



Threats Analysis and Control Strategies in Immunization Programs for Rural Communities in Nigeria

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Abstract: Vaccination is crucial for disease prevention, particularly in rural Nigeria, where access to healthcare is limited. This study examines the challenges to immunization programs, the impact of government policies and local health systems, and the effectiveness of control measures. Key challenges include logistical issues, such as inadequate health facilities, storage for vaccines, and equipment, as well as socio-cultural barriers like lack of knowledge, traditional beliefs, myths, and rumors. Government policies and health systems play a significant role in immunization efforts but are often hindered by resource shortages and inconsistent implementation. Effective strategies, such as mobile vaccination units, community health education, and integrating immunization with other health services, have shown promise in improving vaccination coverage. However, concerns about the sustainability of these interventions highlight the need for systemic strengthening, including community involvement and a reliable vaccine supply chain. This study emphasizes the importance of coordinated efforts by government, healthcare providers, and community leaders to address both structural and cultural barriers. Achieving 100% immunization coverage in rural areas requires inter-sectoral strategies that address social determinants of health. By tackling these underlying factors, sustainable improvements in immunization programs can be ensured, ultimately reducing the burden of vaccine-preventable diseases in hard-to-reach rural areas.

Keywords: Immunization, Rural Nigeria, Vaccine Hesitancy, Healthcare Infrastructure, Cold Chain Management, Government Policies, Health Systems, Mobile Vaccination, Community Engagement.

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INTRODUCTION

Vaccination continues its place among the financially effective and efficient approaches used in global health promotion and disease prevention, particularly of children, and in decreasing the death rates due to infectious diseases [1]. Immunization programs in such countries such as Nigeria are paramount in view of high risk of VPDs including polio, measles, tuberculosis, and hepatitis B. Although the Nigerian government has set its agenda towards ensuring that all children are immunized, immunization challenges in the rural areas remain enormous and drastically affect the immunization program. This is especially worrying since a vast number of the population is rural dwellers who are located in areas that have poor access to health facilities [2].

The immunization gap in Nigeria has also been seen to be high between the rural and urban areas. About fifty percent of the country's population resides in rural regions, and these regions have always presented lower immunization rates than their urban counterparts [3]. The National Immunization Coverage Survey (NICS) conducted in 2019 showed that although immunization coverage in urban areas is about 60% rural areas are significantly lower with coverage rates for basic childhood vaccines often falling below 40% (National Primary Health Care Development Agency [NPHCDA], 2019). The above gaps are due to several factors that are related and which include geographical isolation, infrastructural development, cultural beliefs and security issues which explain why immunization goals remain unmet in rural Nigeria [4].

One of the main challenges of immunization in rural settings is the poor health facility base [5]. There are few equipped health centers in the rural areas and many of the existing local clinics lack such basic amenities as electricity supply, water supply or proper cold chain for vaccines [5, 6]. Cold chain is important in preserving the efficacy of vaccines because a number of vaccines have to be stored and transported at low temperatures, mostly between 2°C and 8°C. Poor cold chain systems have been described as a major risk to immunization in rural areas, mainly because vaccines that are not stored properly cannot be used because they are ineffective. This issue is worst felt in the hard-to-reach areas where there are no roads and little or no means of transport to help in the timely delivery of the vaccines [6].

The Nigerian health care delivery system especially in the rural setting has a health worker problem, especially trained immunization staff [7, 8]. This shortage of personnel is a big problem that

results in a decline in the quality of immunization services, and the absence of health workers in rural areas makes the government seek help from people who are not professionally qualified to work as vaccinators, although they work only for a short time [7]. These healthcare gaps mean that there are disparities in terms of immunization coverage and this is more so where there are disruptions occasioned by such factors as staff turnover, absenteeism or need to transfer staff to other areas [8].

Besides the physical and structural challenges associated with immunization in rural Nigeria, social cultural factors greatly influence immunization success [9]. For those reasons, many individuals from these cultures are skeptical about vaccines due to the holding of preconceptions though the offer of healthcare services [10]. Most of the rural people have inadequate knowledge of the significance of immunization, which is attributed to inadequate knowledge or poor knowledge of health [11]. There are also other myths that vaccines are dangerous, that they are a tool of the government or some foreign power, or that they are not needed if the child does not get sick with the diseases that vaccines protect against [11, 12]. The above-mentioned attitudes are supported by local community leaders such as religious leaders who may question the efficacy of the vaccines or even encourage people not to take them [12].

Beliefs about safety and the need for vaccination are especially strong in some parts of Nigeria, where rural communities are often more trusting of traditional African medicine and faith healing than of Western-style medical treatment [13]. For instance, some cultures in the northern Nigeria feel that immunization is unnatural or it is forced on them by the whites and therefore, they cannot accept it as their practice. Consequently, a large number of people do not receive vaccinations and children can easily get sick with some diseases that could be prevented through immunization, and morbidity and mortality rates increase [13, 14].

In rural areas, inadequate or poorly implemented health education initiatives also play a role too. Because many parents have limited awareness of vaccine-preventable diseases and potential effects of non-vaccination the immunization does not seem urgent to them. In addition, there is no interaction between healthcare workers and rural dwellers so misconceptions remain rife, hence the continued low vaccine uptake [15].

The level of insecurity in many parts of rural Nigeria has however worsened in the recent past and

this has added to the challenges of immunization service delivery. Insurgencies, terrorism and violence from civil militia, Boko Haram and Fulani Herdsmen have disrupted the country especially the northeast, north central and parts of the northwest [16]. These security challenges have seen health facilities being burnt, closed down, staff being threatened or harassed and populations displaced. In his words, normal immunization activities across the affected area, may be disrupted or stopped due to increasing security threats to the vaccinators and inability to reach targeted population as a result of insecurity, as noted by [16, 17].

The insecurity has posed major challenges to the fight against polio in particular where vaccination teams have had to stop conducting polio vaccination due to violence and attacks on health workers. While in some conflict-affected areas the communities are not only unable to receive their regular health care needs met but are also restricted from mass vaccination exercises due to displacement and the collapse of authority structures [17, 18]. Second, perpetuating the situations hinders the ability of health authorities to build trust with intended vaccine recipients, a vital factor in the implementation of vaccination projects [18].

Nevertheless, with the support of the Nigerian government and WHO/UNICEF, GAVI, et cetera, some policies and strategies that have been put down to overcome barriers to immunization have been developed [19]. The National Immunization Schedule and the routine immunization program (RIP) have been the mainstay of the immunization process in Nigeria. Moreover, some of the immunization challenges have been tackled by such campaigns such as the National Polio plus Initiative and Maternal and Child Health programs [19]. However, problems of funding, coordination and organizational inefficiencies remain an encumbrance to the achievement of health objectives of these programs [20].

The fact is, immunization programs in Nigeria have been supported by international donors in form of funding, vaccines, and technical assistance. However, issues related to the efficient utilization of these resources are still outstanding, more so in the rural and hard to reach areas. Immunization programs in Nigeria continue to receive support from international organizations, however, there is need to strengthen the relationship and integration of such support within the health systems in Nigeria [21].

There are various factors that make immunization programs in rural Nigeria difficult and therefore poses threats to the program. These include

the following; infrastructural and logistical factors, socio-cultural factors and security factors all of which contribute towards the continued low coverage of immunization campaigns [22]. These barriers are best solved by not only focusing on the development of the health care infrastructure but also on increasing the community support, raising the level of health literacy and increasing security. It is for this reason that immunization program in rural Nigeria has to overcome the above challenges through joined effort of the government, non-governmental and international organizational, and the community. This research hence aims at identifying the challenges to immunization in rural Nigeria and assessing the impact of the measures put in place to mitigate the challenges. Therefore, this research intends to propose more effective solutions to the problem of low immunization coverage and high prevalence of VPDs in Nigeria's rural areas by reviewing all the available literature on the topic.

METHODOLOGY

This study was a review of the literature. Due to the fact that the barriers to immunization in rural areas are many and diverse, it is essential that the existing literature, research, reports and policies be systematically reviewed in order to identify factors that affect immunization effectiveness. The subsequent sections provide the detailed description of the methodological procedures and data sources applied in this research.

Literature Search Strategy

The main method used in this study includes identifying and reviewing available literature that has been published between 2018 and 2024 including articles, government reports, international organization publications, and grey literature from NGOs and health agencies. The search was done in several academic databases including PubMed, Scopus, Google Scholar, and JSTOR using keywords and phrases like "immunization in rural Nigeria," "barriers to vaccination", "cold chain logistics Nigeria", "vaccine hesitancy in rural areas", "health security challenges Nigeria" and "immunization control strategies Nigeria". To avoid any limitation of the results, both qualitative and quantitative research articles were considered for the review. This study also included reports and data from WHO, UNICEF and GAVI in addition to peer reviewed academic articles.

Inclusion and Exclusion Criteria

Inclusion Criteria

- Articles published before 2018 since the current situation might differ from the status recorded in those studies.

- Works that do not present simple statistics or elaborate discussions of the immunization problems and solutions.
- Articles that address key themes such as logistical barriers (e.g., cold chain issues), socio-cultural factors (e.g., vaccine hesitancy), government policy, security challenges, and control strategies for improving immunization coverage.
- Both qualitative and quantitative studies that provide insights into the threats faced by immunization programs and the strategies used to mitigate these challenges.
- Reports from international organizations, government agencies, and NGOs that contribute to understanding the state of immunization in rural Nigeria.

Exclusion Criteria

- Studies that focus on urban immunization programs in Nigeria, as the study specifically aims to focus on rural communities.
- Articles published before 2018, as they may not accurately reflect the current state of immunization efforts in Nigeria's rural areas.
- Sources that do not provide empirical data or in-depth analysis of immunization challenges and strategies.

Data Extraction and Synthesis

The selected articles and reports were scanned for important themes in regard to the research aims of this study. A detailed data extraction form was used to systematically collect information on the following:

Threats and Challenges – The main threats that have been identified to impact immunization in rural areas including; transport issues, no infrastructure, culturally accepted diseases such as vaccine-preventable diseases, insecurity and others.

The steps that were made to overcome these barriers such as community mobilization, mobile vaccination, policies and partnerships at national and international level.

Policy and Government Support – How that National and Local Authorities can support immunization programs; funding, policies, and actions in response to security threats.

Strategy Implications – Information on the achievements and drawbacks of the implemented strategies with regards to vaccination, vaccine uptake and immunization targets in the rural population.

Data Analysis

As the current study is a literature review, the analysis done was largely of a qualitative nature. The challenges and strategies were grouped according to the thematic analysis that was used when conducting the study of the sources that were reviewed for this paper. In order to assess the relevance of each of the themes that has been identified towards immunization in rural Nigeria, each was expanded.

Limitations of the Methodology

While this literature review provides valuable insights into the threats and control strategies associated with immunization in rural Nigeria, there are certain limitations to the methodology:

Reliance on Published Sources – The study relies only on published work that limits the scope of the study particularly where there is limited primary data or where the latest information may not be available.

Area of Study – The study is confined to rural Nigeria but the problems and solutions mentioned in this paper cannot be extended to all the rural areas in Nigeria. These are; differences in the infrastructure, health systems as well as socio-cultural beliefs across the regions which may influence generalization of results.

RESULTS

Threats and Challenges Facing Immunization Programs in Rural Communities in Nigeria

It will be recalled that immunization programs remain an essential tool in the fight against Vaccine Preventable Diseases (VPDs) in Nigeria. Nevertheless, existing challenges in the country's rural areas make it difficult to complete the vaccination process successfully. These challenges are complex and include operational, physical, social-cultural, and security complexities. These challenges remain a hindrance to adequate immunization coverage even with attempts to enhance immunization protection, immunization coverage has been hindered in the rural areas.

Logistical and Infrastructure Barriers

However, infrastructure remains one of the major challenges to immunization programs especially in terms of transport, storage and health facilities in rural Nigeria. Most of the rural areas in Nigeria are not well developed hence the challenge of delivering vaccines is difficult.

Cold Chain and Vaccine Storage

Some vaccines, especially those such as polio and measles, vaccines are highly sensitive to temperature and must be stored at appropriate temperatures to remain effective. An effective cold chain is essential in order to keep vaccines from spoiling before they are used. Nevertheless, in many rural areas, the problem of a stable electricity supply and proper storage conditions to maintain this cold chain persists [23]. For instance, there are no required refrigerators and backup power in the rural health clinics, which makes it impossible to store vaccines at the right temperature. This is especially important in areas where power supply is unreliable; the vaccines get spoiled and the overall effectiveness of the vaccines is compromised because of poor storage [24].

Transportation and Accessibility

Transportation problems compound the immunization program challenges in rural Nigeria in terms of delivering the vaccines. Most rural populations live in areas that are difficult to access by road networks or in areas that may lack proper road networks at all. This is because there are no good roads through which health workers can access the rural people, especially during the rainy season when some of the areas are almost inaccessible [25]. Consequently, vaccines may not be transported on time, or they end up exposed to heat, which will lead to immunization schedules being missed and children not being immunized on time.

Furthermore, many rural health centers lack the necessary basic stock of medical equipment and most of the healthcare workforce in these regions may be poorly equipped or overworked by large patient volumes. This shortage of human resource in health and health facilities undermines the quantity and quality of the services rendered, starting from immunization [25].

Healthcare Worker Shortages

The inadequate number of professionally qualified healthcare providers who are available in rural Nigeria is another challenge to immunization. Since working conditions and remuneration are generally better in urban areas, healthcare training institutions produce more trained professionals for urban settings than for rural areas [26]. This leads to the problem of large coverage gaps for immunization programs; despite all the efforts, the health workers that are in charge of remote, rural regions are overloaded with work and to spread out to adequately administer the required number of vaccines or monitor the unfolding of the campaigns.

Besides, scarcity of the health-care professionals, inadequate and limited continuing education and training for the health care workers in rural settings may imply that the existing workers are not familiar with new immunization guidelines or standards. This is particularly a challenge when new vaccines or new strategies of vaccine administration are developed since such knowledge as this could lead to errors in administration of vaccines or failure to vaccinate when it is due [27]. For instance, in some countries there is inadequate awareness on up to date WHO immunization guidelines or practices to implement while addressing barriers to immunization like public skepticism.

Socio-Cultural Barriers and Vaccine Hesitancy

This cross-sectional study established that socio-cultural factors played a major role in the vaccination rate in rural Nigerian communities. Most of the rural people have cultural beliefs, perceptions and misconceptions that hinder immunization. The social barriers to immunization include; Vaccine hesitancy as a result of misinformation from anywhere as well as mistrust of the health systems and culture.

Traditional Beliefs and Misinformation

In the rural areas, cultural beliefs are always the main determinants of the health care decisions. For example, some cultures may consider vaccines as a Western conspiracy or behave unsafe for children because it spoils their fertility or causes them to have delayed development. These misconceptions are more evident in the northern part of Nigeria, where there is great cultural barrier to vaccination and especially among certain social ethnic and religious groups [28]. Despite campaigns by health authorities encouraging people to take the vaccines, there is still a lot of misinformation going around on the dangers of vaccines.

For instance, some people in some parts of the world have been giving out the polio vaccine to their children due to some beliefs such as it is used to inject the children with a view of making them infertile or the vaccine has been laced with poison and is fatal to the lives of the children. Such myths are normally encouraged by ineffective community leaders, religious persons, and, in some instances, the local media [29]. As such, these beliefs mean that a large number of families decline immunization, which leads to ongoing clusters of unimmunized populations in rural settings.

Role of Religious and Traditional Leaders

Community health and religious and Traditional authorities have a significant influence on the health practices of the rural dwellers. While many

religious leaders continue to support immunization, others may directly oppose vaccination due to misunderstandings of their own, or due to the distrust of the healthcare system [30]. Traditional healers and religious leaders have a big say in many societies hence the need for them to support immunization in order to eliminate hesitance. But in some other times, these leaders may go out of their way to ensure that people do not get immunized citing religious or cultural reasons [31]. This type of opposition can greatly weaken the process of immunization, especially if these leaders influence major groups of individuals.

Gender and Access to Health Information

Power relations of gender in the rural settings may also influence the use of vaccines especially to women and children. In most rural Nigerian contexts, the women may not be able to decide on their own or for their children, on healthcare issues without consulting with the male counterparts or family members. This patriarchal system may hinder or even cause a postponement of vaccination because some women cannot travel to health centers or may lack the assistance to take children for immunization [32]. Moreover, in such a society, women cannot be informed of the need for immunization and other health management measures that will help child vaccination gaps.

Security Challenges

Violence and insecurity especially in the Northern region have emerged as a major factor discourage immunization. Ethnic and religious conflict coupled with the Boko Haram problem has made it very dangerous for health workers to deliver immunization services.

Impact of Armed Conflicts and Violence

In areas of insecurity in Nigeria, health care providers have been attacked by armed men while health facility have been closed or made unreachable. As a result, vaccination teams have been attacked and health workers have been killed, and immunization campaigns have had to be stopped in some areas [16]. These security threats not only endanger the health workers but also deny the vulnerable communities especially in rural areas where security is worst.

The violence also poses another challenge by destroying the health infrastructure that is required to address the challenge. For instance, in areas of operation of Boko Haram, many health facilities have been closed down, and many health care providers have abandoned their work due to insecurity; hence, immunization and other essential health services are not available to rural communities [16]. In these affected areas, there is also a higher possibility of

diseases spreading, with immunization drives taken indoors, and children and adults remain defenseless in opposition to preventable diseases such as measles, polio, and tetanus.

Displacement and Fragmentation of Communities

Tensions and instability result in population migration, and people leave their homes as a result of war and live in tents or refugee camps. These settings are challenging for immunization programs because displaced persons are hard to locate and are dispersed over a wide area. Mobile vaccination teams may not be able to locate displaced populations because there is no safety and mobility in these areas [16]. Therefore, coverage with routine immunizations in displaced populations remains decentralized, hence increasing the public health risk caused by epidemic spread of vaccine-preventable diseases.

Weak Data Management Systems

As such, reliability in data acquisition and storage is a critical factor when it comes to immunization program planning and assessment. However, the development and strengthening of health information systems in most rural areas in Nigeria are still in their infancy, and this poses a serious challenge to health authorities in terms of assessing vaccination coverage, evaluating the population that has not been immunized or the efficacy of immunization programs [33].

This obviously makes it difficult for the immunization teams to know the specific areas that have low vaccine coverage and therefore any targeted interventions may be poorly timed or poorly coordinated [33]. Similarly, the absence of valid information hampers monitoring and evaluation and, therefore, the evaluation of the progress toward national immunization goals and the identification of effective approaches [34].

The Role of Government Policies and Local Health Systems in Supporting or Hindering Immunization Programs in Rural Settings

This paper identifies government policies and health systems as key determinants of immunization programs in rural Nigeria. Nigerian government has put in place various policies that facilitate immunization but local health systems are confronted with factors that hinder effective delivery of immunization services especially in rural setting. These challenges include; poor funding, poor infrastructure, weak coordination, and governance at the local levels. However, when policies are properly implemented and local health systems are built up, then immunization coverage is improved, and

vaccine-preventable diseases (VPDs) are decreased in rural areas.

Government Policies on Immunization in Nigeria *National Immunization Policies and Strategic Plans*

The Routine Immunization Strategy and the National Immunization Schedule of Nigeria are national policies that target to increase the coverage of vaccines in Nigeria including in the rural areas. Immunization activities through multi-year plans have been adopted and enhanced through NPHCDA and these include; National Immunization Days (NIDs) (that) target all children across the population including those in remote rural areas; Sub-national Immunization Days (SNIDs) [35]. These campaigns, has mostly received support from global organizations like UNICEF and WHO have been crucial in providing vaccines for diseases like polio, measles and yellow fever to the unserved population [35].

The Nigerian government has also supported the Global Vaccine Safety Initiative, and incorporated immunization with other health services, especially maternal and child health to ensure that immunization is availed to the most vulnerable in the rural areas [36]. These national strategies have proved useful in raising immunization coverage especially in hard-to reach zones. Nevertheless, a number of practical concerns at regional level persist to slow the extent of coverage under this national framework, particularly in rural and or conflict-prone zones.

Challenges in Policy Implementation at Local Levels

In Nigeria, there are sound national policies that guide immunization; however, there are always one or two hitches when it comes to the implementation of the policies at the state level. Another problem is that health services are decentralized in Nigeria, and state and local governments are to provide immunization services. In this regard, this has contributed to disparities in vaccine distribution and utilization and most especially the rural regions [37].

For example, in some states, the available funds at the local government level are insufficient to enable the health center to deliver immunization services. In rural areas, health workers are under pressure with limited resources to work with, due to which immunization programs are not efficient and effective [37]. The decentralization from the federal to the state and local governments has also resulted in poor co-ordination of federal, state and local governments. At times, the LHA has little or no

interaction with the national agencies such as the NPHCDA, resulting in a fragmented service delivery system (Ameh *et al.*, 2021).

Local Health Systems and Immunization Delivery *Inadequate Health Infrastructure and Resource Constraints*

Immunization services in rural Nigeria are limited by poor funding of health facilities and weak infrastructure to support the provision of immunization services. Rural health centers often do not have even simple medical commodities such as cold chain equipment for storing vaccines at the correct temperatures. Poor electricity, limited cold chain equipment, and challenges in vaccine transportation for the vaccine hinder vaccination efforts in the remote regions (Nwokolo *et al.*, 2019). Health centers across rural regions are staffed inadequately, and healthcare workers can rarely provide excellent services because they are inadequately trained, poorly paid, and overloaded (Oyebode *et al.*, 2021).

In this area, communication and data infrastructure are also inadequate. Health systems in many rural areas particularly in developing countries lack efficient information management systems and therefore cannot monitor immunization coverage and identify regions with poor coverage. Such absence of data results to wrong estimations of resources and inability to recognize areas of poor immunization coverage especially hard to reach areas that should be given more attention (Olumide *et al.*, 2019).

Role of Local Health Workers and Community Engagement

Immunization services are mostly delivered by local health workers in the rural areas. But these workers often encounter many barriers that limit their capacity in implementing immunization programs. In many rural communities, health workers are not only charged with immunization but also with many other health service delivery functions. It demotivates the health workers since they are overloaded with work, they do not receive nice pay for (Ameh *et al.*, 2021).

Another important factor in immunization in rural Nigeria is the function of the community health workers (CHWs). They are community health workers who are mostly from the target community hence can easily influence the targeted populace. They have been useful tools on creating awareness on the need to take vaccines and encouraging people in the community to take vaccines (Fapohunda *et al.*, 2020). Nevertheless, the community health workers are not fully incorporated into the health care system

and their capacity may be developed in a rather unstructured manner. This absence of study imputes and requisite obstructs the potential of CHWs in immunization crusades.

Community Participation and Local Governance

Immunization programs in rural Nigeria therefore require the support of the people in the community. Engagement of traditional and religious leader can improve acceptability of the vaccines. Some research has revealed that when these local leaders support immunization campaigns, then the community members are more likely to support those immunization campaigns (Suleiman *et al.*, 2020). However, in some rural areas, political leaders or religious leaders or any powerful person in the community can be a very big negative influence to the immunization. For example, there are groups in the northern part of Nigeria where vaccine and immunization fears are caused by cultural beliefs, and therefore the solution lies in a massive community mobilization and sensitization exercise (Chukwuma *et al.*, 2022).

Also, these problems are compounded by poor local governance. A number of subnational governments in developing countries, especially those in rural areas, are often unable to adequately plan and deliver health care services. This leads to a clumsy and ineffective delivery of immunization services. Limited political commitment, inadequate finances, and weak leadership and management at subnational level explain coverage gaps in immunization (Ameh *et al.*, 2021). The local governments can be made efficient, funding and addressing of the targeted communities can be enhanced as well as engagement with the locals would contribute to improvement of the local health system to offer consistent supply of the vaccines in the rural areas.

The Role of External Partners and International Support

While Government Policies and Local Health Systems Play a Crucial Role, External Support

Hence, support which has been afforded by the international organization including UNICEF, WHO as well as GAVI has also helped to enhance immunization in the rural area of Nigeria. These organizations support immunization operations involved in the provision of financial and technical support to immunization programs across the Nigerian territory and especially in marginalized and remote communities. For instance, the Global Polio Eradication Initiative (GPEI) has assisted in the polio vaccination in Nigeria which supplies vaccines, funds and personnel to guarantee coverage of all the rural zones (WHO, 2020). Engaging international partners

has been most relevant in the conflict affected areas of the country where the existing health structures are run down and cannot support immunization service delivery.

However, though support from external sources has been instrumental, such support is usually temporary and, therefore, depends on strong local leadership and sustainable strategies to keep up the immunization programs once outside funding and personnel are withdrawn or reduced (Ameh *et al.*, 2021). Thus, there is a need to develop long term sustainable approaches to enhancing the local health systems to avoid over reliance on donor support and to establish an effective and efficient, sustainable health systems in rural Nigeria.

The Effectiveness of Various Control Strategies Implemented to Overcome Immunization Threats in Rural Nigeria

As a result of the numerous threats to challenges encountered in implementing immunization programs in rural Nigeria the following control measures have been put in place at different levels of government and at the local level. Such interventions are meant to enhance uptake, strengthen human resources in health, deal with cultural factors plea for fair and efficient provision of immunization in underserved populations most of the time in remote areas. The success of these strategies has been mixed, however, several of the mentioned strategies have proved to be instrumental in overcoming major barriers to immunization in rural Nigeria.

National Immunization Days (NIDs) and Sub-National Immunization Days (SNIDs)

Among the most recognized and frequently adopted control measures in rural Nigeria are NIDs and SNIDs, which are more popular than the others. Immunization campaigns have been a key focus of the Nigeria government strategies in quest of achieving high vaccine coverage especially polio, measles and other VPD.

Effectiveness

NIDs and SNIDs have proved to be very effective in reaching out for children in remote rural areas. In these campaigns, health teams visit houses in the villages to immunize children, and usually focus on areas with low vaccine compliance. Mobile vaccination teams have been very crucial in making sure that everyone, including the most remote groups, is vaccinated. These campaigns are implemented with the assistance of WHO, UNICEF and GAVI by way of funding, technical assistance and other logistical support. For instance, the efforts towards polio have been realized with Nigeria being

declared a polio free country in 2020 after years of relentless campaigns (WHO, 2020).

Nevertheless, the problem of sustainability of such campaigns remains the subject of debate. However, both NIDs and SNIDs have been useful in boosting the immunization rates when the campaigns are on, the problem has always been how to sustain the rates once the campaigns are over. The high costs and the problems of organization of these mass vaccination days are also the obstacles to the sustainability of these campaigns.

Mobile Vaccination Units and Outreach Programs

Another strategy which has also been advanced to address the issue of access in rural Nigeria is the use of mobile vaccination units (MVUs). These are mobile units that use vehicle that can access the remote villages in the delivery of vaccines, health education and community mobilization. Other components of community outreach programs include door-to-door visits by health workers to vaccinate residents of communities, staff of schools, and residents of other social congregation places.

Effectiveness

Mobile vaccination units have been especially helpful in Nigeria's rural areas because some facilities could be quite distant from certain communities. MVUs avoid the challenges of transport, and access communities that have little or no access to conventional health care systems. MVUs have ensured immunization coverage is maintained in the northeastern states where insecurity has remained a major challenge to routine immunization (Fapohunda *et al.*, 2020). These units do not only give vaccines but also are critical in educating and engaging people especially on issues to do with vaccines to discourage vaccine myths and misconceptions especially in areas marked by conflict (Ameh *et al.*, 2021).

However, the effectiveness of this strategy is daunted by practicalities for instance, poor road network and poor supply of fuel in the rainy season. Additionally, keeping vaccines available and the cold chain intact in the rural areas is a constant problem.

Community Engagement and Social Mobilization

Community participation is central in enhancing immunization coverage, particularly in rural settings because culture system of the people has a strong influence over their decision to seek medical help or not. Social mobilization strategies are mainly involved with sensitization of the communities, creating awareness on the importance of immunization, myth busting exercise and

participation of policy makers, calabash men, religious leaders etc.

Effectiveness

Experience has shown that the outcome of immunization campaigns in rural Nigeria depends on the mobilization of the traditional leadership. Chukwuma *et al.*, (2022) noted that when religious and traditional leaders support the exercise, there will be increased uptake of vaccines. Several studies have evidenced religious tensions as an informing factor for vaccine hesitancy in Northern Nigeria, hence dialogue with Islamic scholars as well as other stakeholders has successfully increased the acceptancy of vaccines and immunisation activities in the region (Suleiman *et al.*, 2020).

CBOs and local NGOs have equally played an important role in mobilizing people for awareness campaigns and mobilizing people for vaccination campaigns within the villages. These factors have proved work effectively to address misinformation and increase vaccine uptake within the targeted communities (Fapohunda *et al.*, 2020).

However, as powerful and efficient as community engagement strategies are in raising immunization coverage, such interventions are time-consuming and resource intensive in building the necessary rapport to overcome cultural or religious taboos against vaccination. Furthermore, such strategies do not work well in the region where political crisis or armed conflict has destabilized the communities and social organizations.

Incentives for Health Workers and Improved Training

As a solution to the scarcity of health workers in these areas, several policies have been developed to motivate these health workers and their training. Such programs include financial incentives, capacity enhancement activities, and providing promotion opportunities to health workers practicing in hard-to-reach areas. As with the other areas of training for HCW, the enhanced training programs are aimed at improving the knowledge of HCW in some of the key areas including immunization techniques, cold chain management and community relation.

Effectiveness

Working on incentives has not yielded positive outcomes as expected. Some health workers have said that when they are given extra pay or offered promotion or training, they have been encouraged to work harder and remain in rural areas where health facilities are scarce. Ministerial policies have helped in improving overall immunization

coverage and reducing inefficiencies in immunization programs such as vaccine wastage because health workers are motivated and possess good techniques in managing immunization programs according to Olumide *et al.*, (2019). Some states have also offered hostels to the health workers in rural areas to increase retention and reduce turnover by local governments.

But the effectiveness of these programs is hampered by resource availability and the general poor health facilities in the rural areas. However, there are still some health workers who work under conditions that are less than ideal and which may cause burn out, ineffectiveness and in some cases increased vaccine wastage (Nwokolo *et al.*, 2019).

Integration of Immunization with Other Health Services

Another approach that has been adopted to ensure that immunization services is taken to higher levels of coverage is an integration of immunization services with other key health care services particularly MCH and nutrition services. The integration enables health care providers to administer vaccines during other health services visits in health center, mobile clinics or outreach programs. The Integrated Health Outreach Programs (IHOPs) aim at providing immunization, antenatal care and family planning services in one package to allow mothers and children access multiple services at once.

Effectiveness

The immunization with other health services has been effective in promoting the use of vaccines since mothers who are already attending other health facilities for other health related services such as maternal care or ante-natal clinic will also be immunized. An integration of vaccination with these visits improves on the chances that mothers and children will receive vaccines during this otherwise regular health checkup, especially in areas remotely situated. Research has shown that there is increased immunization coverage whereby immunization has been integrated with other relevant service administration especially in the rural and urban areas of Nigeria (Suleiman *et al.*, 2020).

Although this strategy has paid off, it is a very sensitive strategy that needs close collaboration between different health sectors and constant funding. However, in the rural setting where the health facility is a challenge, there is the problem of training the health workers adequately and the integration could further congest the existing overburdened health facilities (Oyebode *et al.*, 2021).

DISCUSSION

The problems associated with the low immunization coverage in rural Nigeria are complex and exogenous and endogenous factors that should call for concerted effort in addressing them. The review has highlighted the effectiveness of various control measures that have been adopted in achieving immunization goals, but also showed the main challenges that have hindered the full achievement of immunization goals. In this discussion, the strategies will be analyzed, and their relevance in the socio-political and healthcare setting of rural Nigeria will be discussed, as well as the main lessons learned.

National Immunization Days (NIDs) and Sub-national Immunization Days (SNIDs) have been used to reach out for the hard-to-reach population in rural Nigeria especially in remote and Boko Haram affected areas. The studies show that these campaigns have proved useful in enhancing immunization rates during the course of the campaigns. For instance, the excision of polio in Nigeria, which was declared in 2020, was said to be due to the effectiveness of those immunization days [35]. Similarly, mass campaigns for measles and yellow fever have also been effective in improving vaccine coverage for inaccessible areas including rural areas where routine immunization is poor.

However, although these campaigns have produced short-term results, the issue of the maintenance of vaccination campaigns has been less of a success. The use of NIDs and SNIDs is sometimes compromised by the fact that follow up of routine immunization is not well maintained once the campaigns are over. The difficulties inherent in the process of mass vaccinations including the question of funding, the issue of cold chain and the continuity of the supply chain, can all detract from the effectiveness of the campaign. The costs of such campaigns are relatively high, and when such campaigns are frequently conducted in the regions, they may lead to the local population's exhaustion of financial resources, which in the future will not always be able to cover such initiatives without international assistance [35]. The review also underlines the necessity of better coordination of mass vaccination campaigns with the promotion of routine immunization services and with the health care systems in the region.

The problem of physical access is therefore expected to be addressed by Mobile vaccination units (MVUs) which are a relatively innovative approach in rural Nigeria. MVUs are most effective where there are poor road networks or where insecurity makes it difficult for health workers to get to people. MVUs are

well placed to administer vaccines to hard-to-reach population, which may not have to cover long distances to reach the health facilities. According to the review, this has been important in conflict areas like the northeast where insurgency has affected health care delivery and restricted mobility to permanent health facilities [38].

However, MVUs have some problems which are related to the transportation system for instance; transport is unreliable, fuel is inadequate, and roads are poorly developed hence making the delivery of vaccines to be slow. However, the cold chain system which is an essential factor in effective vaccine storage and utilization poses a significant problem in the implementation of the immune booster in the rural areas where electricity supply is unsteady at best. These challenges bring into focus the issue of inadequate infrastructure that is required to enhance the functionality of MVUs. This strategy will need to be supported by sustainable solutions such as local level cold chain and improved vehicle maintenance.

Social communication has therefore emerged as this important strategy in sensitization and combating vaccine hesitancy especially Country and Religion where such beliefs dominate; such as rural Nigeria. As for the successes, communities engaging traditional and religious authorities and other leaders of recognition have contributed to the increase in vaccine acceptance. As evidenced, community endorsement involving leaders plays a role of neutralizing misconception around the vaccine safety and its efficacy, thus increasing vaccine acceptance [38].

This has been especially useful in the northern region of Nigeria where the public has been highly skeptical of vaccines because of religious and cultural beliefs regarding their safety and distrust of government motivated health interventions [39]. These barriers have however been overcome through involvement of local religious leaders who have supported immunization. However, the review also brings out the problems of engaging a large cross-section of the community in a fight against traditional beliefs because beliefs differ from one community to another. Use of leaders in implementing the immunization programs is appropriate but there is need to engage the members of the community to enhance their understanding concerning the immunizations in order to win their support towards the process.

Community engagement has been effective in the past but the strategy can also be costly. The issue is in engaging local authorities as well as sustaining commitment to immunization projects,

particularly where local government systems are fragile or where leaders might have other agendas [40].

Inadequate supply of human resources for health especially in the rural areas of Nigeria has remained a major challenge that has dampened immunization. This is a review of the immunization campaign and evaluates the performance of the health workers who transport vaccines and how they are motivated to work in the rural areas. Monetary incentives, promotion, and working conditions have been found useful in encouraging health care workers to remain in facility remote areas. However, continued training and capacity building is considered necessary to ensure that health workers are well prepared to perform a immunization campaign.

Although ugh rewarding health workers has helped to some extent to enhance vaccine delivery, it still is not enough to solve the underlying issues with the rural health care delivery system in Nigeria. Lack of infrastructure, weak cold chain systems and low health center funding hamper the delivery of effective immunization. Based on the evidence, the enhancement of general health facilities in rural areas and encouraging health staff are essential to achieve sustainable changes in immunization [13].

Another successful approach in an effort to enhance immunization has been a delivery of immunization together with various other health services like MCH services. The integration strategy enables health workers to give vaccines during normal service delivery in antenatal clinics, child welfare clinics, and for family planning. The conclusions drawn from this review are that integrated services have enhanced immunization coverage and this has been especially so in the rural areas which have poor health facility access.

However, the integration approach needs effective collaboration of different health sectors and adequate resources to address new workloads for health personnel. The issue, therefore, is how to avoid overloading already thinly-stretched healthcare organizations while delivering integrated services, especially in rural areas where the problem may be most acute. In addition, integrated services need community support in order to work effectively because mothers are more likely to attend health services that they know or which offer more than one service at a time [37].

CONCLUSION

This review of immunization programs in rural Nigeria has shown the major threats and

challenges that affect the use and coverage of vaccines and the measures that have been taken to control the same. Nevertheless, there are still some challenges, which have not been overcome, and which explain why the immunization coverage is still insufficient and not sustainable and equitable for all the rural regions of Nigeria:

The major challenges identified as logistical, lack of infrastructure, vaccine uptake, and socio-cultural factors remain real challenges. These challenges are compounded by elements, for example, fragile health sector, stability concern in some parts and lack of human health capital especially in the rural areas. In addition, the review shows that mass mobilization campaigns have come a long way in boosting coverage but are not sustainable if not complemented by routine services and backed by a sound health system.

The level of effectiveness of control strategies like mobile vaccination units, community mobilization, and incentives to health workers has been moderate. Mobile teams have been useful in ensuring that hard to reach population is vaccinated while community mobilization especially with the help of local opinion leaders has been key in addressing misconceptions about vaccines and encouraging people to get vaccinated. Another factor that has promoted immunization programs is provision of incentives to healthcare workers and immunization in collaboration with development of other health facilities, but the difficulties are witnessed in coordination of programs, finances and resources.

However, based on the findings of the above interventions, sustainable immunization in rural Nigeria requires a complex solution. Therefore, it may be concluded that immunization programs require enhancement of local health systems, improvement of cold chain, stable supply of vaccines, and socio-cultural approaches through community mobilization. For this reason, every stakeholder such as local governments, traditional leaders, community-based organizations as well as international partners need to be involved in the process of providing an enabling environment for immunization.

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REFERENCES

1. Rodrigues, C. M., & Plotkin, S. A. (2020). Impact of vaccines; health, economic and social perspectives. *Frontiers in microbiology*, *11*, 1526.
2. Obi-Jeff, C., Oguntimehin, F., Adejumo, A., Ibrahim, A., Ade-Banjo, O., Gadzama, D., ... & Onimisi, A. (2024). Strengthening Capacity for Tailored Immunization Programs Using Adult Learning Principles: A Case Study from Nigeria. *Global Health: Science and Practice*, *12*(5).
3. Mohammed, Y., Reynolds, H. W., Waziri, H., Attahiru, A., Mikailu, F., Adewole, A. O., ... & Nguku, P. (2024). Exploring the Landscape of Routine Immunization in Nigeria: A Scoping Review of Barriers and Facilitators.
4. Okesanya, O. J., Olatunji, G., Olaleke, N. O., Mercy, M. O., Ilesanmi, A. O., Kayode, H. H., ... & Lucero-Prisco III, D. E. (2024). Advancing immunization in Africa: overcoming challenges to achieve the 2030 global immunization targets. *Adolescent Health, Medicine and Therapeutics*, *83-91*.
5. Akanpaabadai, E. A., Adiak, A. A., Nukpezah, R. N., Adokiya, M. N., Adjei, S. E., & Boah, M. (2024). Population-based cross-sectional study of factors influencing full vaccination status of children aged 12-23 months in a rural district of the Upper East Region, Ghana. *BMC pediatrics*, *24*(1), 168.
6. Saeed, K. M. I., Naeemi, S., Naser, R., Rasooly, B., Hakim, M. S., Arman, K., & Nishat, H. (2024). Child Immunization Coverage in Urban Settings of Twelve Provinces Plus Kabul, Afghanistan, 2019. *BioMed Research International*, *2024*(1), 5400013.
7. Salako, J., Bakare, D., Uchendu, O. C., Bakare, A. A., Graham, H., & Falade, A. G. (2024). Factors associated with immunization status among children aged 12-59 months in Lagelu local government area, Ibadan: a cross-sectional study. *The Pan African Medical Journal*, *47*.
8. Solomon-Rakiep, T., Olivier, J., & Amponsah-Dacosta, E. (2024). Towards contextualized complex systems approaches to scaling-up hepatitis B birth-dose vaccination in the African region: a qualitative systematic review. *Frontiers in Public Health*, *12*, 1389633.
9. Adeyanju, G. C., & Betsch, C. (2024). Vaccination decision-making among mothers of children 0–12 months old in Nigeria: A qualitative study. *Human Vaccines & Immunotherapeutics*, *20*(1), 2355709.
10. Gidado, S., Musa, M., Ba'aba, A. I., Okeke, L. A., Nguku, P. M., Hassan, I. A., ... & Atkins, S. (2024).

- COVID-19 vaccination intention among internally displaced persons in complex humanitarian emergency context, Northeast Nigeria. *Plos one*, 19(8), e0308139.
11. Ali, V. E., Asika, M. O., Elebesunu, E. E., Agbo, C., & Antwi, M. H. (2024). Cognizance and mitigation of falsified immunization documentation: Analyzing the consequences for public health in Nigeria, with a focus on counterfeited COVID-19 vaccination cards: A case report. *Health Science Reports*, 7(2), e1885.
 12. Zemariam, A. B., Abebe, G. K., Kassa, M. A., Alamaw, A. W., Molla, R. W., Abate, B. B., ... & Fentanew, M. (2024). Immunization coverage and its associated factors among children aged 12–23 months in Ethiopia: An umbrella review of systematic review and meta-analysis studies. *Plos one*, 19(3), e0299384.
 13. Uzochukwu, B. S., Okeke, C., Shuaib, F., Torres-Rueda, S., Vassall, A., Jit, M., ... & Ruiz, F. (2024). A health technology assessment of COVID-19 vaccination for Nigerian decision-makers: Identifying stakeholders and pathways to support evidence uptake. *Health research policy and systems*, 22(1), 73.
 14. Ahmed, L. Q., Adebowale, A. S., & Palamuleni, M. E. (2024). Bayesian spatial analysis of incomplete vaccination among children aged 12–23 months in Nigeria. *Scientific Reports*, 14(1), 18297.
 15. Alrasheedy, A. A., Alharbi, A. T., Alturaifi, H. A., Alkhamis, R. A., Almazyad, R. S., Almozaini, S. S., ... & Meyer, J. C. (2024). Community pharmacists' knowledge, beliefs, and perceived barriers toward vaccination services at community pharmacies: A cross-sectional study from Saudi Arabia. *Human Vaccines & Immunotherapeutics*, 20(1), 2414551.
 16. Barau, A. S., Abubakar, I. R., Kafi, K. M., Olughodi, K. H., & Abubakar, J. I. (2023). Dynamics of negotiated use of public open spaces between children and adults in an African city. *Land Use Policy*, 131, 106705.
 17. Kisanga, A., Stamidis, K. V., Rumbe, S., Lamunu, D., Ben, A., Thomas, G. R., & Berchmans, J. (2024). Leveraging the CORE Group Partners Project polio infrastructure to integrate COVID-19 vaccination and routine immunization in South Sudan. *Global Health: Science and Practice*, 12(Supplement 1).
 18. Wang, C. P., Lin, Y. T., Du, Y. Z., Zhang, T., Wang, Y. Y., Wang, Y. J., ... & Feng, L. Z. (2024). Impact of innovative immunization strategy on PCV13 vaccination coverage among children under 5 years in Weifang city, China: A retrospective study. *Vaccine*, 42(5), 1136-1144.
 19. Dougherty, L., Adediran, M., Akinola, A., Alabi, M., Etim, E. O., Ohioghame, J., & Adedimeji, A. (2024). An evaluation of a multi-partner approach to increase routine immunization coverage in six northern Nigerian States. *BMC Health Services Research*, 24(1), 951.
 20. Noh, D. H., Darwar, R., Uba, B. V., Gab-Deedam, S., Yani, S., Jimoh, A., ... & Ikwe, H. (2024). Cost of COVID-19 vaccine delivery in nine States in Nigeria via the US Government Initiative for Global Vaccine Access. *BMC Health Services Research*, 24(1), 1232.
 21. Vadrevu, L., Jain, M., & Parsekar, S. S. (2024). Analyzing the usage of theories of change for routine immunization programs--a review of impact evaluations from LMICs. *Journal of Health, Population and Nutrition*, 43(1), 141.
 22. Mahachi, K., Kessels, J., Boateng, K., Baptiste, A. E. J., Mitula, P., Ekeman, E., ... & Gabrielli, A. F. (2022). Zero-or missed-dose children in Nigeria: contributing factors and interventions to overcome immunization service delivery challenges. *Vaccine*, 40(37), 5433-5444.
 23. Weir, E., & Hatch, K. (2004). Preventing cold chain failure: vaccine storage and handling. *Canadian Medical Association Journal*, 171(9), 1050.
 24. Westbury, S., Ghosh, I., Jones, H. M., Mensah, D., Samuel, F., Irache, A., ... & Oyeboode, O. (2021). The influence of the urban food environment on diet, nutrition and health outcomes in low-income and middle-income countries: a systematic review. *BMJ Global Health*, 6(10), e006358.
 25. Mohammed, Y., Reynolds, H. W., Waziri, H., Attahiru, A., Mikailu, F., Adewole, A. O., ... & Nguku, P. (2024). Exploring the Landscape of Routine Immunization in Nigeria: A Scoping Review of Barriers and Facilitators.
 26. Naicker, S., Plange-Rhule, J., Tutt, R. C., & Eastwood, J. B. (2009). Shortage of healthcare workers in developing countries—Africa. *Ethnicity & disease*, 19, 60-64.
 27. Džakula, A., Relić, D., & Michelutti, P. (2022). Health workforce shortage—doing the right things or doing things right?. *Croatian medical journal*, 63(2), 107-109.
 28. Sallam, M., Kareem, N., & Alkurtas, M. (2024). The negative impact of misinformation and vaccine conspiracy on COVID-19 vaccine uptake and attitudes among the general public in Iraq. *Preventive Medicine Reports*, 102791.
 29. Bianchi, F. P., & Tafuri, S. (2023). Spreading of misinformation on mass media and digital platforms regarding vaccines. A systematic scoping review on stakeholders, policymakers, and sentiments/behavior of Italian consumers. *Human Vaccines & Immunotherapeutics*, 19(2), 2259398.
 30. Ruijs, W. L., Hautvast, J. L., Kerrar, S., Van der Velden, K., & Hulscher, M. E. (2013). The role of religious leaders in promoting acceptance of

- vaccination within a minority group: a qualitative study. *BMC public health*, 13, 1-8.
31. Syed, U., Kapera, O., Chandrasekhar, A., Baylor, B. T., Hassan, A., Magalhães, M., ... & Bhatti, A. (2023). The role of faith-based organizations in improving vaccination confidence & addressing vaccination disparities to help improve vaccine uptake: a systematic review. *Vaccines*, 11(2), 449.
 32. Tracey, G., Olivia, B., Jean, M., Megan, H., & Sagri, S. (2024). Why does gender matter for immunization?. *Vaccine*, 42, S91-S97.
 33. Wetherill, O., Lee, C. W., & Dietz, V. (2017). Root causes of poor immunisation data quality and proven interventions: a systematic literature review. *Annals of infectious disease and epidemiology*, 2(1), 1.
 34. Saidu, Y., Gu, J., Ngenge, B. M., Nchinjoh, S. C., Adidja, A., Nnang, N. E., ... & Clemens, R. (2023). Assessment of immunization data management practices in Cameroon: unveiling potential barriers to immunization data quality. *BMC Health Services Research*, 23(1), 1033.
 35. Igbokwe, U., Ibrahim, R., Aina, M., Umar, M., Salihu, M., Omoregie, E., ... & Aigbogun Jr, E. (2024). Evaluating the implementation of the National Primary Health Care Development Agency (NPHCDA) gateway for the Basic Healthcare Provision Fund (BHC PF) across six Northern states in Nigeria. *BMC Health Services Research*, 24(1), 1404.
 36. Lambo, K., Prescott, M., Wiwa, O., Asolo, J. A., & Daradara, K. (2024). Minimizing Vaccine Wastage in Nigeria: A National Assessment of Vaccine Wastage Rates and Potential Determinants. *Vaccines*, 12(8), 900.
 37. Rachlin, A., Adegoke, O. J., Sikare, E., Adeoye, O. B., Dago, E., Adeyelu, A., ... & Bolu, O. (2023). Lessons learned from early implementation of the Growing Expertise in E-health Knowledge and Skills (GEEKS) program in Nigeria, 2019-2021. *Pan African Medical Journal*, 46(1).
 38. Aminu, T., Otokpen, O., Mmirikwe, I., Adetunde, O., Ajuwon, I., Adelakun, A., ... & Aina, M. (2023). Improving program outcomes through responsive feedback: a case study of a leadership development academy in Nigeria. *Global Health: Science and Practice*, 11(Supplement 2).
 39. Eze, P., Agu, U. J., Aniebo, C. L., Agu, S. A., Lawani, L. O., & Acharya, Y. (2021). Factors associated with incomplete immunisation in children aged 12–23 months at subnational level, Nigeria: a cross-sectional study. *BMJ open*, 11(6), e047445.
 40. Abad, N., Uba, B. V., Patel, P., Barau, D. N., Ugochukwu, O., Aliyu, N., ... & Bolu, O. (2021). A rapid qualitative assessment of barriers associated with demand and uptake of health facility-based childhood immunizations and recommendations to improve immunization service delivery in Sokoto State, Northwest Nigeria, 2017. *The Pan African Medical Journal*, 40(Suppl 1).