the healthcare services and accommodation	1	Ability to perceive
2	Effectiveness of the essential vaccines	2	Ability to seek
3	Approachability to be administered the essential vaccines	3	Ability to reach
4	Acceptability of the essential vaccines and the services provided	4	Ability to pay
5	Affordability of the essential vaccines	5	Ability to engage
6	Appropriateness or Relevance of the essential vaccines		
7	Physical accessibility of essential vaccines (geographic accessibility)		
8	Information/Communication		

Table 5: The identified dimensions of access and identified people’s ability to interact with the dimensions of access

It is important to note that in table 5, the dimensions of access and identified human ability to interact with these dimensions are not arranged in any corresponding order. The listed dimensions of access and people’s ability to interact with access as listed on table 5, are the parameters that would determine the information to be identified and extracted from the studies included in the systematic review and the interviews.

5.1 Study Identification and selection

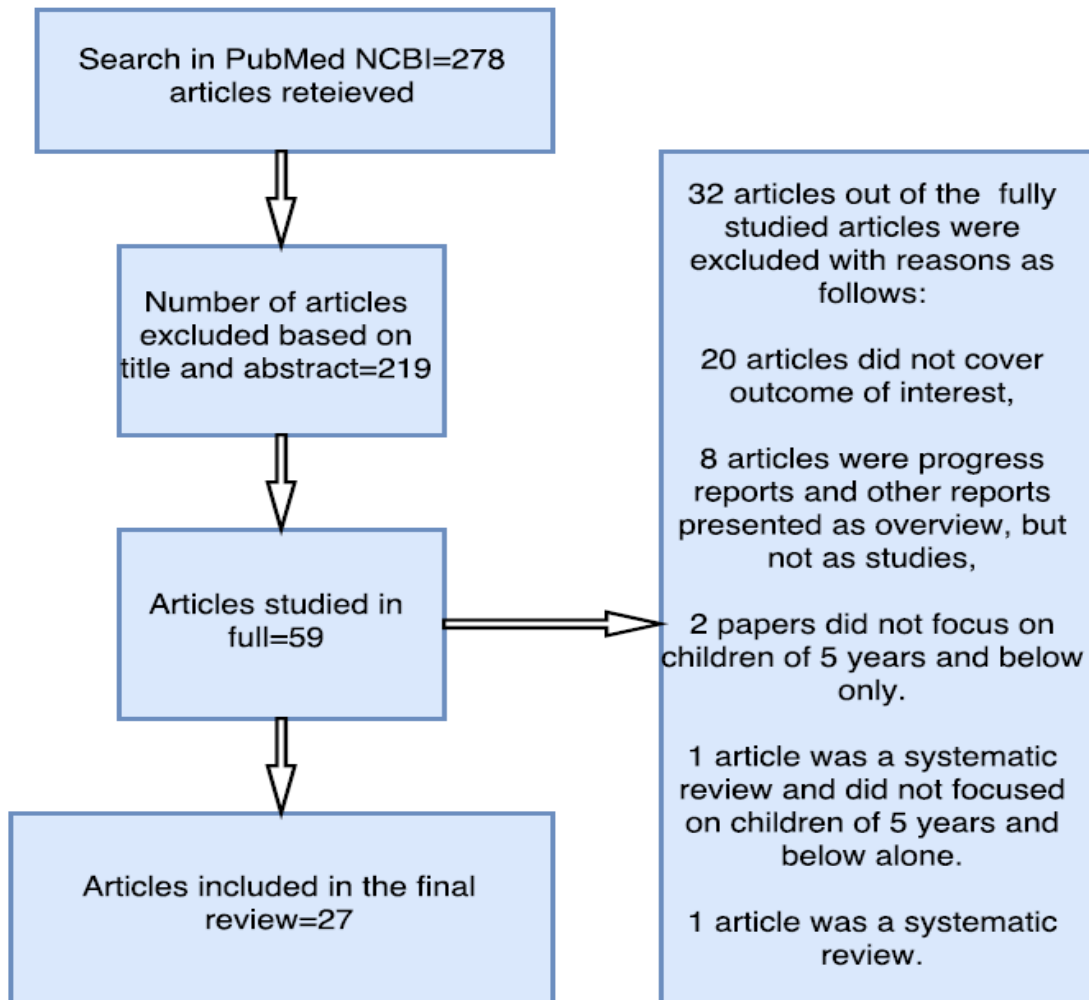


Figure 3: Schematic diagram for detailed search of review articles

After applying the search key terms and filters (as explained in table 12 in appendix), 278 articles were gotten. From the title and abstract, 219 articles were excluded. The remaining 59 articles were fully studied, after which only 27 were finally included in the study while 31 were excluded with reasons as shown in the schematic diagram; figure 3 (See table 14 in appendix, for fully studied articles and reasons for exclusion)

5.2 Characteristics of included articles

	Reference	Title	Sources of data	Location of study	Type of study/Description of study
1	(Eboime et al., 2015)	Access to routine Immunization: A comparative analysis of supply side disparities between Northern and southern Nigeria	Routine government data	Abia, Ondo, Jigawa and Kano states	Cross sectional study
2	(Oku et al., 2016)	Communication strategies to promote the uptake of childhood vaccination in Nigeria: A systematic Map	Interviews, observations and through relevant documents.	Bauchi State in Northern Nigeria and Cross River State in Southern Nigeria.	Qualitative study, using semi structured interviews, observations and document analysis.
3	(Michael, Ashenafi, et al., 2014)	An Evaluation of Community Perspectives and Contributing Factors to Missed Children During an Oral Polio Vaccination Campaign – Katsina State, Nigeria	semi structured questionnaires and focus group discussions	Katsina state	2 phases: a cross-sectional study and focus group discussions (FGDs).
4	(Warigon, Mkanda, Muhammed, et al., 2016)	Demand Creation for Polio Vaccine in Persistently Poor-Performing Communities of Northern Nigeria: 2013–2014	Data from demand creation interventions implemented by WHO Nigeria and its partners in support of the Nigerian federal government	Bauchi, Borno, Kaduna, Kano, Katsina, Kebbi, Niger, Sokoto, Yobe, and Zamfara.	Assessment of interventions
5	(O’Connell & Wonodi, 2016)	Routine Immunization Consultant Program in Nigeria: A Qualitative Review of a Country-Driven Management Approach for Health Systems Strengthening	semi-structured interviews and online surveys	Edo, Imo, Kano, Kogi, Niger, and Oyo	Mixed method using interviews and online survey. retrospective review
6	(Singh, Haney, &	Maternal Autonomy and Attitudes Towards	2008 Nigeria demographic and health survey (DHS).	Entire country	Cross sectional study

	Olorunsaiye, 2013)	Gender Norms: Associations with Childhood Immunization in Nigeria			
7	(Barau, Zubairu, Mwanza, & Seaman, 2014)	Improving Polio Vaccination Coverage in Nigeria Through the Use of Geographic Information System Technology	Global position system (GPS) tracking of vaccination teams was conducted in selected areas and daily feedback provided to supervisors	Kebbi, Sokoto, Zamfara, Katsina, Kano, Jigawa, Yobe, and Borno	Type not clearly stated/using high-resolution satellite imagery
8	(Duintjer Tebben s, Pallansch, Wassilak, Cochi, & Thompson, 2015)	Combinations of Quality and Frequency of Immunization Activities to Stop and Prevent Poliovirus Transmission in the High-Risk Area of Northwest Nigeria	data on RI coverage and SIA plans.	Northwest Nigeria	Type of study not clearly stated/one-way and multi-way sensitivity analyses
9	(Nasiru et al., 2012)	Breaking community barriers to polio vaccination in northern Nigeria: the impact of a grass roots mobilization campaign (Majigi)	Analyzed data on the uptake of polio vaccination across Nigeria Data from cumulative uptake of Vaccine (RI) in each settlement was taken after awareness campaign	Kano state (Gezawa Local Government area)	Type of study not clearly stated/examine the impact of a community-based intervention on the trends in the uptake of polio vaccination following a community mobilization eradication
10	(Warigon, Mkanda, Banda, et al., 2016)	The Journalists Initiatives on Immunization Against Polio and Improved Acceptance of the Polio Vaccine in Northern Nigeria 2007–2015	Data determining the total number of media materials produced and the number of newspaper clips and bulletins published in support of polio eradication. Also, the number of households in noncompliant communities that became compliant with vaccination.	Kaduna state	Type of study not clearly stated/Analyzed activities of Journalist Against Polio (JAP)

11	(Sibeudu, Uzochukwu, & Onwujekwe, 2017)	Investigating socio-economic inequity in access to and expenditures on routine immunization services in Anambra state	Questionnaires administered to primary care givers or their representative (in their absence)	Anambra state	Cross sectional study
12	(Ali et al., 2016)	Strengthening Routine immunization in Areas of Northern Nigeria at high Risk for Polio Transmission During 2012–2014	Routine Immunization administrative data and findings from supportive supervisory visits	107 high risk LGAs in Northern Nigeria	A retrospective study
13	(Brown, Oluwatosin, Akinyemi, & Adeyemo, 2016)	Effects of Community Health Nurse-Led Intervention on Childhood Routine Immunization Completion in Primary Health Care Centers in Ibadan, Nigeria	Data from two interventions; The use of a reminder/recall (R/R) system and Primary Health Care Immunization Providers' Training (PHCIPT) intervention	Oyo state (Ibadan)	group randomized controlled trial
14	(Mohammed et al., 2014)	Characteristics of persons refusing oral polio vaccine during the immunization plus days – Sokoto, Nigeria 2011	Interviews to head of households refusing polio vaccine to obtain information on socio-demographics, media habits, and knowledge of Immunization plus days (IPD).	Sokoto state	Unmatched case control study
15	(Musa et al., 2016)	Youth Group Engagement in Noncompliant Communities During Supplemental Immunization Activities in Kaduna, Nigeria, in 2014	data from polio vaccination activities in OPV-refusing communities	Kaduna state	Lot quality assurance survey
16	(Fowotade et al., 2015)	Measles Vaccine Potency and Sero-Conversion Rates among Infants Receiving Measles Immunization in	The pre- and post-measles vaccination sera of the children were tested using the Hemagglutination Inhibition test. And The measles vaccines	Ilorin, Kwara State	Prospective study ("Prospective Cohort study" even though not clearly stated by paper)

		Ilorin, Kwara State, Nigeria	administered at the immunization center were also tested for their potency using in-vitro titration method		
17	(Gammino, Nuhu, Gerber, et al., 2014)	An Evaluation of Polio Supplemental Immunization Activities in Kano, Katsina, and Zamfara States, Nigeria: Lessons in Progress	Structured survey, observation instruments, document review, and stakeholder interviews.	Katsina and Zamfara states	Use of structured survey and observation instruments, document review, and stakeholder interviews
18	(Gammino, Nuhu, Chenoweth, et al., 2014)	Using Geographic Information Systems to Track Polio Vaccination Team Performance: Pilot Project Report	Data from GPS	Kano, Katsina, and Zamfara	geospatial analysis
19	(Fatiregun, Adebowale, Ayoka, & Fagbamigbe, 2013)	Assessing full immunisation coverage using lot quality assurance sampling in urban and rural districts of southwest Nigeria	Questionnaires, Immunization card and verbal report	Oyo state	Cross sectional survey
20	(Goodman, Aderibigbe, Sekoni, Osagbemi, & Akande, 2013)	Health worker's sensitization: effects on perceived quality of immunization services among mothers of under five children in Ilorin, North Central Nigeria.	Pre-and post-intervention interviews	Kwara state (Ilorin)	Quasi experimental study
21	(Onyeneho, Igwe, I'Aronu, & Okoye, 2015)	Compliance with Regimens of Existing Vaccines in Orumba North Local Government Area of Anambra State, Nigeria	Questionnaires, Interview	Anambra state	cross-sectional survey
22	(Tagbo, Ughasoro, & Esangbedo, 2014)	Parental acceptance of inactivated polio vaccine in Southeast Nigeria:	Structured-questionnaire	Enugu state, Abia state	Qualitative Cross-sectional study

		A qualitative cross-sectional interventional study			
23	(Murele et al., 2014)	Vaccine perception among acceptors and non-acceptors in Sokoto State, Nigeria	in-depth interview with opinion and religious leaders; parents identified to have persistently refused or accepted vaccination as well as leaders of community-based organizations	Sokoto state	In depth, qualitative interviews
24	(Okafor, Dolapo, Onigbogi, & Iloabuchi, 2014)	Rural-urban disparities in maternal immunization knowledge and childhood health-seeking behavior in Nigeria: A mixed method study	Questionnaire survey and focus group discussions	Lagos state	cross-sectional comparative study
25	(Fatiregun & Etukiren, 2014)	Determinants of uptake of third doses of oral polio and DTP vaccines in the Ibadan North Local Government Area of Nigeria	semi-structured, interviewer-administered questionnaire	Oyo state	cohort study
26	(Gidado et al., 2014)	Outreach to Underserved Communities in Northern Nigeria, 2012–2013	Data from (1) community engagement meetings, (2) training of field teams, (3) field work, and (4) acute flaccid paralysis surveillance.	Borno, Kano, Sokoto, and Yobe	Type of study not stated/ standard operating procedure (SOP) for outreach to underserved communities was developed
27	(Michael, Ogbuanu, et al., 2014)	An Assessment of the Reasons for Oral Poliovirus Vaccine Refusals in Northern Nigeria	semi structured questionnaires among households in which the vaccine was refused	Katsina, Kano, Kaduna, Jigawa and Zamfara.	Cross-sectional study

Table 6: Included articles and their characteristics

5.3 Assessing the validity of included studies

The studies included in this review were both Qualitative and Quantitative studies. This is so, because of the nature of the information we are looking for and the nature of the research question we are trying to answer. The assessment of the quality of these papers were done in a stepwise manner, depending on the type and nature of the studies included.

5.3.1 Randomized control Trials.

	Domain	Sequence generation	Allocation concealment	Blinding	Incomplete outcome data	Selective outcome reporting	other sources of bias
No.	Reference						
1	(Brown, Oluwatosin, Akinyemi, & Adeyemo, 2016)	Yes	Yes	Unclear	Yes	Yes	Cluster randomized control trial and cannot be generalized. Did not involve rural setting

Table 7: Assessment of risk of bias in randomized control study included: Yes=Low risk of bias, No=High risk of bias

5.3.2 Other randomized non-control trials

	Domain	Sequence generation	Incomplete outcome data	Selective outcome reporting	other sources of bias
No.	Reference				
1	(Sibeudu, Uzochukwu, & Onwujekwe, 2017)	Yes	Yes	Yes	Multiple visit to some respondents, before the interview, may give a preconception
2	(Mohammed et al., 2014)	Yes	Yes	Yes	Unclear
3	(Fatiregun, Adebowale, Ayoka, & Fagbamigbe, 2013)	Yes	Yes	No	Yes
4	(Tagbo, Ughasoro, & Esangbedo, 2014)	NO	Yes	Yes	Yes
5	(Fowotade et al., 2015)	No	Yes	Yes	The drop out of patients may likely affect the applicability of the result

Table 8: Assessment of risk of bias in other randomized non-control trials: Yes=Low risk of bias, No=High risk of bias

5.3.3 Studies utilizing qualitative technique

No.	Reference	Credibility	Transferability	Dependability	Confirmability
1	(Oku et al., 2016)	Member checking applied, Recorded interviews	Description was backed with other routine data	Pair interview	Transcribing and reanalyzing interviews, Interview in pairs
2	(Michael, Ashenafi, et al., 2014)	3 participants in the interview:	Carrying out both focus group discussion and interview with individual interviews	Randomly selecting participants	Use of both open ended and Yes or No questions
3	(O'Connell & Wonodi, 2016)	A study advisory group of Experts, was formed to provide guidance on the data collection	discussion guides were refined iteratively throughout the data collection process	Study advisory group for audit inquiry	Independent research consultants trained in survey administration administered the interview (Neutrality). Audio recording to capture salient points
4	(Gammino, Nuhu, Gerber, et al., 2014)	Peer debriefing, persistent observation	Thick description, both from interviews and observation	Guide and protocol from US Centers for Disease Control and Prevention (CDC) and the Nigeria Primary Health Care Development Agency (NPHCDA)	Review of data collection instrument every night for completeness
5	(Goodman, Aderibigbe, Sekoni, Osagbemi, & Akande, 2013)	Not clearly stated	Through both interviews, routine data and observations	Selection was not random	Yes, outcome was confirmed both from interviews and observation
6	(Murele et al., 2014)	Triangulation, peer debriefing,	Through Thick description, analyzing emerging themes	Not clear	Triangulation, open ended questions, flexibility
7	(Okafor, Dolapo, Onigbogi, & Iloabuchi, 2014)	Using Triangulation by encoding and statistical analysis, multi stage sampling technique.	Thick description and other references	unclear	Confirmability and triangulation
8	(Fatiregun & Etukiren, 2014)	Triangulation	Thick description	unclear	Triangulation
9	(Michael, Ogbuanu, et al., 2014)	Triangulation, Member checking	Thick description	Unclear	Triangulation

Table 9: Assessment of risk of bias in studies utilizing qualitative design

5.3.4 Studies based on analyzing Routing immunization data, government data, other empirical analysis and reports.

The assessment of the validity of these papers were based on the source of information, method utilized in the research, data analysis and interpretation of results. These papers are listed in table 10.

	Title of Papers	Names of Authors and Year of publication
1	Strengthening routine immunization in areas of Northern Nigeria at high risk of polio transmission during 2012-2014	Ali, D., Banda, R., Mohammed, A., Adagadzu, J., Murele, B., Seruyange, R., ... Vaz, R. G. (2016)
2	Improving polio vaccine coverage in Nigeria through the use of Geographic Information system technology	Barau, I., Zubairu, M., Mwanza, M. N., & Seaman, V. Y. (2014)
3	Combination of quality and frequency of immunization activities to stop and prevent poliomyelitis transmission in high risk areas of Northwest Nigeria	Duintjer Tebbens, R. J., Pallansch, M. A., Wassilak, S. G. F., Cochi, S. L., & Thompson, K. M. (2015).
4	Access to routine immunization: A comparative analysis of supply side disparities between Northern and southern Nigeria	Eboreime, E., Abimbola, S., & Bozzani, F. (2015).
5	Using geographic information system to track polio vaccination team performance.	Gammino, V. M., Nuhu, A., Chenoweth, P., Manneh, F., Young, R. R., Sugerman, D. E., ... Gasasira, A. (2014).
6	Outreach to underserved communities in Northern Nigeria.	Gidado, S. O., Oluabunwo, C., Nguku, P. M., Ogbuanu, I. U., Waziri, N. E., Biya, O., ... N-STOP Outreach Team. (2014).
7	Youth group engagement in non-compliant communities during supplementary immunization activities in Kaduna	Musa, A., Mkanda, P., Manneh, F., Korir, C., Warigon, C., Gali, E., ... Vaz, R. G. (2016).
8	Breaking community barriers to polio vaccination in Northern Nigeria: The impact of grassroots mobilization campaign (Majigi)	Nasiru, S.-G., Aliyu, G. G., Gasasira, A., Aliyu, M. H., Zubair, M., Mandawari, S. U., ... El-Kamary, S. S. (2012).

9	Maternal autonomy toward gender norms associated with childhood immunization in Nigeria.	Singh, K., Haney, E., & Olorunsaiye, C. (2013).
10	The Journalist initiative for immunization against polio and improved acceptance of the polio vaccine in Northern Nigeria	Warigon, C., Mkanda, P., Banda, R., Zakari, F., Damisa, E., Idowu, A., ... Vaz, R. G. (2016).
11	Demand creation for polio vaccine in persistently poor-performing communities of Northern Nigeria	Warigon, C., Mkanda, P., Muhammed, A., Etsano, A., Korir, C., Bawa, S., ... Vaz, R. G. (2016).

Table 10: List of papers that utilize data from routine immunization, government data, empirical data and reports

5.4 Data extraction and full list of included studies

The data extracted from each paper was done carefully, listing the main findings from each paper as listed on table 11.

Study reference	Population characteristics	Type of vaccine (intervention)	Identified dimensions of access	Identified people's ability	Other identified parameters	Main findings of the studies
(Eboreime et al., 2015)	Population of 2 Northern and southern states of Nigeria	BCG, diphtheria, tetanus, pertussis (DTP) (3 doses), polio (3 doses), and measles vaccine.	Availability: Inadequate availability of mid-level health professionals and unequal distribution of health facilities and outlets in interior settlements Affordability: Problem of affordability by local government to maintain a good supply chain		*Socio-cultural factors contributing to vaccine non-uptake	Disparities in uptake of immunization in Nigeria is mainly as a result of socio-cultural factors. Weakest link in the supply chain is the local government, due to weakest financing and technical capacity. Inadequate skilled human resources. Inequitable distribution of health facilities.

(Oku et al., 2016)	Information and Data on all children eligible for childhood vaccination from 0-9 months	All vaccines used in routine immunization from 0-9 months old	Communication strategies: Vaccine communication not adequate and one sided Acceptability: Vaccine refusal due to religious and socio-cultural reasons		*vaccine hesitancy	Vaccine communication not adequately aimed at teaching skills, enhancing community ownership and to provide support or facilitate decision making Main targets for interventions were caregivers and community members, few were aimed at Health workers Interventions used in context of campaigns rather than routine immunization context No interventions to enhance communication by health workers
(Michael, Ashenafi, et al., 2014)	Caregivers/Mothers with children <5 years old	Polio Vaccine	Geographical/Physical inaccessibility: Children away from home during vaccine visits or homes not visited at all by health workers. Acceptability: refusal by caregiver or parent	Ability to perceive	*Prioritization of health and other needs: Vaccine seen as not a necessity and other health and personal needs seen as more important	In-access to polio vaccine was either because the team did not visit home, or the child was absent from home. Government are expected to address other crucial health problems. Due to in acceptance and lack of trust for the vaccine some parents actively refused presenting their wards for vaccination
(Warigon, Mkanda, Muhammad, et al., 2016)	Children under 5 and their mothers or caregivers	Polio vaccine	Acceptability, Accommodation, Information/communication, Physical accessibility,	Ability to perceive. Ability to seek	*Security *Trust for program and government	Demand creation improved polio vaccine uptake and increase immunity to polio virus. Demand creation useful aspect of enhancing access to polio vaccine and can

			appropriateness or relevance in site of communities			be extended to other health interventions
(O'Connell & Wonodi, 2016)	Routine immunization for children under 5 years	Routine immunization	Acceptability; of quality of service offered by staff and Information/communication			Poor organization, weakness in managerial input and improper training affect Routine immunization performance (affects access)
(Singh et al., 2013)	Married women with children 12-23 months	Polio vaccine, Diphtheria vaccine, Pertussis, Tetanus, Bacille Calmette-Guerin and Measles vaccine		Ability to seek, Ability to engage, Ability to pay		gender equality is important in and of itself, this focus also has the potential to improve a woman's ability to access an important child health prevention service and thereby prevent under-five mortality.
(Barau et al., 2014)	Remote settlement population, targeting children < 5 years	Polio Vaccine	Physical Accessibility: GIS helped improve accessibility and thus immunization coverage	*Ability to reach	*Security	GIS helps to improve vaccine coverage and reduce number of missed children. It helps improve micro planning
(Duintjer Tebben s, Pallansch, Wassilak, Cochi, & Thompson, 2015)	Children < 5 years	Polio vaccine	Availability of vaccines: can improved coverage and quality of RI will help improve access to routine immunization			Sufficiently improving RI coverage and improving SIA quality will reduce the frequency of SIAs required to stop and prevent future poliovirus transmission (improving coverage implying improving availability)
(Nasiru et al., 2012)	Children < 5 years	Polio vaccine	Acceptability: vaccine was believed to cause HIV, and infertility, ownership of vaccine initiative was a problem Communication/Information: Using Campaign and road shows, Community and religious leaders to inform people (channels of communication are	Ability to perceive: reinforced by films and drama. Ability to engage: opportunity to ask questions at campaigns.		Polio vaccination uptake can be enhanced with effective communication strategy, promoting ownership, engage and empower communities, thereby addressing misconceptions and enhancing vaccine uptake.

			important in access). Physical accessibility: problem of access to migrating children.	Ability to seek: at campaign grounds.		
(Warigon, Mkanda, Banda, et al., 2016)	Children < 5 years	Polio vaccine	Information/communication: wrong information is a large source of vaccine noncompliance in the north. Use of religious leaders Journalists initiative on immunization against polio JAP utilized social media for communicating information about vaccines			Information through media resulted to marked increase in people obtaining positive information through mass media from 26% to 33%, number of vaccinated children in previously non-compliant homes increased to 5122 out of 5992 (85.8%)
(Sibeudu, Uzochukwu, & Onwujekwu, 2017)	Routine Immunization for under 5 years' children. Family/care givers socioeconomic data	Routine immunization	Physical accessibility: Distance from health facility Appropriateness/relevance: Quality of services (difference in quality of care in private/public health facility). Approachability: how easy it is to engage with care providers.	Ability to pay: Cost of transportation, service charges. Ability to reach: Having long distances to health facility.	*Quality of care	ability to pay affects access to services, even when such services are free at point of consumption since the SES of a household influences utilization of routine immunization services, with lower SES groups having less access to services and also having other constraints such as transportation.
(Ali et al., 2016)	LGAs that were at a high risk for polio transmission	Routine Immunization for children under 5 years (Polio vaccine, DPT vaccine)	Availability: Communication: Source of information and manner of communication			intensification of RI activities in areas where coverage is low, and RI has been identified as weak should be considered. A sustainable mechanism should be elaborated while continuing and scaling up the implementation of these activities.
(Brown, Oluwatosin, Akinyemi,	Children 0-12 months	BCG, DPT, OPV, Hep. B, Yellow fever,	Information/communication: Phone reminders.		*Quality of service	The study demonstrated the effectiveness of

& Adeyemo, 2016)	old and Mother pair	Measles vaccine	<p>Approachability: communication with patients increase receptivity.</p> <p>Appropriateness/Relevance: training to improve not only knowledge but skills of healthcare providers</p>			reminder/recall intervention and multicomponent intervention in improving immunization compliance and completion.
(Mohammed et al., 2014)	heads of households where the parent or guardian of an eligible child refused OPV in the last three consecutive rounds of IPD	OPV	<p>Information/communication: from untrained town announcer, not usually from Radio or TV.</p> <p>Acceptability: Negative attitudes towards OPV</p>			Noncompliant heads of households compared to compliant heads of households had low level of education, lacked knowledge of immunization, and had negative attitude towards OPV. They get information about OPV from town announcers and lacked access to functional radio and television.
(Musa et al., 2016)	Youth groups,	OPV	<p>Acceptability: Harassment of workers by youth groups was addressed, use of traditional leaders to intervene.</p> <p>Communication/Information: Lectures, discussions and role plays</p>	Ability to engage: dialogue, sensitization, shows through youth associations	*Security	Systematic engagement of youth groups has a great future in polio interruption. It promises to be a veritable innovation in reaching chronically missed children in OPV-refusing communities
(Fowotade et al., 2015)		Measles Vaccine	Vaccine Effectiveness: need to maintain a viable cold chain system			Seroconversion rate of 68.6% was observed among vaccinated children, as against the required 95% to stop measles transmission. Low seroconversion rate is probably due to ineffective vaccines
(Gammino, Nuhu, Gerber, et al., 2014)	Children < 5 years	OPV, Measles	<p>Effectiveness: Problem of supply chain</p> <p>Communication/information.</p>	Ability to engage: Prohibition by husband for a	*Security. *Quality of service. *Prioritization: Other	Acceptance of vaccine is high, but teams have a critical role in surmounting residual vaccine resistance

			<p>Acceptability: Lack of trust for vaccine, fear of contraceptive treatment of vaccine, cultural acceptability.</p> <p>Availability: stock outs and irregularities</p>	<p>woman to interact with health workers without permission.</p> <p>Ability to Seek: spousal disagreement,</p> <p>Ability to perceive: Acceptance of measles and meningitis vaccines, seen as killers, but rejecting polio vaccine seen as benign</p>	<p>Vaccines for killer diseases seen as more important</p>	
<p>(Gammino, Nuhu, Chenoweth, et al., 2014)</p>			<p>Physical accessibility: Hand drawn maps prove to be ineffective in showing the full area to be covered by vaccination team. Some areas are hard to reach and hence have been skipped during immunization exercise.</p>			<p>Team tracks overlaid on satellite imagery revealed that teams commonly missed swaths of contiguous households and indicated that geospatial data can improve microplanning and provide nearly real-time monitoring of team performance.</p>
<p>(Fatiregun, Adebawale, Ayoka, & Fagbamigbe, 2013)</p>	<p>Mothers and children < 5 years</p>	<p>BCG, OPV, DTP, Hep. B, Measles, Yellow Fever</p>	<p>Acceptability: Fear of side effect or subsequent doses.</p> <p>Communication/Information</p>	<p>Ability to reach: No time</p> <p>Ability to engage: Education, Time</p>		<p>Full immunization coverage was unacceptable in almost all the wards. Educational intervention on the importance of completion of immunization schedule</p>

						should target young, uneducated mothers, mothers who delivered their babies at home and those with a high birth order
(Goodman, Aderibigbe, Sekoni, Osagbemi, & Akande, 2013)	Mothers and < 5 years old children, Healthcare workers	BCG, OPV, DTP, Hep. B, Measles, Yellow Fever	Information /Communication: Availability of vaccines and particularly accommodation (number of seats). Approachability: Here the workers were receptive in the intervention group, Affordability: services were affordable		*Quality of service: waiting time, poor supply chain	Sensitization of health workers affected mothers' perception of waiting time and adequacy of information received. Waiting time in health facilities by clients should be reduced as this may give clients a positive perception of the service they have come to access. Information dissemination to clients should be encouraged among health workers as this would affect clients' knowledge and also quality of health care delivery.
(Onyeneho, Igwe, I'Aronu, & Okoye, 2015)	Mothers with children eligible for RI	DTP3	Approachability: Having good perception. Information/communication. Acceptability: Satisfactory experience with health service	Ability to perceive: Aware that immunization protects their children. Ability to engage: older mother suggests more experienced		As it is found that experience and perception of the health service influenced uptake more. Health education and campaigns should be directed at factors that would encourage mothers to adopt required behaviors.
(Tagbo, Ughasoro, & Esangbedo, 2014)	Parents of children < 5 years eligible for IPV	IPV	Information/Communication: plays key role in vaccine acceptance. Acceptability: Workers level of	Ability to pay: Additional local anesthesia to	*Safety of product: fear of paralysis	The knowledge of parents on vaccine was poor, as well as the acceptability of IPV (pre-health education). However, the acceptability of IPV

			<p>training in vaccine administration. Safety and Pain caused by vaccine.</p> <p>Approachability: Positive attitude of health workers towards care givers.</p>	prevent pain.		improved with provision of knowledge on IPV. Despite the improved acceptability, most were concerned about injection associated pain and use of untrained health personnel to administer the vaccine
(Murele et al., 2014)	Parents/Mothers of polio vaccine eligible children, Community leaders, both acceptors and non-acceptors	Polio Vaccines	<p>Acceptability: of both the vaccine administrators and the vaccines.</p> <p>Information/Communication: No knowledge of the vaccines, lack of information.</p> <p>Relevance: Need for the vaccine, they believe it is not in the Quran</p>	<p>Ability to seek: Authority of the husband is final or community leader.</p> <p>Ability to engage: the act based on what they are told, not on enquiry, eg. Govt, Health workers</p>	Trust: for program	The effectiveness of health interventions relies not only on their clinical efficacy, but also on a range of factors, such as the attitudes and behaviors of target groups, and of the wider community (including those implementing interventions)
(Okafor, Dolapo, Onigbogi, & Iloabuchi, 2014)	Mothers of eligible children in both rural and urban settlements	Vaccines for < 5 years Routine immunization	<p>Information/communication: Parents have vaccine awareness, but poor knowledge of Vaccine Preventable Diseases</p> <p>Appropriateness or relevance: No guaranteed appropriate treatment in poor resource settings.</p> <p>Effectiveness: fake and substandard drugs drive mothers to patronize traditional providers.</p>	<p>Ability to pay: Preference for home or alternative treatment due to cost and high out of pocket payment.</p> <p>Ability to perceive: Believe child is taken to hospital only in</p>		Mothers in both rural and urban areas had poor knowledge of VPDs. Both groups of women also had multiple treatment sources for sick children (more in the urban area). Weak health system and fake medicines should also be addressed.

			Physical accessibility: Proximity to health facility	worsening condition		
(Fatiregun & Etukiren, 2014)	400 Mother child pair < 5 years	OPV3 and DTP3	Physical accessibility: In this study mothers > 30 min to the health facility are associated with higher OPV3 uptake. Availability/Accommodation: Tertiary hospitals have better stock management and less likely to have stock outs. Information/Communication: How the health care workers are able to communicate the benefits of vaccines better in tertiary facilities	Ability to engage: Mothers age and level of education associated with better vaccine knowledge. Ability to perceive: 95% of Mothers thought immunization to be beneficial	*Order of child birth. Type of health facility. Order of child birth.	Uptake of third doses of vaccines was influenced by the type of health facility attended and the child birth order. Efforts to reduce vaccination dropouts should include creation of awareness of the importance of completing immunization schedules for children of higher birth orders as well as improved service delivery at health facilities
(Gidado et al., 2014)	Underserved communities with target < 5 years	Polio Vaccine	Physical accessibility: Communities never visited by vaccination team. Availability: continually missed communities	Ability to engage: Non-engagement of community leaders in micro planning	*Trust: better trust of vets which can be partnered with in RI.	During a year of outreach to >45 000 scattered, nomadic, and border settlements, approximately 1 in 5 identified were missed in the immediately preceding SIAs. These missed settlements housed a large number of previously unvaccinated children and potentially served as reservoirs for persistent wild poliovirus transmission in Nigeria

(Michael, Ogbuanu, et al., 2014)	Persons responsible for household health decisions, care givers of children eligible for OPV	OPV	Information/Communication: Wrong teachings by religious sects about vaccines. Vaccine acceptance: Need to engage religious leaders, and community members in planning, social mobilization, and vaccine teams so as to promote ownership.	Ability to perceive: Low polio risk perception 59% participants say vaccine is unnecessary. Ability to engage: Husband makes final decision.	*Vaccine safety: they believe vaccine may cause infertility. *Lack of trust for government: They want government to concern also with other health needs like Malaria *Prioritization of other needs	
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Table 11: List of included papers with identified dimensions of access, the abilities of persons to interact with the dimensions of access and other factors that affect access to essential vaccines

5.5 Synthesis of results and findings from systematic review

5.5.1 Dimensions of access to essential vaccines

Based on the identified dimensions of access to essential vaccines, the findings from the review papers listed on table 11, were carefully evaluated and qualitatively synthesized. This synthesis describes how the various dimensions of access to essential vaccines interrelate with each other and other interdependent factors to determine vaccine uptake.

1. Availability and accommodation:

Availability has been identified as a factor that affects the access to essential vaccines in 6 of the reviewed papers, in these papers (Ali et al., 2016; Duintjer Tebbens et al., 2015; Eboreime et al., 2015; Gammino, Nuhu, Gerber, et al., 2014; Gidado et al., 2014; Goodman et al., 2013), availability of essential vaccine has been shown to play in terms of Inadequate availability of mid-level health professionals, vaccine out of stock and unequal distribution of health facilities and outlets in interior settlements. In one of the papers (Gidado et al., 2014), some communities were completely left out of routine immunization

programs, due to geographical inaccessibility and not being in the map plan. These communities were continually missed; hence Polio vaccines were completely unavailable to eligible children.

Accommodation was only mentioned in 1 paper (Goodman et al., 2013), where the number of seats for mothers, who bring children for vaccination was not sufficient to accommodate all of the mothers, resulting to inconvenience and discomfort during immunization exercise.

2. Effectiveness:

The effectiveness provided vaccines, was only discussed in 3 papers (Fowotade et al., 2015; Gammino, Nuhu, Gerber, et al., 2014; Okafor et al., 2014). Among these papers, only one (Fowotade et al., 2015) actually dealt with the measurement of vaccine potency by testing both blood sera, and the vaccine product by invitro titration. The persistent presence of fake and substandard drugs drive mothers to rely more on other traditional health providers for their health needs. This leads to their children missing out on the opportunity of benefitting from immunization activities that are only available in modern type healthcare facilities (Okafor et al., 2014).

3. Approachability:

How informed the mothers are about essential vaccines, the transparency of information and how receptive the health providers are, have an impact on how these routine immunization services are sought for. Approachability was identified in 4 of the reviewed papers (Brown et al., 2016; Goodman et al., 2013; Nasiru et al., 2012; Onyeneho et al., 2015)

4. Acceptability:

Irrespective of availability and effectiveness of these essential vaccines, 13 of the papers (Fatiregun et al., 2013; Gammino, Nuhu, Gerber, et al., 2014; Michael, Ashenafi, et al., 2014; Michael, Ogbuanu, et al., 2014; Mohammed et al., 2014; Murele et al., 2014; Nasiru et al., 2012; O'Connell & Wonodi, 2016; Oku et al., 2016; Onyeneho et al., 2015; Tagbo et al., 2014; Warigon, Mkanda, Muhammed, et al., 2016), have shown that when a community refuses to accept these essential vaccines due to lack of trust, it serves as a big barrier. This was especially common in northern parts of Nigeria

5. Affordability:

Surprisingly, out of the 27 papers included in the review, only 2 (Eboreime et al., 2015; Goodman et al., 2013) discussed affordability as a factor that affects access to essential vaccines. Affordability reflects the economic capacity for people to spend resources and time to use appropriate services (Levesque et al., 2013). Affordability of cold chain by local governments was identified as a major factor (Eboreime et al., 2015). In the second paper, the vaccines and services provided were found to be affordable (Goodman et al., 2013). But on the contrary, "ability to pay", determines if access will be complete or not, because irrespective of the vaccines being affordable (either direct or indirect cost) the

ability of the mothers/ Parents to pay for these Vaccines/services will determine if they will access the services or not.

6. Appropriateness/Relevance:

Opportunity to utilize only services of poor quality is seen as restriction of access to health care (Levesque et al., 2013), this concept of appropriateness and relevance was identified in 4 papers (Brown et al., 2016; Okafor et al., 2014; Sibeudu et al., 2017; Warigon, Mkanda, Muhammed, et al., 2016). The problem of disparity between Private and public healthcare facilities, the level of training of the healthcare providers, and the perception of the healthcare providers' qualification, have been identified as a major factor that affects vaccine access in these papers.

7. Physical accessibility:

In 9 of the papers (Barau et al., 2014; Fatiregun & Etukiren, 2014; Gammino, Nuhu, Chenoweth, et al., 2014; Gidado et al., 2014; Michael, Ashenafi, et al., 2014; Nasiru et al., 2012; Okafor et al., 2014; Sibeudu et al., 2017; Warigon, Mkanda, Muhammed, et al., 2016), the ability to either reach the eligible children with the vaccines, or the ability of the eligible children to reach the vaccine were identified as factors that affect the access to these essential vaccines. This is a problem that may be because of remoteness of settlements, distance, restriction of admittance of a certain group of people or poor transport means.

8. Information/Communication:

Information/Communication has been mentioned repeatedly in 17 of the reviewed papers (Ali et al., 2016; Brown et al., 2016; Fatiregun et al., 2013; Fatiregun & Etukiren, 2014; Gammino, Nuhu, Gerber, et al., 2014; Goodman et al., 2013; Michael, Ogbuanu, et al., 2014; Mohammed et al., 2014; Murele et al., 2014; Musa et al., 2016; Nasiru et al., 2012; O'Connell & Wonodi, 2016; Okafor et al., 2014; Onyeneho et al., 2015; Tagbo et al., 2014; Warigon, Mkanda, Banda, et al., 2016; Warigon, Mkanda, Muhammed, et al., 2016). Information /communication, have proven to be aspects of access to essential vaccines that play vital role among the determinants of access to essential vaccines in Nigeria. These factors were mentioned in more papers than any other dimension of access identified. Insufficient information, wrong channel of outreach or poor communication strategies lead to mistrust and lost confidence in the vaccines or vaccination exercise. These reasons are sufficient for some communities to reject or boycott the vaccination exercise.

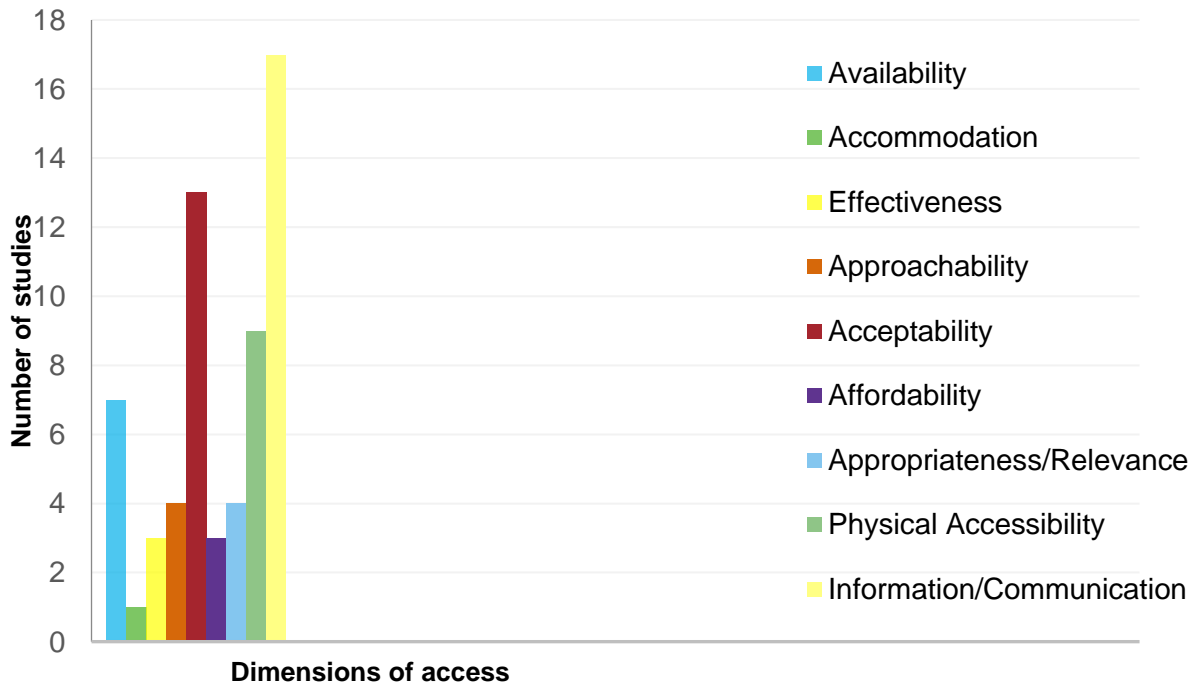


Figure 3: A plot of the number of articles that identified each dimension against the Dimensions of access

5.5.2 Peoples ability to interreact with different dimensions of access

As for the ability of people to interact with the different dimensions of access, the following abilities were identified in the reviewed papers;

1. Ability to perceive:

To achieve meaningful utilization of healthcare services, “the ability to perceive” the need for healthcare among populations was, seen to play relevant roles. The ability to perceive health needs have been found to be determined by such factors as health literacy, knowledge about health and beliefs related to health and sickness” (Levesque et al., 2013). Out of the 27 papers, 8 of them (Fatiregun & Etukiren, 2014; Gammino, Nuhu, Gerber, et al., 2014; Michael, Ashenafi, et al., 2014; Michael, Ogbuanu, et al., 2014; Nasiru et al., 2012; Okafor et al., 2014; Onyeneho et al., 2015; Warigon, Mkanda, Muhammed, et al., 2016), have identified this factor, to determine access to essential vaccines by mother and child. This factor is mainly dependent on the individuals (or care giver’s) intrinsic ability to sense the need for these vaccines. Findings from these studies show varying perception of vaccines, ranging from 59% participants of one of the studies having the view that vaccines are unnecessary (Michael, Ogbuanu, et al., 2014), to another paper where 95% of Mothers agree that immunization is beneficial (Fatiregun & Etukiren, 2014)

2. Ability to seek:

Ability to seek health care can be described by the concepts of personal autonomy and capacity or ability to decide to seek care. This is determined by what the individual knows about health care options and individual rights. These determine if an individual would express the intention to obtain health care. An example here is, where women are prohibited from the initiation of care (Levesque et al., 2013); In these instances, permission must be sought from the husband before a woman can present her child for vaccination, or seek any medical attention. This factor was identified in 5 (Gammino, Nuhu, Chenoweth, et al., 2014; Murele et al., 2014; Nasiru et al., 2012; Singh et al., 2013; Warigon, Mkanda, Muhammed, et al., 2016) of the papers reviewed.

3. Ability to reach:

In this aspect, the barriers include; people having to walk long distance to get to health centers or hospitals (Sibeudu et al., 2017), having no time due to house chores (Fatiregun et al., 2013) or unreached due to remoteness of their community (Barau et al., 2014), resulting to continually being missed or left out of routine immunization visits. Another factor is having no nearby centers or assigned extension healthcare workers. These factors were identified in 3 of the reviewed papers (Barau et al., 2014; Fatiregun et al., 2013; Sibeudu et al., 2017)

4. Ability to pay:

“It describes the capacity to generate economic resources through income, savings, borrowing or loans - to pay for health care services without catastrophic expenditure of resources required for basic necessities (e.g. sale of home)” (Levesque et al., 2013). Poverty, social isolation, or indebtedness, among many are contributing factors limiting the capacity of people to pay for needed care. Even though essential vaccines are provided free of charge by the federal government in Nigeria, other forms of indirect expenses have been identified to make vaccines access beyond the reach of the people due to low economic resources. Ability to pay was identified in 4 of the studies (Okafor et al., 2014; Sibeudu et al., 2017; Singh et al., 2013; Tagbo et al., 2014).

5. Ability to engage:

Ability to engage appeared more frequently than the other abilities, it was mentioned in 10 of the studies (Fatiregun et al., 2013; Fatiregun & Etukiren, 2014; Gammino, Nuhu, Gerber, et al., 2014; Gidado et al., 2014; Michael, Ogbuanu, et al., 2014; Murele et al., 2014; Musa et al., 2016; Nasiru et al., 2012; Onyeneho et al., 2015; Singh et al., 2013). “Ability to engage has been shown to relate to the participation and involvement of the client in decision-making and treatment decisions, which is in turn strongly determined by capacity and motivation to participate in care and commit to its completion” (Levesque et al., 2013). In this concept, the ability to communicate properly, highlighting the needs of the patient, the extent of health awareness and self-motivation of the patient, determines how well the mother or care

giver is able to engage with vaccinators and get involved fully with the vaccination process up to its completion.

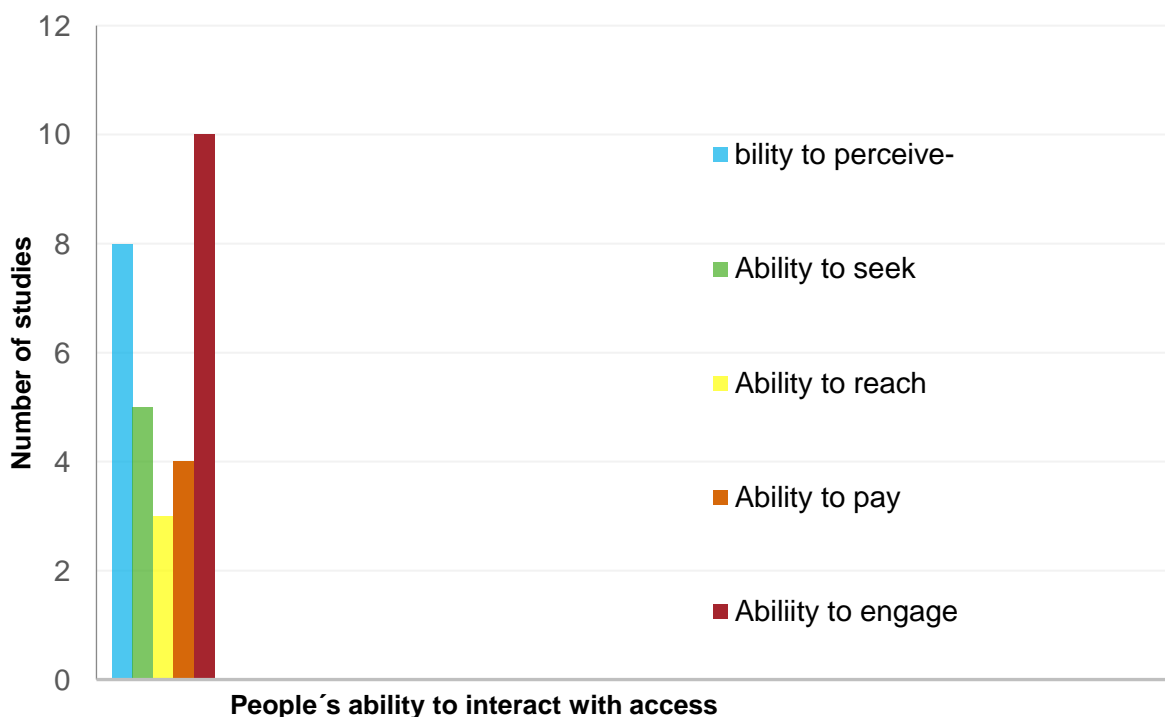


Figure 4: A plot of the No. of studies against the people’s ability to interact with dimensions of access

5.5.3 Other identified Parameters that affect access to essential vaccines not listed in table 5

1. Sociocultural factors:

Sociocultural factors was mentioned by (Eboime et al., 2015) as the major influencing factor in the uptake of vaccines in Northern Nigeria. This paper did not elaborate on the type of sociocultural factors involved but has made it clear that factors other than the mere availability or complete supply play significant roles in the uptake of vaccination.

2. Vaccine hesitancy:

Vaccine hesitancy due to religious belief has been identified in the study by (Oku et al., 2016). In this paper, this factor plays role in affecting vaccines uptake irrespective of availability of the vaccines or accompanied services. Normally the people in the communities wait for the approval of their elders or religious leaders, before taking vaccines.

3. Prioritization:

Another identified factor in 3 of the studies, is the prioritization of other diseases and personal problems, over vaccine preventable diseases or in some cases prioritizing some more fatal vaccine preventable diseases (measles, meningitis) over others (Polio) (Gammino, Nuhu, Gerber, et al., 2014; Michael, Ashenafi, et al., 2014; Michael, Ogbuanu, et al., 2014)

4. Security:

The issue of security and access to essential vaccines has proven to be of high impact, especially in the Northeastern region of Nigeria. In 4 of these papers (Barau et al., 2014; Gammino, Nuhu, Gerber, et al., 2014; Musa et al., 2016; Warigon, Mkanda, Muhammed, et al., 2016), the issue of insecurity in most cases brought RI and SIA activities to a complete halt, leading to the reemergence of earlier contained diseases such as polio and measles. This factor is another dimension that can single handedly pose an adverse outcome to entire vaccination process, irrespective of the availability of other requirements.

5. Trust:

The issue of trust was identified in 4 of the papers (Gidado et al., 2014; Michael, Ogbuanu, et al., 2014; Murele et al., 2014; Warigon, Mkanda, Muhammed, et al., 2016). The challenges range from trust for the government to trust for the immunization programs, including healthcare workers and the vaccine products. In one of the papers (Gidado et al., 2014), the nomads had more trust for the Vets than for the healthcare workers. It was also found that suspicion was great among people who blame the government for neglecting other diseases, while persuading them to take vaccines for polio free of charge (Michael, Ogbuanu, et al., 2014; Murele et al., 2014; Warigon, Mkanda, Muhammed, et al., 2016)

6. Quality of care/Service:

Another identified factor that affects access to vaccines is the quality of care and or services. 4 papers (Brown et al., 2016; Gammino, Nuhu, Gerber, et al., 2014; Goodman et al., 2013; Sibeudu et al., 2017) have identified quality parameters ranging from the training of the healthcare providers, method and type of information provided by the healthcare providers, attitude of the healthcare providers and the time spent in accessing vaccines, to be factors that play role in determining access to essential vaccines.

7. Safety of vaccine:

For some Mothers/parents the major concern is the safety of the Vaccine products. This factor was identified in 2 of the reviewed papers (Michael, Ogbuanu, et al., 2014; Tagbo et al., 2014). This safety fears range from; parents being afraid of the possibility of the vaccines causing infertility (Michael, Ogbuanu, et al., 2014) to the fear of pain caused by vaccines (Tagbo et al., 2014).

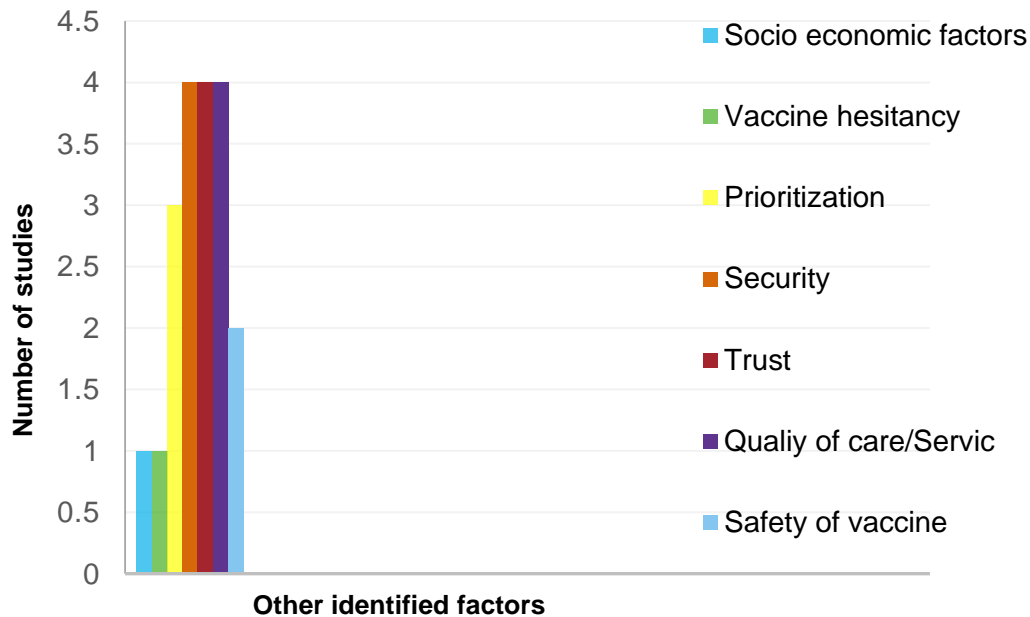


Figure 5: A plot of the number of studies against other identified factors that influence access

5.6 Summary of results from interviews

A total of 3 healthcare professionals were purposively selected and administered a semi structured interview. The interviewed participants included; a state team leader of Clinton Health Access Initiative(CHAI), a consultant Pediatrician at Federal Medical Centre (FMC) Keffi and the Secretary to one of the state Primary healthcare development boards (SPHCDB). All the interviewed professionals requested to remain anonymous.

5.6.1 In practice, what does access to essential vaccines mean to the respondents?

Firstly, when asked “what access to essential vaccines meant to him?”, the state team leader CHAI responded; “Access to essential vaccines has to do with a lot of components” by so, confirming our rationale to study essential vaccines on the level of the dimensions of access. All the respondents stated that access to essential vaccines is achieved when a number of conditions were met. These conditions cut across the dimensions of access, that were identified in the theoretical conceptualization and systematic review. Secondly, they mentioned availability of vaccines at the site delivery point, information about the vaccine products (ranging from the information about the importance and value of vaccines, to simple information such as how to go about the vaccination process within a given healthcare facility). All of the 3 healthcare providers also mentioned the interdependency of factors such as; physical accessibility, due to distance, quality of services offered by the health workers, difference in the quality

and cost of services offered between private and state-owned hospitals, sociocultural factors (example is when household health decisions are made solely by the husband) and lastly, they also talked about the challenges faced by the care givers in the process of making a child available for immunization.

Secondly, on what access to essential vaccines meant in practice, the interviewed consultant Pediatrician from FMC Keffi also stated, “*there can only be access to vaccines when the end users even know about it*” thus telling us the usefulness of communication and information. Another factor mentioned by the state team leader CHAI is the challenge faced in transporting and storage of vaccines, he mentioned that “*the logistics around vaccines is different from logistics of other essential commodities*”. He emphasized that there is a strict requirement for the adherence to temperature and type of carriage for vaccines. Access to vaccines he stated is also about providing special type of refrigerators and addressing poor power supply to maintain the supplied vaccines in good quality.

5.6.2 Personal experiences, and challenges to essential vaccine access in practice

Based on experiences in practice, both the consultant pediatrician from FMC Keffi and the state team Leader CHAI mentioned the problem of having fixed days for Immunization. The Pediatrician expressed his concern on the problem of having immunization on specific days, where the people are grouped into cohorts and administered the vaccines. In a situation where a child misses these vaccination days, then the care giver will probably have to return in another scheduled week. He also mentioned that “depending on where the eligible mother-child pair reside (Urban or Rural area), the waiting time or schedule may be longer for people in the Rural areas. In some cases, even children born within a given healthcare facility, where vaccines are usually being administered, may not get some vaccines needed immediately. The parents may have to bring the child back on the week scheduled for general vaccination with the cohort.

The state Secretary SPHCDB and the Pediatrician also talked about the disparities in the distribution of healthcare facilities between urban and Rural areas; they explained that in practice this also affects access to essential vaccines for mother and child. Based on the definition of access by WHO, the pediatrician mentioned that “even within a walking distance of 1 hour, some Rural areas still don’t have functional primary Healthcare centers”. He stated that there is also the issue of better choice of health facilities in the urban areas, where the residents can choose either a private or public health facility. This is not the case in the Rural areas, where public or state-owned health facilities were predominant and, in some cases, poorly staffed, offering services that are considered unsatisfactory.

All of the three informants mentioned the issue of hidden cost in vaccine access. According to the pediatrician, “*generally immunization is free in Nigerian government hospitals, but from time to time,*

little unforeseen logistic costs are added, which the patient is made to pay. Probably the government may have only budgeted for vaccines without budgeting for other supplies like cotton wool and syringes that will go along. So, these costs are channeled back to the patient to bear; a lot of people find that expensive even if the cost is minimal; so, this prevents access for some groups even if the vaccines are available”.

The secretary SPHCDB and the team leader CHAI, also made mention of stock outs at PHCs. In the words of the secretary, *“this can be a big discouragement especially for care givers coming from a far distance on a scheduled immunization day and yet to their disappointment, find out that they cannot get vaccines for their children mainly due to vaccine stock out”.*

Lastly, all of the three respondents acknowledged that lately, there has been a lot of social mobilization on vaccines and immunization, taking place in Nigeria. So, people are better mobilized and motivated about vaccination and what it entails. According to them, this has the potential to improve on the obtainable Immunization culture in the country.

5.6.3 Emerging factors affecting essential vaccine access

Despite all the social mobilization on vaccine, among the emerging factors threatening RI in Nigeria, security is one of the factors strongly indicated by all the 3 respondents. The reemergence of polio for example in northeastern Nigeria is sited as an example.

6.0 Discussion

Extensive efforts have been made by both National and international bodies in the drive towards financing vaccines in developing countries, one would expect that some of the most encountered problem of access to essential vaccines would be availability, affordability or ability to pay. But by breaking down, the study of access into smaller dimensions, we could identify other salient factors that play significant role in the uptake of routine immunization.

These factors serve as barrier to uptake of RI, even when other obligations like availability, affordability or ability to pay have been fulfilled. For example, the kind and source of Information/communication about the vaccines and the acceptability of either the vaccine product, the healthcare workers or the routine immunization program, by the eligible population.

Information/communication, have been identified as the most discussed dimensions of access in 17 studies, while acceptability was in 13 studies, followed by physical accessibility being identified in 9 studies. Our findings show that even when these vaccines are made available free to the people, the

uptake of immunization is faced with hindrances, because of the type of information the people already have about the vaccines. These obstacles along with other negative preconceptions, reinforce to prevent the people from accepting and utilizing routine immunization.

When it comes to approachability, the issue of caregiver-healthcare provider relationship comes into play. How open, how supportive and informative the RI program is, is a relevant factor that must always be put into consideration to encourage parents to come forward and get more informed. This will increase their trust and confidence in the RI exercise. These studies have shown how health workers' performance or attitude and receptivity can either promote access to vaccines or serve as barriers.

In some cases, the language of communication plays a significant role in determining the approachability of the healthcare providers. There is better acceptance when the healthcare provider speaks the local language of the care giver or when the care giver can express his or her self in a common language, understood by the healthcare workers.

The topic of appropriateness/relevance, has a broad range of variation, example; from supply side problem of difference in quality of care, between private and public facilities (Sibeudu et al., 2017), to the demand side problem. For example, where patients believe that vaccines were irrelevant, because they were not in the Quran (Murele et al., 2014). This shows how key it is, to properly educate the caregivers about health issues, so that they acknowledge the relevance of essential vaccines and therefore, seek to vaccinate their children or themselves. The difference in type and quality of services rendered from one community to the other (Urban/Rural) or difference between private and government owned hospitals, go a long way in determining access to essential vaccines. In some cases, the disparity in the type of service, is as a result of the differences in the level of training of health workers in these facilities, and the difference in how equip these facilities are to support routine immunization continuously without hitches. There is also the problem of choices of facilities to patronize being limited, especially in the rural areas, compared with the Urban areas.

Affordability was discussed in 2 articles, this is where the problem of ability of the local governments to maintain a pull of vaccines from the state governments is hindered due to financial incapacity, frequent stock outs and poor maintenance of cold chain and supply chain (Eboreime et al., 2015). On the other hand, in one of the articles, there was a general belief that the services were affordable, considering that the RI activities were subsidized by the government, and designed to be free except for service charges, in some facilities (Goodman et al., 2013).

In many cases even where the cost of accessing these vaccines are considered affordable, it was seen that a certain group of financially hindered people may still miss vaccination due to minor reasons

like; the minimal service charges, time, or cost of transportation. For these reasons, it is suggested that efforts should be made to eliminate all forms of out of pocket charges, including service charges at the point of vaccine administration.

Effectiveness of vaccines is another dimension of influence. The problems include; fake and substandard drugs (Okafor et al., 2014), which drive mothers to patronize alternative medicine. Secondly, the problem of the need to maintain proper cold chain to maintain vaccine quality has also been shown to be of concern (Fowotade et al., 2015; Gammino, Nuhu, Gerber, et al., 2014). The problem of poor road connectivity and power instability have been identified to make cold chain management very difficult in Nigeria, even though efforts are being made by the federal government in conjunction with Non-Governmental Organizations (NGOs), to improve on the supply chain capabilities of different states. This problem is being addressed by setting up modern cold chain facilities.

To deliver care effectively, the comfort of the patient, care givers and healthcare providers must be ensured. A good accommodation, provides the atmosphere for better care. Even though this is a factor not widely discussed in the reviewed papers or interviews, it is shown to have a significant effect on the mothers and their children.

To address the factors that are attributed to the people's abilities to interact with the dimensions of access, the ability to engage has proven to have the most encountered influence on essential vaccine access. Factors that were identified to contribute to the problem of the ability to engage include; lack of knowledge of the disease enough to promote further inquiry, the language barrier to communicate properly with health professionals, the problem of lack of autonomy of most mothers, since their health decisions are ultimately determined by their husbands. Lastly, the prohibition of women to interact with male health workers and poor training of healthcare providers, make it difficult for patients and care givers to engage them.

Ability to perceive, the second most frequently mentioned factor, shows that mothers/parents do not see vaccine preventable diseases as a priority. Other killer diseases such as malaria, measles and malnutrition were seen as more important, or of greater priority than others. So parents tend to give more priority to some diseases over others (Okafor et al., 2014). Some mothers believe that, children are only taken to the hospital when a disease is worsening, therefore preventive treatments are not seen as important. In the interviews, the respondents made mention that most care givers prioritize their immediate needs for example; nutrition and safety, before they consider vaccinating their children. However in one of the studies, vaccines were identified as necessary and essential by caregivers

(Onyeneho et al., 2015). In all there is variation in beliefs and level of knowledge of vaccines and vaccine preventable diseases by the caregivers.

Considering “ability to pay”, this factor influences access to essential vaccines, but it was not discussed as often as would be expected by the included papers. Only four studies identified this factor. This was probably so, because RI vaccines in Nigeria are provided as free preventive treatment to Mothers and their children. In most regions, the cost at the site delivery point is eliminated, making it completely free, especially in government facilities.

As for the ability to seek and the ability to reach, ability to seek has been identified to be influenced by the individual’s autonomy or ability to understand the value of these vaccines to the extent that he or she will be motivated to seek to get their children vaccinated. On the other hand, ability to reach has been shown to be influenced by many factors such as geographic accessibility, distance and how readily available information is to enable access to these vaccines. In Nigeria, considering the level of education of most of the people living in the rural areas, ability to seek is low, due to lack of the knowledge of the health value of vaccines. Another problem with ability to reach is that, most of the commonly missed populations, include migrating populations. These are mostly cattle herds men, migrating with their families, thus making it difficult to access the population eligible for vaccination.

Other identified factors that were not mentioned in the frame work of access, but were identified as factors that influence access to essential vaccines are; sociocultural factors, identified by (Eboreime et al., 2015) to be the major reason why there is poor vaccine uptake especially in northern Nigeria. Sociocultural factors here cover a broad area of consideration, it entails the people’s way of life; their tradition, religious beliefs, customs etc. For these reasons, it was not surprising to encounter other influencing factors like “lack of trust”, resulting to other factors such as “vaccine hesitancy” and “worries about the safety of vaccines”. It is evident from these findings that sociocultural factors influence the choices made by communities and influence essential vaccine access by mother and child.

Security was identified to be major influencing factor affecting the access to essential vaccines. Considering the recent security unrest in northern Nigeria, where insecurity lead to a complete halt in Immunization activities, leading to the reemergence of wild polio virus, security is factor that must be taken into consideration when considering essential vaccine access in sub-Saharan Africa. To ensure continues vaccine access security of both the patients and healthcare providers, play a determining role.

Prioritization was encountered where people will prioritize security, other more fatal diseases and personal needs, before considering vaccine preventable disease. This calls for incorporating other

welfare activities like nutrition into immunization programs. Secondly, proper reeducation of the people on the real value of vaccinating their children, even when they appear to healthy is necessary.

When facilities or programs aimed at providing vaccine services are made available, the next consideration is the quality of the services provided. This can be a hindrance to accessing lifesaving vaccines. The training of healthcare providers, their communication skills, attitude of the health workers and available choices, may determine whether a care giver will patronize a healthcare facility or not. In some cases, community health workers are only given minimal training on how to go about their activities. This can lead to lack of confidence in the health workers by the served communities.

7.0 Conclusion

The research findings were consistent with the hypothesis that “analyzing mother and child access to essential vaccines at the level of the dimensions of access, can provide a better understanding of the salient aspects, which affect the uptake of essential vaccines in Nigerian communities. In Nigeria, the problems of vaccine access vary from one region to the other, but in all of the regions, information/communication were found to have the most impact on vaccine uptake.

When information and communication strategies are designed in such a way that the health and economic values of vaccines are appropriately and continually communicated to care givers, as opposed to occasional and brief immunization campaigns, it promotes trust, the capacity of mothers to engage with health workers and also, community acceptance of essential vaccines.

Policies aimed at establishing a continuous system of educating communities about the value and advantages of vaccines, have the capacity to incorporate child immunization by default in the care givers.

7.1 Policy, recommendations and limitations of the research

1. In the study of child access to essential vaccines, it is recommended that further studies should be carried out using data generated from the care givers to better understand the problems associated with the 5 human abilities to interact with the dimensions of access.
2. In tackling the problems of essential vaccine access to mother and child, policies should be made to provide continuous education to parents through well-structured communication and Information programs. This will make the people appreciate the value of routine immunization and more inclined towards the ownership of the immunization programs.
3. When empowering and educating women, it will be essential to involve their male counterparts and the youth. This will help reduce the usual friction experienced in seeking the consent of husbands before seeking for medical attention by mothers.

4. Security considerations should be included in immunization planning, especially in northeastern part of the country. Insecurity destabilizes the health system and destroys the previous success achieved.
5. The limitations of the research include:
 - Search for the review papers was done in one electronic search library (PubMed NCBI).
 - Only papers in English language were included in the research
 - Only full texts were included, there could have been papers that are relevant to this topic, but not yet fully available.
 - Both qualitative and quantitative studies were included in the review
 - The study result was only synthesized qualitatively without a meta-analysis.

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9.0 Appendix

9.1 Mathematical explanation of Herd Immunity

$$p_c = 1 - 1/R_0$$

where;

P_c = the critical proportion of the population that must be immunized to achieve elimination

R_0 = herd immunity threshold, or the number of new infections generated by the first infectious individual in a completely susceptible population

In this mathematical representation, it is assumed that it is a closed system where the effective reproduction number (R_E) is the number of new infected individuals produced by one infectious individual. R_E is defined by the product of R_0 and the proportion of the population that is susceptible (Metcalf et al., 2015).

In other words, at the point where newly infected individuals can infect only less than one new individual ($R_E < 1$), the remaining susceptible individuals enjoy indirect protection from the rest of the population. The herd immunity threshold is the fraction of the population that is susceptible at the point where R_E falls below 1 and the number of infectious individuals peaks (Anderson & May, 1985; Metcalf et al., 2015).

9.2 Search strategy (PubMed NCBI):

NR.	Key terms
1	Child
2	Infant
3	“Mother-child”
4	“Maternal child”
5	“Mother-infant”
6	“Maternal infant”
7	Child OR infant OR “mother-child” OR “maternal child” OR “mother-infant” OR “maternal infant”
8	Access
9	Accessibility
10	Utilization
11	Supply

12	Demand
13	Access OR accessibility OR utilization OR supply OR demand
14	Vaccines
15	Vaccination
16	“Essential vaccines”
17	“Childhood vaccination”
18	“Infant vaccination”
19	Immunization
20	“Childhood immunization”
21	“Infant immunization”
22	“Routine immunization”
23	“Routine vaccination”
24	Vaccines OR Vaccination OR “Essential vaccines” OR “Childhood vaccination” OR “Infant Vaccination” OR Immunization OR “Childhood immunization” OR “Infant immunization” OR “Routine immunization” OR “Routine vaccination”
25	Nigeria
26	#7 AND #13 AND #24 AND #25

Table 12: Table of search key terms

Advanced search was used on the electronic data base, there were four subsets of terms combined with the operator OR. The inverted comas “” were used to search specific combined words as one meaning. In the last phase, the subsets of terms #7, #13, #24 and #25, were combined with the operator AND in the search data base to get the final hits for the review papers.

1. Details in Search strategy (PubMed NCBI):

Child OR infant OR “mother-child” OR “maternal child” OR “mother-infant” OR “maternal infant” AND Access OR accessibility OR utilization OR supply OR demand AND Vaccines OR Vaccination OR “Essential vaccines” OR “Childhood vaccination” OR “Infant Vaccination” OR Immunization OR “Childhood immunization” OR “Infant immunization” OR “Routine immunization” OR “Routine vaccination” AND Nigeria

2. Filters:

- Full text,
- 5 years
- Humans

- English language
- Date of search 14.03.2016
- Total Articles found 278

9.3 Tool for Exclusion

Title and Author	Excluded based on title	Excluded based on abstract	Excluded based on study population	Excluded based on intervention	Excluded based on outcome	Excluded based on study type
			*			
	*					*
		*			*	

*Form 1: Sample tool for exclusion. * indicates the parameters used for exclusion*

9.4 Template for Cochrane collaboration tool for assessing risk of bias

Domain	Description	Review Author`s judgement
Sequence generation		
Allocation concealment		
Blinding		
Incomplete outcome data		
Selective outcome reporting		
other sources of bias		

Form 2: Template for The Cochrane collaboration tool for assessing risk of bias

9.5 Tool for assessing the validity of qualitative studies

	Reference	Credibility	Transferability	Dependability	Confirmability
1					
2					

Form 3: sample tool for assessing the validity of qualitative studies

9.6 Data extraction tool

The data extraction form was designed to collect all the information needed to address the review questions (Kitchenham, 2008). It was then used to collect data items specified in the review protocol. The data extraction form was then tested using 2 randomly selected papers as shown in table 9.

	Study reference	Population characteristics	Type of Vaccine (immunization) Or Intervention	Identified dimensions of access	Identified people`s ability to interact with dimensions of access	Other Identified parameters not listed in table 5	Main findings of the study
1	(Eboreime et al., 2015)		BCG, diphtheria, tetanus, pertussis (DTP) (3 doses), polio (3 doses), and measles vaccine.	Inadequate availability of mid-level health professionals and unequal distribution of health facilities and outlets in interior settlements Problem of affordability by local government to maintain a good supply chain		*Socio-cultural factors contributing to vaccine non-uptake	Disparities in uptake of immunization in Nigeria is mainly as a result of socio-cultural factors. Weakest link in the supply chain is the local government, due to weakest financing and technical capacity. Inadequate skilled

							human resources. Inequitable distribution of health facilities.
2	(Barau, Zubairu, Mwanza, & Seaman, 2014)	Remote settlement population, targeting children < 5 years	Polio Vaccine	Physical Accessibility : GIS helped improve accessibility and thus immunization coverage	*Ability to reach	*Security	GIS helps to improve vaccine coverage and reduce number of missed children. It helps improve micro planning

Table 13: Sample data Extraction table

9.7 All Full articles studied with main reason for exclusion

	Articles	PMID	Included or Excluded	Reason for exclusion
1	Access to routine immunization: A comparative analysis of supply side disparities between Northern and southern Nigeria	26692215	Included	
2	Communication strategies to promote the uptake of childhood vaccination in Nigeria: A systematic map	26880154	Included	

3	An evaluation of community perspective and contributing factors to missed children during oral polio vaccination campaign	25316827	included	
4	Trends and patterns of under 5 vaccinations in Nigeria, 1990-2008: What manner of progress?	23573874	Excluded	Paper discusses trends or characteristics of people, but did not directly address access
5	Determinants of routine immunization coverage in Bungudu, Zamfara state Northern Nigeria	25328628	Excluded	
6	Progress towards Poliomyelitis eradication in Nigeria	25316862	Included	
7	Demand creation for polio vaccine in persistently poor-performing communities of Northern Nigeria	26908717	Included	
8	Routine immunization consultant in Nigeria: A qualitative review of a country driven management approach for health system strengthening	27016542	Included	
9	Limitations of using administratively reported immunization data for monitoring routine immunization system performance in Nigeria	25316876	Excluded	Paper focusses on the short comings of using administratively reported data for monitoring RI system performance and did not deal with factors affecting access to vaccines.
10	Polio field census and vaccination of underserved populations.	23965829	Excluded	
11	Maternal autonomy toward gender norms associated with childhood immunization in Nigeria.	22696106	Included	
12	Improving polio vaccine coverage in Nigeria through the use of Geographic Information system technology	25316823	Included	
13	Combination of quality and frequency of immunization activities to stop and prevent poliomyelitis transmission in high risk areas of Northwest Nigeria	26068928	Included	

14	Breaking community barriers to polio vaccination in Northern Nigeria: The impact of grassroot mobilization campaign (Majigi)	23265374	Included	
15	The Journalist initiative for immunization against polio and improved acceptance of the polio vaccine in Northern Nigeria	26721745	Included	
16	Analysis of vaccination campaign effectiveness and population immunity to support and sustain polio elimination in Nigeria	27029535	Excluded	The paper is based on determining vaccine effectiveness, not on access
17	Investigating socioeconomic inequality in access to and expenditures on routine immunization services in Anambra state	28143605		
18	Strengthening routine immunization in areas of Northern Nigeria at high risk of polio transmission during 2012-2014	26917576	Included	
19	Effect of community health Nurse lead intervention on childhood routine immunization completion in primary healthcare centers in Ibadan	26395786	Included	
20	Experiences, perception and preferences of mothers towards childhood immunization reminder/recall in Ibadan Nigeria	27386039	Excluded	Paper was based on what mothers think about or perceive immunization recall or reminder.
21	Characteristics of persons refusing oral polio vaccine during immunization plus days	25328629	Included	
22	The impact of declining vaccination coverage on measles control: A case study of Abia state.	24244791	Excluded	The paper talks about the declining immunization coverage and measles outbreak, but did not address the reasons for decline in the immunization coverage
23	Youth group engagement in non-compliant communities during	26609003	Included	

	supplementary immunization activities in Kaduna.			
24	Measles vaccines potency and seroconversion rates among infants receiving measles immunization in Ilorin Kwara State.	24825255	Included	
25	An Evaluation of Polio Supplemental Immunization Activities in Kano, Katsina, and Zamfara States, Nigeria: Lessons in Progress	25316881	Included	
26	Using geographic information system to track polio vaccination team performance.	25316882	Included	
27	Multiyear trend analysis in of childhood immunization and immunization in Nigeria.	23710666	Excluded	The paper topic focusses on topics such as household wealth and mother's education in relation to being immunized or not, but did not discuss how these factors interact to affect access
28	Assessing full immunization coverage using lot quality assurance sampling in urban and rural districts of southwest Nigeria	24062523	Included	
29	World health organization innovative direct disbursement mechanism for payment of grassroots immunization personnel and operators in Nigeria	26908746	Excluded	Paper focusses on how immunization personnel and operator's payment is made and not on access to vaccines
30	Health workers sensitization: Effects on perceived quality of immunization services among mothers of under 5 years children in Ilorin	24783892	Included	
31	Revised household-based microplanning in polio supplemental immunization activities in Kano state Nigeria	26908755	Excluded	The paper only analyzed the outcome of household micro planning during supplemental immunization, not on factors that affect vaccine access

32	Strategic engagement of technical surge capacity for intensified polio eradication initiative in Nigeria	26912379	Excluded	Paper focuses on the engagement of partners to boost technical capacity towards improving polio eradication initiative in Nigeria 2012
33	Compliance with existing regimens of existing vaccines in Orumba North local government area of Anambra state.	25856804	Included	
34	Parental acceptance of inactivated polio vaccine in southeast Nigeria: A qualitative cross-sectional intervention study.	25223271	Included	
35	Vaccine perception among acceptors and non-acceptors in Sokoto state Nigeria	24713368	Included	
36	Rural Urban disparities in maternal immunization knowledge and childhood seeking health behaviors in Nigeria: A mixed method	25320582	Included	
37	Determinates of uptake of third doses of oral polio and DTP vaccines in Ibadan North local government of Nigeria.	24844557	Included	
38	Polio towards poliomyelitis eradication in Nigeria Jan 2013-sept 2014.	25412063	Excluded	A report not in form of a study.
39	Outreach to underserved communities in Northern Nigeria.	25316825	Included	
40	The importance of the patient and the patient voice in vaccination and vaccine safety: Are we listening?	27939015	Excluded	Study was not focused on children under 5years or mothers with children under 5 years.
41	Polio eradication and the role of National stop transmission of polio program.	25316824	Excluded	Paper discussed National stop transmission program, but not patient access to vaccines or what affects it.
42	Intensified local resource mobilization for polio eradication initiative: The experience of world Health Organization in Nigeria during	26912380	Excluded	Addresses only operational funds mobilization and activities planning

43	Key issues in the persistence of poliomyelitis in Nigeria: A case control study.	25104665	Excluded	Study also includes a systematic review, and is not focused on children less than 5 years old
44	Effect of supplemental measles immunization on cases of measles admitted at Wesley Guild Hospital Ilesa	26060469	Excluded	Paper not focused on children under 5 years old and only discusses the effect of SIA on admission to Wesley Guild Hospital and not on access and factors affecting access
45	Measles surveillance in Nigeria: Enough information for policy making?	24778206	Excluded	Topic not on access to vaccine but addresses measles surveillance and policy making.
46	The differential impact of Oral polio virus vaccine formulation choices on serotype-specific population immunity to polio virus transmission	26382234	Excluded	Paper discusses population immunity and to polio virus, not on access.
47	Progress towards poliomyelitis eradication in Nigeria. Jan 2012-sept 2013	24436996	Excluded	A progress report, but not a study focused on vaccine access
48	Progress towards poliomyelitis eradication in Nigeria.	23139955	Excluded	A progress report, but not a study focused on vaccine access
49	A survey of neutralizing antibodies to the three type of polio virus among children in Maiduguri Nigeria.	22337311	Excluded	Paper only studied the antibodies to polio in children
50	An assessment of the reasons for oral polio vaccines refusal in Northern Nigeria	25326826	Included	
51	Prioritizing polio	23252381		Not a study, an expert report
52	Progress towards poliomyelitis eradication	26292207	Excluded	A progress report, but not a study focused on vaccine access
53	Progress towards poliomyelitis eradication	23134973	Excluded	A progress report, but not a study focused on vaccine access

54	Lot quality assurance sampling to monitor supplemental immunization activity quality: An essential tool for polio performance in polio endemic countries	25316852	Excluded	Paper does not address the population under 5 years and access to vaccines.
55	Diphtheria outbreak with high mortality in northeastern Nigeria	23866913	Excluded	Study not based on vaccine access or Diphtheria in children under 5 years alone
56	Listening to rumors: what the northern Nigerian polio vaccine boycott can tell us ten years on.	24294986	Excluded	Also, a systematic review of literature
57	Progress towards poliomyelitis eradication	2698883	Excluded	A progress report, but not a study focused on vaccine access
58	Antidiphtheria immunity in Nigeria mothers and their newborns	24731812	Excluded	Paper addresses immunity not access
59	Trends in neonatal and post neonatal tetanus admission at Nigerian teaching hospital	23276738	Excluded	Paper did not address access but trends in tetanus admission

Table 14: Table of fully studied articles with reasons for exclusion

9.8 Assessing the Risk of Bias in the included studies

The studies included in this review were both Qualitative and Quantitative studies. So, in assessing the risk of bias in the studies, they were grouped and assessed together when the research uses the same type of study design. The two methods of assessing the quality of the included studies as explained in table 8 and table 9, were not all completely applicable to the entire 27 studies included. This is because 11 out of the included studies utilized the use of routine data for immunization or other routine data from government or other immunization intervention activities with a descriptive or observational approach.

9.8.1 Randomized control Trials.

	Domain	Sequence generation	Allocation concealment	Blinding	Incomplete outcome data	Selective outcome reporting	other sources of bias
No.	Reference						
1	(Brown, Oluwatosin, Akinyemi, & Adeyemo, 2016)	Yes: Use of ballot system for random selection	Yes, means there was allocation of concealment	Unclear; it was not clearly stated if there was	Yes: All the outcome of interest was complete and	Yes: There was complete	Cluster randomized control trial and cannot be generalized.

			and low risk of bias	blinding or not and details were not given as to who was blinded	reported clearly	outcome report	Did not involve rural setting
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Table 15: Assessment of risk of bias in randomized control study included: Yes=Low risk of bias, No=High risk of bias

9.8.2 Other randomized non-control trials

	Domain	Sequence generation	Incomplete outcome data	Selective outcome reporting	other sources of bias
No.	Reference				
1	(Sibeudu, Uzochukwu, & Onwujekwe, 2017)	Yes	Yes	Yes	Multiple visit to some respondents, before the interview, may give a preconception
2	(Mohammed et al., 2014)	Yes	Yes	Yes	Unclear
3	(Fatiregun, Adebowale, Ayoka, & Fagbamigbe, 2013)	Yes	Yes	No	Yes
4	(Tagbo, Ughasoro, & Esangbedo, 2014)	NO	Yes	Yes	Yes
5	(Fowotade et al., 2015)	No	Yes	Yes	The drop out of patients may likely affect the applicability of the result

Table 16: Assessment of risk of bias in other randomized non-control trials: Yes=Low risk of bias, No=High risk of bias

For tables 12 and 13, Yes signifies a low risk of bias, all the necessary steps under that particular heading were taken to minimize bias, while No, implies that the steps to minimize bias were not taken. Unclear on the other hand is when adequate details are not given about the procedure to be able to tell whether it was done or not.

9.8.3 Assessment of bias in studies utilizing qualitative technique

No.	Reference	Credibility	Transferability	Dependability	Confirmability
1	(Oku et al., 2016)	Member checking applied, Recorded interviews	Description was backed with other routine data	Pair interview	Transcribing and reanalyzing interviews, Interview in pairs
2	(Michael, Ashenafi, et al., 2014)	3 participants in the interview:	Carrying out both focus group discussion and interview with individual interviews	Randomly selecting participants	Use of both open ended and Yes or No questions
3	(O'Connell & Wonodi, 2016)	A study advisory group of Experts, was formed to provide guidance on the data collection	discussion guides were refined iteratively throughout the data collection process	Study advisory group for audit inquiry	Independent research consultants trained in survey administration administered the interview (Neutrality). Audio recording to capture salient points
4	(Gammino, Nuhu, Gerber, et al., 2014)	Peer debriefing, persistent observation	Thick description, both from interviews and observation	Guide and protocol from US Centers for Disease Control and Prevention (CDC) and the Nigeria Primary Health Care Development Agency (NPHCDA)	Review of data collection instrument every night for completeness
5	(Goodman, Aderibigbe, Sekoni, Osagbemi, & Akande, 2013)	Not clearly stated	Through both interviews, routine data and observations	Selection was not random	Yes, outcome was confirmed both from interviews and observation
6	(Murele et al., 2014)	Triangulation, peer debriefing,	Through Thick description, analyzing emerging themes	Not clear	Triangulation, open ended questions, flexibility
7	(Okafor, Dolapo, Onigbogi, & Iloabuchi, 2014)	Using Triangulation by encoding and statistical analysis, multi stage sampling technique.	Thick description and other references	unclear	Confirmability and triangulation
8	(Fatiregun & Etukiren, 2014)	Triangulation	Thick description	unclear	Triangulation

9	(Michael, Ogbuanu, et al., 2014)	Triangulation, Member checking	Thick description	Unclear	Triangulation
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Table 17: Assessment of risk of bias in studies utilizing qualitative design

9.8.4 Studies based on analyzing Routing immunization data, government data, and other credible sources.

	<i>Article</i>	<i>Type or source of data used</i>
1	Strengthening Routine Immunization in Areas of Northern Nigeria at High Risk for Polio Transmission During 2012-2014 (Ali et al., 2016)	Routine Immunization administrative data and findings from supportive supervisory visits in 107 high-risk LGAs
2	Improving polio vaccination coverage in Nigeria through the use of geographic information system technology (Barau et al., 2014)	Data from GIS and routine immunization exercise
3	Combinations of Quality and Frequency of Immunization Activities to Stop and Prevent Poliovirus Transmission in the High-Risk Area of Northwest Nigeria (Duintjer Tebbens et al., 2015)	<i>Using a differential-equation based poliovirus transmission model tailored to high-risk areas (with information from routine immunization data) in Nigeria</i>
4	Access to Routine Immunization: A Comparative Analysis of Supply-Side Disparities between Northern and Southern Nigeria (Eboreime et al., 2015)	data for this study was obtained as part of the national Primary Health Care (PHC) reviews,
5	Using geographic information systems to track polio vaccination team performance: pilot project report (Gammino, Nuhu, Chenoweth, et al., 2014).	Data from GIS and supplementary immunization activities
6	Outreach to underserved communities in northern Nigeria, 2012-2013 (Gidado et al., 2014)	Data from SIA following the national guidelines for management of supplemental immunization activities (SIAs)
7	Youth Group Engagement in Noncompliant Communities During Supplemental Immunization Activities in Kaduna, Nigeria, in 2014 (Musa et al., 2016)	Data from polio vaccination activities
8	Breaking community barriers to polio vaccination in Northern Nigeria: the impact of a grass roots mobilization campaign (Majigi) (Nasiru et al., 2012)	analyzed data on the uptake of polio vaccination across Nigeria

9	Maternal autonomy and attitudes towards gender norms: associations with childhood immunization in Nigeria (Singh et al., 2013)	Methods—Data from currently married women with a child 12–23 months from the 2008 Nigeria Demographic and Health Survey (DHS)
10	Demand Creation for Polio Vaccine in Persistently Poor-Performing Communities of Northern Nigeria: 2013-2014 (Warigon, Mkanda, Muhammed, et al., 2016)	Data from 77 LGAs on polio-related interventions
11	The Journalists Initiatives on Immunisation Against Polio and Improved Acceptance of the Polio Vaccine in Northern Nigeria 2007-2015 (Warigon, Mkanda, Banda, et al., 2016)	determining the total number of media materials produced and the number of newspaper clips and bulletins published in support of polio eradication. And data from SIA 2007 in in Kaduna state

Table 18: List of studies that were based on analyzing routine immunization data, government data, and other credible sources.

9.9 PRISMA Check list

Section/topic	#	Checklist item
TITLE		
Title	1	Identify the report as a systematic review, meta-analysis, or both.
ABSTRACT		
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.
INTRODUCTION		
Rationale	3	Describe the rationale for the review in the context of what is already known.
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).
METHODS		
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis.

Table 19: PRISMA Check List 1 (Source; Moher D, Liberati A., Tetzlaff J, Altman DG, The PRISMA Group, (2009))

Section/topic	#	Checklist item
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.
RESULTS		
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).
DISCUSSION		
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.
FUNDING		
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.

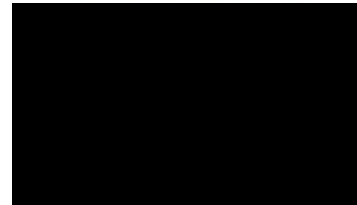
Table 20: PRISMA Check list 2 (Source; Moher D, Liberati A., Tetzlaff J, Altman DG, The PRISMA Group, (2009))

9.10 Letter of request for an interview



Hamburg

 Hochschule für Angewandte
Wissenschaften Hamburg
Hamburg University of Applied Sciences
Ulmenliet 20, 21033



Date _____

Dear Mr./Mrs./Mss./Dr./Prof. _____

I am a master of Public Health student at University of Applied Sciences Hamburg, I will like to invite you to participate in an interview, which will form a part of my master thesis. The topic of my thesis is "Achieving maternal and child access to essential vaccines in Sub-Saharan Africa: An assessment of the dimensions of access to essential vaccines in Nigeria".

The interview will last about 20 minutes and on your request, your confidentiality will be strictly ensured. I will be very honored if you will accept my invitation for participation. Anticipating on your kind reply, thank you.

Sincerely,

Dauda John Duguru

9.11 Questionnaire for Semi structured interviews

ACHIEVING MATERNAL AND CHILD ACCESS TO ESSENTIAL VACCINES IN SUB-SAHARAN AFRICA: AN ASSESSMENT OF THE DIMENSIONS OF ACCESS TO ESSENTIAL VACCINES IN NIGERIA

SEMI-STRUCTURED INTERVIEW

Personal Data

1. Can you kindly state your name and occupation Sir/Madam? _____
2. Can you kindly tell us Where you work and your position? _____

PART 1 EXPERIENCES OF ACCESS TO ESSENTIAL VACCINES

1. How long have you been working on vaccines in Africa/Nigeria? _____
2. What does access to essential vaccines or routine immunization mean to you?

(Interviewer translate the concept of "access to essential vaccines by mother and child" and the concept of dimensions of access as an approach of study)

(Use table as reminder of the dimensions)

	Identified Dimensions of access		Identified People's ability to interact with the Dimensions of access
1	Availability of essential vaccines, the healthcare services and accommodation	1	Ability to perceive
2	Effectiveness of the essential vaccines	2	Ability to seek
3	Approachability to be administered the essential vaccines	3	Ability to reach
4	Acceptability of the essential vaccines and the services provided	4	Ability to pay
5	Affordability of the essential vaccines	5	Ability to engage
6	Appropriateness or Relevance of the essential vaccines		

7	Physical accessibility of essential vaccines (geographic accessibility)		
8	Information/Communication		

Table 1: The identified dimensions of access and identified people's ability to interact with the dimensions of access

Probe: Let the interviewee tell you what they understand about access to essential vaccines

Part 2. GIVE RESPONDENTS A DEFINITION OF ACCESS TO ESSENTIAL VACCINES

Definition 1: The United Nations define Access as 'having medicines continuously available and affordable at public or private health facilities or medicine outlets that are within one hour's walk from the homes of the population' (UN, 2003)

Definition 2: Access to healthcare at a general level is also defined as "entailing the ability to secure a specified set of healthcare services, at a specified level of quality, subject to a specified maximum level of personal inconvenience and cost, while in possession of specified amount of information" (Oliver & Mossialos, 2004).

1. **Question:** Tell me about your experiences of Vaccine access and RI in Nigeria considering the dimensions of access mentioned earlier?

Probe: Ask them to relate experiences since working on essential vaccines for children under 5 (Both on supply and demand side factors in relation to the dimensions of access and then people's factors)

Prompt: From your experience working on vaccines, for <5 years children and pregnant women, what factors or dimensions of access do you consider as biggest challenge?

Probe: from your experience, how do these factors interact to come into play, example even when made available people still reject vaccines, can you shed more light on this (provider factors and population factors)

Probe: Ask them to relate experiences

2. **Question:** Are childhood vaccines free for the end users in Nigeria?

Probe: If there are hidden charges what are they?

3. **Question** Some factors have been identified that play a major role in vaccine access independent of both supply and demand, but affects both and that is "Security" What is the future of interrupting infectious disease transmission in security compromised areas?
4. **Question: What are the contributions of other factors such as;** Sociocultural factors, Vaccine hesitancy, prioritization, Quality of care and services, Safety of Vaccines and Trust

Part 3: Advantage of present study

1. **Question:** Do you think that the study of access on the level of its dimensions has the potential of giving us a better tool to solving the problem of understanding access to essential vaccines by mother and children < 5 years of age?

Yes _____ or No _____

Probe: What advantages do you think it has?

Declaration:

“I hereby declare that I wrote this thesis without any assistance and used only the aids listed. Any material taken from other works, either as a quote or idea has been indicated under ‘Sources’.”

Signature.....

