

Unlocking the Future: Predicting Malaria Vaccine Uptake and Likely Barriers in Nigeria

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Abstract

Malaria vaccination was identified as a major effort to curb the Africa's challenge of death amongst children under 5. As malaria vaccines are yet to be distributed in Nigeria, there is a debate on their acceptability, accessibility, and barriers to receiving them. This study was conducted to assess the uptake of the malaria vaccination, and its determinants among internet users in Nigeria. An online survey was conducted between July and August 2023 using a semi-structured questionnaire. It was set up using kobotoolbox forms and data were collected online. Data collected were analyzed using GNU PSPP. A total of 399 respondents participated in the study, with a mean age of 43.52 years (± 10.90). The majority of the respondents were young adults. The majority of our respondents (72.9%) have heard of the malaria vaccine while the majority said they would take the malaria vaccine if available (85.2%). The major source of information on the malaria vaccine was the internet (55.4%), health workers (51.9%), and media (Radio/Television/Posters/Billboards/Pamphlets) (44.9%). Malaria vaccination uptake had a significant positive association with the level of education and level of monthly income ($p < 0.05$ respectively). Lack of availability, information, knowledge, awareness, cost of a malaria vaccine, the long distance to get to vaccination centers were the leading barriers to vaccine uptake. This calls for key stakeholders to ensure that malaria vaccination sensitization is championed immediately in Nigeria and discouragement of the spread of conspiracy theories to eliminate the infodemic associated factors will reduce vaccine hesitancy and thereby increase malaria vaccination uptake in Nigeria.

Keywords: Barriers, Determinant, Malaria, Malaria vaccine, Uptake, Vaccine.

Introduction

Multiple *Plasmodium* species cause malaria, including *P. falciparum*, which is prevalent in Africa, and *P. vivax*, prevalent in some areas of Asia and Latin America. *P. vivax* is one of the two known *Plasmodium* species that can be found in the liver, springing up periodically to

cause illness after a very long time from the infectious mosquito bite.

The World Health Organization (WHO) reported that in 2018, *P. falciparum* accounted for 99.7% of estimated malaria cases in the WHO African Region 50% of cases in the WHO South-East Asia Region, 71% of cases in the Eastern Mediterranean, and 65% in the Western

Pacific [1]. The most vulnerable group affected by malaria are children aged under 5 years; in 2019, 67% (274 000) of all malaria deaths in the whole world were related to children under 5 years old [1]. There are interventions like antimalarial drugs, bed nets and insecticides that have helped to mitigate the burden of malaria in the past decade, even though malaria remains a leading cause of morbidity and mortality in children below the age of 5 years [2]. According to WHO, vaccination is a simple, safe, and effective way of protecting people against harmful diseases before they contact with the disease. The vaccine makes use of an individual's body's natural defenses to build resistance to specific infections and enables the immune system stronger [3]. The duty of a vaccine is to train the immune system to create antibodies, just as it does when it's exposed to disease [3].

According to the University of Oxford news, 229 million cases of clinical malaria were reported in 2019, and the World Health Organization (WHO) estimates that malaria

causes over 400,000 deaths each year globally [4]. Most deaths are amongst children in Africa where very high transmission rates are found in many countries [4]. Previous studies in sub-Saharan Africa have found that malaria is seen as a major public health problem [5].

In an interview, Gareth Jenkins, Director of Advocacy, Malaria No More UK, said that 'An effective and safe malaria vaccine would be a hugely significant extra weapon in the armory needed to defeat malaria, which still kills over 270,000 children every year [4]. For several decades, British scientists have been at the forefront of developing new ways to detect, diagnose, test, and treat malaria, and we must continue to back them. Gareth Jenkins also said that 'A world without malaria is a world safer both for the children who would otherwise be killed by this disease and for us here at home. He also said that countries freed from the malaria burden will be much better equipped to fight off new disease threats when they inevitably emerge in the future. [4]



Figure 1. A Picture of Malaria Vaccine

Success Stories

The malaria vaccine has a very high-level vaccine efficacy of 77% in African children, Scientists have achieved and surpassed the WHO-specified efficacy goal of 75% [6]. Malaria Vaccine was monitored and evaluated in

450 children which showed an adequate safety profile and was well-tolerated without any side effects. In terms of logistics, demand and supply, the malaria vaccine researchers at the University of Oxford found that the Malaria vaccine candidate, R21/Matrix-M, has excellent potential for large-scale manufacturing, low-cost

supply and demonstrated high-level efficacy of 77% over 12-months of follow-up [4]. **GAVI, the Vaccine Alliance**, announced its intentions in December 2021 to help fund the rollout of the vaccine in sub-Saharan Africa. Others in the global health community, including **GlaxoSmithKline (GSK), PATH, and UNICEF**, have also stepped in to boost production of the vaccine.

In their findings (*posted on SSRN/Preprints with The Lancet*) University of Oxford discovered that they were the first to meet the World Health Organization's Malaria Vaccine Technology Roadmap goal of a vaccine with at least 75% efficacy [4].

The researchers reported (*in findings in press with The Lancet*) from a Phase IIb randomized, controlled, double-blind trial conducted at the Clinical Research Unit of Nanoro (CRUN) / Institut de Recherche en Sciences de la Santé (IRSS), Burkina Faso that 450 participants, aged 5-17 months, were recruited from the catchment area of Nanoro, covering 24 villages and an approximate population of 65,000 people [4]. The participants were split into three groups, with the first two groups receiving the R21/Matrix-M (with either a low dose or high dose of the Matrix-M adjuvant) and the third, a rabies vaccine as the control group. Doses were administered from early May 2019 to early August 2019, largely prior to the peak malaria season [4]. The researchers reported that there is a vaccine efficacy of 77% in the higher-dose adjuvant group, and 71% in the lower dose adjuvant group, over 12 months of follow-up, with no serious adverse effects as a result of the malaria vaccine uptake [4].

Following these results, the Phase IIb trial, which was funded by the EDCTP2 programme supported by the European Union (grant number RIA2016V-1649-MMVC), was extended with a booster vaccination administered before the next malaria season one year later [4].

Halidou Tinto, Professor in Parasitology, Regional Director of IRSS in Nanoro, and the trial Principal Investigator said: The researchers,

in collaboration with Serum Institute of India Private Ltd., and Novavax Inc., started recruitment for a Phase III licensure trial to assess large-scale safety and efficacy in 4,800 children, aged 5-36 months, across four African countries which turned out to be successful again [4].

Adrian Hill, Director of the Jenner Institute and Lakshmi Mittal and Family Professor of Vaccinology at the University of Oxford, and co-author of the paper, said 'These new results support our high expectations for the potential of this vaccine, which we believe is the first to reach the WHO's goal of a vaccine for malaria with at least 75% efficacy' [4]. Adrian Hill said that 'with the commitment by their commercial partner, the Serum Institute of India, to manufacture at least 200 million doses annually in the coming years, the vaccine has the potential to have major public health impact if licensure is achieved [4].

Lynsey Bilsland, from Wellcome, which helped fund the research, said 'Despite global efforts against malaria, too many lives are still lost to this disease, especially babies and young children. Vaccines would change this. This is an extremely promising result showing the high efficacy of a safe, low-cost, scalable vaccine designed to reach the huge numbers of children who are most at risk of the devastating impact of Malaria [4]. Whilst further studies are required, this marks a significant and exciting step forward on a critical global health challenge [4].

Professor Charlemagne Ouédraogo, Minister of Health, in Burkina Faso said that 'Malaria is one of the leading causes of childhood mortality in Africa [4]. Burkinabes have been supporting trials of a range of new vaccine candidates in Burkina Faso and these new data show that licensure of a very useful new malaria vaccine could well happen in the coming years [4]. This would be an extremely important new tool for controlling malaria and saving many lives [4].

Dr. Cyrus Poonawalla and Mr. Adar Poonawalla, Chairman and CEO of the Serum Institute of India said that 'They were highly

excited to see these results on a safe and highly effective malaria vaccine which will be available to the whole world through an excellent collaborative effort between Serum Institute, the University of Oxford and Novavax Inc. Serum Institute is committed to global disease burden reduction and disease elimination strategies by providing high volume, affordable vaccines. We are highly confident that we will be able to deliver more than 200 million doses annually in line with the above strategy as soon as regulatory approvals are available [4].

Dr Michael Makanga, EDCTP Executive Director, congratulated the Multi-stage Malaria Vaccine Consortium on these highly promising results from the Burkina Faso trial of R21 [4]. This study represents a key advance in the clinical development of the R21 malaria vaccine towards licensure, and an important step closer to malaria control and elimination [4].

Literature Review

The World Health Organization on Wednesday October 6th, 2021, endorsed the first-ever vaccine to prevent malaria, debuting a tool that could save the lives of tens of thousands of children in Africa each year [7].

The World Health Organization (WHO) has recommended a widespread use of the RTS, S/AS01 (RTS,S) malaria vaccine among children in sub-Saharan Africa and in other regions with moderate to high *P. falciparum* malaria transmission. The recommendation was based on results from a pilot programme in Ghana, Kenya and Malawi that has reached more than 900 000 children since 2019 [7].

The WHO Director-General Dr Tedros Adhanom Ghebreyesus said that this was a historic moment. The long-awaited malaria vaccine for children is a breakthrough for science, child health and malaria control [7]. The WHO Director emphasized that using this vaccine on top of existing tools to prevent malaria could save tens of thousands of young lives each year because Malaria remains a primary cause of childhood illness and death in

sub-Saharan Africa [7]. More than 260 000 African children under the age of five die from malaria annually. In recent years, WHO and its partners have been reporting a stagnation in progress against the deadly disease [7].

Dr Matshidiso Moeti, WHO Regional Director for Africa said that for centuries, malaria has stalked sub-Saharan Africa, causing immense personal suffering, Africans have long hoped for an effective malaria vaccine and now for the first time ever, we have such a vaccine recommended for widespread use [7]. Today's recommendation offers a glimmer of hope for the continent which shoulders the heaviest burden of the disease, and we expect many more African children to be protected from malaria and grow into healthy adults [7].

WHO Recommendation for the RTS,S Malaria Vaccine

Based on the advice of two WHO global advisory bodies, one for immunization and the other for malaria, WHO recommends that in the context of comprehensive malaria control the RTS, S/AS01 malaria vaccine be used for the prevention of *P. falciparum* malaria in children living in regions with moderate to high transmission as defined by WHO. RTS,S/AS01 malaria vaccine should be provided in a schedule of 4 doses in children from 5 months of age for the reduction of malaria disease and burden [7]. The Malaria Vaccine Implementation Programme (MVIP) coordinates the routine implementation of the RTS,S vaccine pilot in strategically selected locations in Malawi, Kenya, and Ghana [8].

Across the 3 countries, challenges around the dosing schedule were similar, as were some of the interventions put in place to tackle them [9]. Countries will need plans to ensure all children receive 4 doses of the vaccine. The most effective scheduling decisions and interventions are country specific [9].

Key findings of the pilots informed the recommendation based on data and insights generated from two years of vaccination in child

health clinics in the three pilot countries, implemented under the leadership of the Ministries of Health of Ghana, Kenya and Malawi. Findings include:

Feasible to Deliver

1. Vaccine introduction is feasible, it would improve health and save lives, with good and equitable coverage of RTS,S seen through routine immunization systems. This was seen during COVID-19 pandemic [4].
2. **Reaching the unreached:** RTS,S will increase equity in access to malaria prevention.
 - a. Data from the pilot programme showed that more than two-thirds of children in the 3 countries who were not sleeping under a bednet were benefitting from the RTS,S vaccine [4].
 - b. Which means that over 90% of children would benefit from at least one preventive intervention (insecticide treated bednets or the malaria vaccine) [4].
3. **Strong safety profile:** As of August 2021, more than 2.3 million doses of the vaccine have been administered in 3 African countries – the vaccine has a favorable safety profile [4].
4. **No negative impact on uptake of bednets, other childhood vaccinations, or health seeking behavior for febrile illness.** In areas where the vaccine has been introduced, there has been no decrease in the use of insecticide-treated nets, uptake of other childhood vaccinations or health seeking behavior for febrile illness [4].
5. **High impact in real-life childhood vaccination settings:** Significant reduction (30%) in deadly severe malaria, even when introduced in areas where insecticide-treated nets are widely used and there is good access to diagnosis and treatment [4].
6. **Highly cost-effective:** Modelling estimates that the vaccine is cost effective in areas of moderate to high malaria transmission [4].

Next steps for the WHO-recommended malaria vaccine were country decision-making on whether to adopt the vaccine as part of national malaria control strategies [4]. According to a research findings, after Malaria Vaccine Pilot Implementation Project, the most influential driving forces of Ghana's decision for nationwide scale-up of the RTS,S/AS01E malaria vaccine were the malaria disease burden and the efficacy/effectiveness of the vaccine [2] while the potential barriers to the scale-up of the RTS,S/AS01E malaria vaccine were the logistics for the nationwide delivery of the vaccine and funding [2].

A previous study stated that there were several challenges needed to be addressed to ensure the success of vaccination programs, this includes the acceptability perspective, issues such as inadequate community engagement, concerns about side effects, and issues with the delivery and quality of healthcare services can affect the acceptance of the vaccine [10]. From the feasibility standpoint, factors such as lack of transportation or long distances to healthcare facilities and the perception of completion of the vaccination calendar can affect the feasibility of the vaccine, finally the availability of the vaccine is also a major concern as it may not be readily available to meet the demands of the population [10].

A study recommended that given the negative impact of lack of awareness and knowledge, misinformation and conspiracy theories on immunization programs, public health campaigns preceding the population-wide roll-out of the novel malaria vaccine should target the less-educated, and those residing in more rural areas, while assuring equitable them of access to the malaria vaccine across sub-Saharan Africa [11].

Research Questions for this Study

As vaccines are yet to be distributed in Nigeria, there is a debate on their acceptability, accessibility, and barriers to receiving them. Are Nigerians ready to accept Malaria Vaccines in

the future? Should the sensitization start now or when the malaria vaccine has been approved for public consumption?

Assumptions

The assumption in this study is that there is the probability of low malaria vaccination uptake, lack of knowledge, and cost that leads to increased self-medication with malaria drugs. However, due to the high infodemic about malaria vaccine, lack of time to visit the hospital, and often personal beliefs, and the fear of going to the hospital after-effects like contracting diseases, people usually regard WHO's clinical assessment and new vaccines as a voluntary rather than compulsive measure.

Hypothesis

Lack of knowledge, awareness of the effectiveness of malaria vaccine and high cost gives rise to low uptake of malaria vaccine, and there may be other multiple factors or significant determinants that are difficult to measure and quantify, which determine uptake of malaria vaccine.

AIM: Our study aims to find out the attitude, knowledge, and infodemic of malaria vaccine and if malaria vaccine uptake would be accepted in Nigeria.

Specific Objectives

1. To examine the level of knowledge of malaria vaccine.
2. To find out the frequency of malaria vaccine uptake.
3. To assess the barriers that cause low malaria vaccine uptake.
4. To examine the association of socio-cultural factors with malaria vaccine uptake.

Methodology

Study Design

A descriptive cross-sectional study was carried out to assess the knowledge of malaria, malaria vaccine and malaria vaccination uptake

among parents/childcare givers in Nigeria (online population based).

Description of Study Area

Nigeria is officially called the Federal Republic of Nigeria, it is a country in the southeast of West Africa, with a coast at the Bight of Benin and the Gulf of Guinea. Nigeria is surrounded by Benin, Cameroon, Chad, and Niger, it shares maritime borders with Equatorial Guinea, Ghana, and São Tomé and Príncipe [12].

With an area of 923,768 km² the country is almost four times the size of the UK or slightly more than twice the size of the U.S. state California. Nigeria's main rivers are the Niger, where it got its name from, and the Benue, the main tributary of the Niger. The country's highest point is *Chappal Waddi* (or Gangirwal) with 2,419 m (7,936 ft.), located in the Adamawa mountains in the Gashaka-Gumti National Park, Taraba State, on the border with Cameroon [13]. Nigeria has a population of 224, 777, 259 million population [13], making it the seventh most populous country in the world. The capital city is Abuja, located in the center of the nation, while Lagos is the country's primary port, economic hub and largest city. Spoken languages are English (official), Hausa, and Igbo, it is estimated that Nigeria has about 250 different ethnolinguistic groups. Islam (41%) and Christianity (58%) are the country's major religions.

Selection of the Study Area

The study area was parents/childcare givers/Guardians who vaccinate their children and live in Nigeria (online population-based).

Sample Size Determination

The Cochran formula is [14] - The sample size was determined to have a 95% confidence limit of 5% maximum error of the estimate when the probability is 46.93% of mothers agreed to give their children COVID-19 vaccines if available [15]. This leads to a requirement of 383 residents in Nigeria. After cleaning the data collected 399 participants filled the Kobo

toolbox questionnaires for the study in the aforementioned period (July – August 2023) through convenience sampling.

Sampling Technique

Convenience sampling was used for this research which is a type of nonprobability sampling in which people are sampled simply because they are “convenient” sources of data for researchers. A convenience sample is a type of non-probability sampling method where the sample is taken from a group of people easy to contact or to reach because we used an online survey questionnaire.

Data Collection

A questionnaire (mixed method: quantitative and qualitative) was developed for this study based on the previous research questions related to malaria and malaria vaccination. A pilot study was carried out for 20 residents with children in Nigeria and necessary modifications were carried out. The questionnaire contained four sections. The first was the demographic section, which contains questions regarding age, gender, marital status, educational level, household income, employment status and health insurance. The second section was on Knowledge of malaria vaccination and likely barriers connected to malaria vaccination uptake.

The principal investigator explained the study to the participants while sharing the questionnaire online, including the conditions for participating, as well as privacy and confidentiality for data collection. Although the study was free from any serious ethical issues, the researcher designed a participant’s information sheet that explained the voluntary nature of the study in detail, and the anonymity and confidentiality in the study.

Data Analysis

511 participated via koboboxtool questionnaire, 12 submitted empty forms and

100 didn’t complete all questions, we needed 383 participants, and we got $n = 399$ after cleaning up the data. The outcome of interest was to find out about their awareness of the malaria vaccine. This was categorized into two options: Yes or No. The question asked in the survey was: “Have you heard about the malaria vaccine?” Data collected were analyzed using GNU PSPP. Descriptive data analysis was first done to summarize the data. Secondly, the relationship between lack of knowledge, awareness of the effectiveness of malaria vaccine, high cost, side effects, lack of trust, distance to the health facility, the attitude of hospital staff, and lack of health insurance and uptake of the malaria vaccine was investigated using a linear regression model. The level of significance (alpha) was set to 0.05.

Ethical Considerations

Ethical approval was obtained from the Research and Ethics Committee of Lagos University Teaching Hospital before the commencement of the study. Participation was voluntary, all the participants were required to provide written informed consent and they were assured of confidentiality regarding information collected from them.

Results

This section presents the major findings from the study. The results are divided into two subsections, namely: Socio-demographic characteristics of respondents, knowledge of malaria vaccination and likely barriers connected to malaria vaccination uptake.

Section A: Socio-Demographic Data

The mean, modal ages, and standard deviation of respondents were 43.52 years, 39 years old, and 10.90. The youngest respondent was 18 years old, and the oldest respondent was 72 years old, and the range was 54 years old.

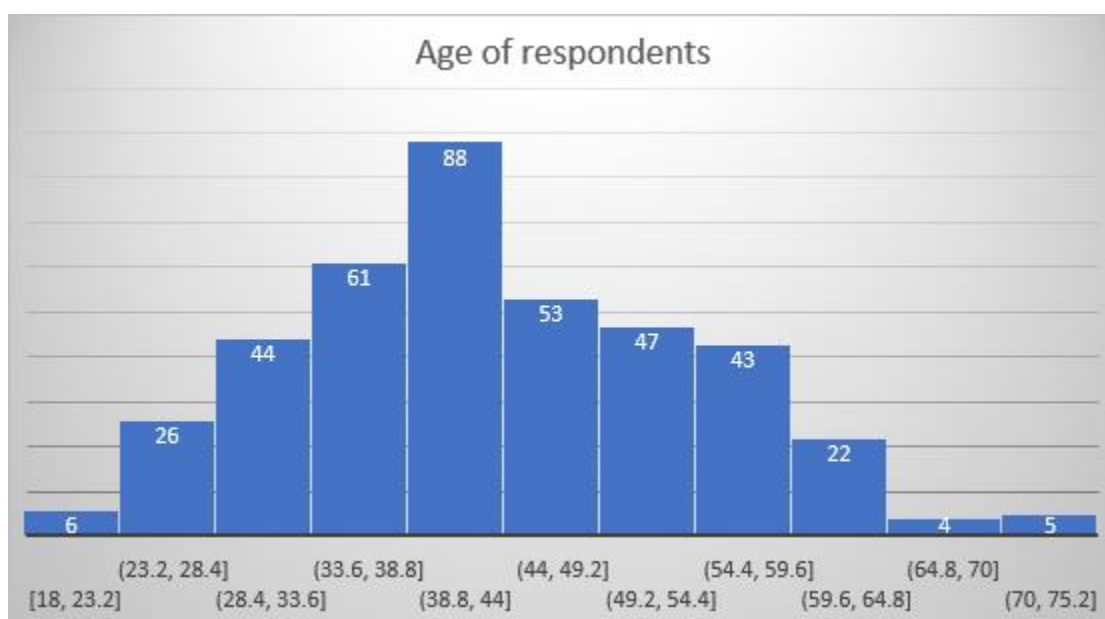


Figure 2. Socio-Demographic Data

Table 1. Socio-demographic Characteristics of Respondents

| Characteristics | Frequency n = 399 | Percentage (%) |
|--------------------------|-------------------|----------------|
| Sex of respondent | | |
| Male | 189 | 47.4 |
| Female | 210 | 52.6 |
| Marital Status | | |
| Single | 81 | 20.3 |
| Married | 310 | 77.7 |
| Divorced | 4 | 1.0 |
| Separated | 4 | 1.0 |
| Education | | |
| No formal education | 0 | 0 |
| Primary | 0 | 0 |
| Secondary | 3 | 0.8 |
| Tertiary | 396 | 99.2 |
| Religion | | |
| Christian | 350 | 87.7 |
| Islam | 47 | 11.8 |
| Others | 2 | 0.5 |
| Employment Status | | |
| Employed | 268 | 67.2 |
| Unemployed | 19 | 4.8 |
| Self employed | 112 | 28.1 |
| Income | | |
| <50,000 Naira | 35 | 8.8 |
| 50,000 – 99,999 | 63 | 15.8 |
| 100,000 – 150,000 | 38 | 9.5 |

| | | |
|--------------------------------|-----|------|
| >150,000 | 263 | 65.9 |
| Health Insurance status | | |
| Yes | 210 | 52.6 |
| No | 189 | 47.4 |

Respondents that are females were 52.6%, and 47.4% were males. The majority of our respondents were married (77.7%) while 20.3% were single, 1% were divorced and separated, respectively. Most parents/guardians were Christians (87.7%), Muslims were 11.80%. Almost all our respondents interviewed had tertiary education (99.2%), while 0.8% had secondary education. 1.24%. The majority of our respondents were employed (67.2%), about 28.1% of our respondents were Self - employed and 4.8% of our respondents were unemployed. It was interesting to discover that 65.9% of our respondents earn above 150,000 Naira monthly, 15.8% earn between 50,000 naira, and 99,999 naira monthly, 9.5% earn between 100,000 – 150,000 naira monthly, and 8.8% earn below 50,000 Naira monthly respectively. More than half of respondents (52.6%) have health

insurance, while only 47.4% of respondents do not have health insurance.

Section B: Knowledge of Malaria Vaccination and likely Barriers Connected to Malaria Vaccination Uptake

Majority of our respondents (72.9%) have heard of malaria vaccine. The major source of information on malaria vaccine were internet (55.4%), health worker (51.9%), and media (Radio/Television/Posters/Billboards/Pamphlets) (44.9%). The trusted people that give the right health information according to our respondents were health workers (77.7%). More than half of our respondents (75.4%) said that malaria vaccine protects the receiver from getting malaria and 92.5% said that malaria vaccine protects other people who do not receive the vaccine.

Table 2. Knowledge of Malaria Vaccine and likely Barriers Connected to Malaria Vaccination Uptake

| Characteristics | Frequency n = 399 | Percentage (%) |
|---|--------------------------|-----------------------|
| Have you heard of malaria vaccination? | | |
| Yes | 291 | 72.9 |
| No | 108 | 27.1 |
| What are your major sources of information on Malaria vaccine? | | |
| Health worker | 207 | 51.9 |
| Family/friends | 38 | 9.5 |
| Media (Radio/Television/Posters/Billboard/Pamphlets) | 179 | 44.9 |
| Newspaper | 26 | 6.5 |
| Internet | 221 | 55.4 |
| Religious places | 5 | 1.3 |
| Who do you trust to give you right health information? | | |
| Health worker | 310 | 77.7 |
| Family/friends | 7 | 1.8 |
| Media (Radio/Television/Posters/Billboard/Pamphlets) | 22 | 5.5 |
| Newspaper | 1 | 0.3 |
| Internet | 40 | 10.00 |
| Religious places | 2 | 0.5 |
| Government official | 17 | 4.3 |

| Does Malaria vaccine protect the receiver from getting Malaria? | | |
|---|-----|------|
| Yes | 301 | 75.4 |
| No | 98 | 24.6 |
| Does malaria vaccination protect other people who do not receive vaccine? | | |
| Yes | 369 | 92.5 |
| No | 30 | 7.5 |
| If malaria vaccination is available, will you take it? | | |
| Yes | 340 | 85.2 |
| No | 59 | 14.8 |
| Are there likely barriers connected to malaria vaccination uptake? | | |
| Yes | 252 | 63.2 |
| No | 147 | 36.8 |
| Apart from the qualitative reason you gave, could these be other reasons? (Multiple answers) | | |
| Cost of Malaria Vaccine | 207 | 51.9 |
| Side effects | 176 | 44.1 |
| Distance to health facility | 116 | 29.1 |
| Lack of trust | 151 | 37.8 |
| Attitude of health workers | 98 | 24.6 |
| No health insurance | 75 | 18.8 |
| Spiritual reasons | 59 | 14.8 |
| Malaria vaccine is not important | 20 | 5.0 |
| Lack of knowledge | 170 | 42.6 |
| Superstitious beliefs | 79 | 19.8 |
| No time to go to health facility | 46 | 11.5 |
| My Husband won't approve of it | 23 | 5.8 |
| My Wife won't approve of it | 13 | 3.3 |
| My in – laws won't approve of it | 11 | 2.8 |

Most of our participants (85.2%) are willing to take the malaria vaccine if available, 63.2% stated that there are likely barriers connected to malaria vaccination uptake like Cost (51.9%), side effects (44.1%), lack of knowledge (42.6%), lack of trust (37.8%), distance to health facility (29.1%) and attitude of health workers (24.6%).

The Reasons for Likely Barriers Connected to Malaria Vaccination Uptake were (Qualitative)

1. Availability, Cost of the malaria vaccine and easy accessibility to malaria vaccine because protocols of National Health Insurance Scheme (NHIS) is cumbersome.
2. Lack of information about the malaria vaccine, Inadequate information on the side

effects, Inadequate knowledge about the malaria vaccine, lack of awareness, illiteracy, media, and publicity, not aware where to take the malaria vaccine.

3. Fear of injection/needle phobia, fear of the unknown, multiple dosing, pungent smell of the malaria vaccine.
4. Beliefs: religious background, tradition, cultural beliefs, religious beliefs, tribalism, ignorance, and beliefs.
5. Lack of community and public acceptance of malaria vaccine, community Pharmacists would not want a permanent solution to malaria, Skepticism, varying options on the use of malaria vaccine, inadequate awareness, and lack of sensitization.

6. Lack of trust in vaccination, concern over its efficacy considering how long it has taken to develop malaria vaccine, makers of malaria drugs, level of education, government policies/corruption, experience with previous vaccination.
7. Conspiracy theory is likely to emerge and propaganda, misconception and Disinformation, Suspicion on the vaccine coming from the western countries, perception of target users, rumours of infertility and outcome of COVID – 19 vaccinations, vaccine hesitancy as with other vaccines is a thing commonly fueled by fear of side effects.
8. Distance to health facility, Lack of transportation to remote areas, Access to remote areas or IDP camps and insecurity issues and location, malaria vaccine has not been made publicly available especially in my family's health Centre facility, access to rural areas.
9. Other health challenges and bottle necks, malaria is seen as not severe as other illnesses, the authenticity of the vaccine, individual's health condition and proper storage due to power failure in Nigeria.

Discussion

As vaccines are yet to be distributed in Nigeria, there is a debate on their acceptability, accessibility, and barriers to receiving them. From our study, we found that Nigerians are aware of Malaria Vaccines even though we found some likely barriers. Our study investigated the demographic factors, including age, gender, residence, and education status, relative to the awareness of the malaria vaccine.

From the demographics study showed that there was a greater number of young adults that responded to the forecast on malaria vaccine uptake. There was a slightly symmetrical distribution of gender respondents which was almost like findings obtained from a vaccine study that showed a slightly greater proportion of the female respondent [16]. The majority of

the respondents interviewed and educated was about 99.2% while 0.8% had secondary education. Our study found out that most of our respondents with health insurance accounted for was 52.6% which is a little higher than non-health insurance holders unlike a similar study [17] where respondents with health insurance accounted for were about two times higher than non-health insurance holders.

Majority of our respondents (72.9%) have heard of malaria vaccine which is like another malaria vaccine research conducted earlier in Nigeria [18]. The major source of information on malaria vaccine were internet (55.4%), health worker (51.9%), and media (Radio/Television/Posters/Billboards/Pamphlets) (44.9%), therefore we need to leverage on these medium and start sensitization in both rural and urban areas in Nigeria. The trusted people that give the right health information according to our respondents were health workers (77.7%), there is an urgent need to ensure that all health workers and public health experts are trained ahead of time to help increase malaria vaccination uptake in future. It is worthy to note that some patients call their health care providers on the phone or use telemedicine which has come to stay [16]. More than half of our respondents (75.4%) said that malaria vaccine protects the receiver from getting malaria and this means that their major source of information is giving them the right information which should be leveraged upon, however 92.5% said that malaria vaccine protects other people who do not receive the vaccine which is wrong because malaria is not an infectious disease like COVID – 19 but a deadly vector borne disease. Most of our respondents (85.2%) are willing to take the malaria vaccine if available, while in a similar study carried out in a remote Nigerian community, the malaria vaccination acceptance rate was found to be 91.6% [18]. Therefore, sensitization should start now and continued even when the malaria vaccine has been deployed for public consumption in Nigeria. However, due to the high infodemic about

malaria vaccine, lack of time to visit the hospital, and often personal beliefs, and the fear of going to the hospital, people usually regard WHO's clinical assessment and new vaccines as a voluntary rather than compulsive measure. 63.2% stated that there are likely barriers connected to malaria vaccination uptake like Cost (51.9%), side effects (44.1%), lack of knowledge (42.6%), lack of trust (37.8%), distance to health facility (29.1%) and attitude of health workers (24.6%), which is similar to Hassan et al's findings. The vaccine's ease of administration and low cost can help increase demand and uptake of malaria vaccine in low and middle-income countries like Nigeria, where malaria is a major public health concern [19] [20]. Malaria was seen as not severe as other illnesses by our respondents which is contradicting previous studies in sub-Saharan Africa because malaria is seen as a major public health problem.

Febir et al stated that a major important aspect to consider when addressing vaccine acceptance in sub-Saharan Africa is cultural and religious beliefs. Studies have shown that some communities in Africa may have specific cultural or religious beliefs that may affect their willingness to accept vaccination [21]. For example, some communities may view vaccination as a violation of their traditional beliefs or as a form of Western intervention [22]. Hassan et al recommended that it is very important for healthcare providers and researchers to engage with these communities, understand their specific cultural and religious beliefs, and address any concerns they may have [10]. This could be done by involving community gatekeepers like local leaders, religious leaders, traditional healers and Traditional Birth Attendants in the implementation of vaccination programs [10]. Additionally, addressing vaccine hesitancy among healthcare providers, especially Pharmacists (who may run out of business as a result decrease in demand for malaria drugs) will help to increase vaccine acceptance in the region. Previous studies discovered that some

healthcare providers may have misconceptions or concerns about vaccines which can hinder their ability to effectively communicate the benefits of vaccination to their patients [23]. Therefore, addressing these concerns through education and training programs can help increase the confidence of healthcare providers in the safety and efficacy of vaccines and improve their ability to persuade patients to accept vaccination. While the overall acceptance of malaria vaccines in sub-Saharan Africa is high, there are still various challenges and barriers that need to be addressed to ensure the success of vaccination programs in the region [10]. Arora et al recommended a multifaceted approach that includes effective community engagement, addressing concerns about side effects, improving the delivery and quality of healthcare services, as well as cultural and religious considerations, and addressing vaccine hesitancy among healthcare providers is needed to ensure that the benefits of vaccination reach everyone in need [24].

The malaria vaccine has been piloted successfully in Ghana [26]. Fran Bodine found that the 15% of parents who said they might get their child vaccinated but need more information is understandable considering most were unaware of the vaccine prior to the survey. The information they are most interested in is whether the vaccine is safe (58%), followed by if it will help if they already have bed nets (26%) [25]. Adjei et al stated that intensive advocacy; community engagement, and social mobilization; and regular onsite supportive supervision are critical enablers for the successful introduction of new vaccines [26]. Their study discovered that stakeholders were convinced of the feasibility of a nationwide scale up using a phased subnational approach taking into consideration malaria epidemiology and global availability of vaccines [26].

We are therefore accepting our hypothesis that lack of knowledge and awareness of effectiveness of malaria vaccine $p < 0.05$ and high cost gives rise to low uptake of malaria

vaccine and there are other multiple factors or significant determinants side effects, lack of trust, distance to health facility, the attitude of hospital staff and lack of health insurance, which determine uptake of malaria vaccine.

Recommendation

1. The Public should ensure that they sleep under insecticide treated mosquito nets especially children and pregnant women.
2. All health workers and public health experts should be trained ahead of time to help increase malaria vaccination uptake in future.
3. We recommend the use of media (television, radio, newspaper, magazine, billboards, Facebook, Twitter, Instagram, LinkedIn, Telegram, Tik Tok, Threads, Whatsapp etc.) to encourage the masses to give their children and themselves malaria vaccine.
4. Leaders at all levels should be involved in public health education based on story telling for positive change and the discouragement of the spread of conspiracy theories to eliminate the infodemic associated factors will reduce vaccine hesitancy and thereby increase malaria vaccination uptake in Nigeria.

Conclusion

Nigerians are ready to accept Malaria Vaccines in the future. However, lack of availability, information, knowledge, awareness, cost of malaria vaccine, the long distance to get to vaccination centers were the leading barriers to vaccine uptake. Conspiracy theory is likely to emerge and propaganda, misconception and Disinformation, Suspicion on the vaccine

coming from the western countries, perception of target users, rumours of infertility and outcome of COVID – 19 vaccinations, vaccine hesitancy as with other vaccines is a thing commonly fueled by fear of side effects. Hence, this calls for key stakeholders to ensure that malaria vaccination sensitization and campaign is championed immediately to parents/Guardians/Childcare givers in Nigeria and for leaders at all levels to be involved in public education based on story telling for positive change and the discouragement of the spread of conspiracy theories to eliminate the infodemic associated factors will reduce vaccine hesitancy and thereby increase malaria vaccination uptake in Nigeria.

Limitations

This study has its limitations which cannot be overlooked; however, future studies should look into improving on the limitations of this study. This study was online based hence, this study needs to be done with physical data methodology to allow longitudinal inferences.

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Conflicts of Interest

The authors declare no conflict of interest.

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