

Facilitators and barriers influencing willingness to take the malaria vaccine among mothers of under 5 years in Abuja, Nigeria

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Abstract

Background:

Malaria remains endemic in Nigeria and continues to significantly affect children under five years. With the introduction of the malaria vaccine, understanding multi-level determinants of vaccine uptake is essential to inform effective implementation strategies, particularly in complex urban-rural settings such as the Federal Capital Territory (FCT), Abuja.

Objective:

To examine facilitators and barriers influencing malaria vaccine uptake among mothers of under-five children in Abuja, Nigeria, incorporating perspectives from healthcare workers and policy makers.

Methods:

A convergent mixed-methods cross-sectional study was conducted between February 2024 and August 2024 in the FCT, Nigeria. The study involved three stakeholder groups: mothers of children under-five years, healthcare workers (HCWs), and policymakers from the State Ministry of Health (SMOH) and Federal Ministry of Health (FMOH). Three purposively selected health facilities representing primary (Gwagwalada Council Township Clinic), secondary (Garki General Hospital), and tertiary (Asokoro General Hospital) levels of care were included.

For the quantitative component, 371 mothers were recruited using stratified sampling across the three tiers of care. Structured questionnaires assessed knowledge, attitudes, practices, and perceived barriers and facilitators related to malaria vaccination. Data were analyzed using STATA version 17, with descriptive, bivariable, and multivariable logistic regression analyses conducted at a 5% significance level.

For the qualitative component, 35 participants (28 HCS and 7 policymakers) were purposively selected for key informant interviews. Interviews explored individual, institutional, and policy-level factors influencing malaria vaccine uptake. Transcripts were analyzed thematically using Dedoose software, guided by the Consolidated Framework for Implementation Research (CFIR). Quantitative and qualitative findings were integrated through triangulation and joint display.

Results:

A total of 373 pregnant women participated (mean age 31.8 ± 7.0 years), with most aged 30–39 years (45.3%), tertiary educated (59.2%), married (92.8%), and residing in urban areas (78.6%). Overall willingness to accept the malaria vaccine was high (98.4%), with 97.9% expressing desire to be vaccinated and 95.4% willing to receive it if provided by the government. Most respondents (96.0%) were willing to encourage others to vaccinate.

Key facilitators of willingness included perceived benefits to the unborn child (98.9%), belief in vaccine effectiveness (97.9%), prevention of disease (98.1%), and recommendations from healthcare providers (98.4%) and the Federal Ministry of Health (98.1%). However, concerns about side effects (82.6%), doubts about effectiveness (85.8%), and fears of immune weakening (81.0%) were prominent barriers. Over one-third (37.3%) believed side effects might outweigh benefits.

Bivariate analysis showed no significant association between willingness and most sociodemographic or health-related variables. However, positive perception toward the malaria vaccine was strongly associated with willingness (90.8% vs. 73.2%, $p < 0.001$). In multivariable logistic regression, positive perception independently predicted willingness (OR = 4.14, 95% CI: 2.18–7.86), and Christian respondents were more likely to be willing compared to Muslims (OR = 2.69, 95% CI: 1.28–5.66). The model explained 9.1%–15.9% of the variance in willingness.

Qualitative findings corroborated the high acceptability, driven by perceived protection for mothers and children and trust in healthcare workers. However, misinformation, COVID-19–related vaccine experiences, concerns about safety, spousal influence, weak health system infrastructure, and potential stockouts were identified as contextual barriers that could limit translation of willingness into uptake.

Conclusion:

Pregnant women showed strong readiness to accept the malaria vaccine, especially when endorsed by healthcare providers and provided they are informed and assured that the vaccine protects their unborn children. While a positive perception is seen as a primary determinant of willingness, safety concerns still remain the key barrier. A successful roll out will require strengthening of the health system capacity, continuous availability of the vaccine, integration of the vaccine into the routine immunization schedules, and leveraging the opinion leaders in the community to reinforce confidence and address myths and misinformation.

Introduction

Malaria continues to pose a significant threat to global health, with an estimated 263 million clinical cases and 597 000 deaths in 2023 (World Health Organization, 2023). Children under five account for nearly 80% of these deaths, highlighting the disease's severe impact on the most vulnerable population groups. Across Africa, malaria's burden is disproportionately high. In 2023, the continent contributed 94% of all malaria cases and 95% of malaria deaths worldwide (WHO, 2022). Within this continental picture, Sub-Saharan Africa (SSA) remains the epicentre of transmission, driven by climatic suitability for Anopheles vectors, widespread Plasmodium falciparum resistance to older antimalarials, and persistent health-systems challenges. Nigeria bears the heaviest share of this regional burden. The country recorded an estimated 68 million cases and 194 000 deaths in 2021, 95 000 of them children under five representing roughly 27% of the global malaria burden (Dasgupta et al., 2022).

Malaria thus remains the leading cause of under five mortality in Nigeria, responsible for about 95 000 child deaths each year. Despite successive control frameworks including the National Malaria Strategic Plans (NMSP), the National Malaria Elimination Programme (NMEP), and the recently inaugurated Nigeria End Malaria Council (NEMC) progress has plateaued (Sokunbi et al., 2022). Vector control and treatment strategies have delivered some gains. Artemisinin-based combination therapies (ACTs), insecticide-treated nets (ITNs), and intermittent preventive treatment in pregnancy (IPTp) remain core interventions (Olliaro et al., 2004). Yet ITN coverage has stalled, diagnostic testing rates are low, and equitable access to treatment is hampered in rural and insurgency affected areas (Omojuyigbe et al., 2023). Shortfalls in previous strategic plans underscore the need for innovative tools and renewed community engagement.

One such innovation is vaccination. Nigeria licensed the R21/Matrix-M malaria vaccine in April 2023, after clinical trials demonstrated up to 80% efficacy in children under five (Hassan et al., 2025). Pilot introduction in high burden states offers a new opportunity to curtail malaria mortality. However, the vaccine's public health impact depends not only on supply, but also on caregiver acceptance particularly among mothers, who are primary decision makers for child health. Evidence from earlier immunisation campaigns shows that perceived vaccine safety and efficacy, trust in healthcare workers, cultural norms, service accessibility, and exposure to misinformation can each operate as facilitators or barriers to uptake (Omojuyigbe et al., 2023). Understanding these social behavioural drivers is therefore critical to achieving Nigeria's immunisation targets and the broader goal of malaria elimination.

This study seeks to identify the facilitators and barriers influencing mothers' willingness to have their under five children vaccinated against malaria in Nigeria. By exploring maternal knowledge, attitudes, and perceived obstacles, the research will generate evidence to guide communication strategies and service delivery models that can maximize vaccine uptake and accelerate progress toward a malaria free Nigeria.

Methods

Study Design

A mixed-method, cross-sectional study design was employed to gather data from three key stakeholder groups: mothers of children under five years, healthcare workers (HCWs), and policy makers at both state and federal levels, specifically the State Ministry of Health (SMOH) and Federal Ministry of Health (FMOH) in the federal capital territory, Nigeria.

Study Period

February 2024 to January 2025

Study Setting

This study was conducted in the Federal Capital Territory (FCT) of Nigeria, a region comprising both urban and rural environments. The FCT is administratively divided into six area councils and hosts a diverse population served by a multi-tiered healthcare system, including primary, secondary, and tertiary health facilities. The region is endemic for malaria and has been the focus of extensive national malaria control interventions. These attributes make the FCT an appropriate setting for examining perceptions and determinants of malaria vaccine uptake.

Three health facilities in the Federal Capital Territory (FCT) were purposively selected to represent the different tiers of service delivery: primary, secondary, and tertiary levels. The selected facilities were: (1) Gwagwalada Council Township Clinic (primary level), (2) Garki General Hospital (secondary level), and (3) Asokoro General Hospital (tertiary level).

Study Population

The study population comprised three key stakeholder groups directly involved in child health and immunization services:

Mothers of children under five years, who were accessing maternal and child health services during the study period at the study sites.

Healthcare workers (HCWs), including nurses, midwives, community health extension workers (CHEWs), and facility immunization officers working in primary and secondary health facilities within the selected study area.

Policymakers, specifically officers and program managers from the State Ministry of Health (SMOH) and the Federal Ministry of Health (FMOH) who are involved in child health, immunization, and policy implementation.

Inclusion and Exclusion Criteria

Inclusion criteria:

- Mothers of children under five years who were receiving care at selected health facilities.
- HCWs directly involved in malaria prevention and immunization services.
- Policy makers responsible for immunization and public health programs at SMOH and FMOH.

Exclusion criteria:

- Mothers who were critically ill or unable to provide informed consent.

- HCWs not engaged in vaccine-preventable disease programs.
- Administrative or support staff at SMOH/FMOH not involved in relevant policy areas.

Sample Size and Sampling Technique

Quantitative Component:

A total of 371 mothers of children aged 0–5 years were recruited for the quantitative survey. The sample size was calculated based on prevalence estimates reported in a similar study conducted in Ethiopia, which yielded a minimum required sample size of 334. After accounting for a 10% non-response rate, the final sample size was increased to 371, with approximately 124 participants recruited per study site.

Participants were selected using stratified sampling from primary, secondary, and tertiary health facilities within the Federal Capital Territory (FCT).

Qualitative Component:

For the qualitative arm, 35 participants were purposively selected to provide diverse perspectives across community, service delivery, and policy levels. This included 28 healthcare workers; 12 from primary, 8 from secondary, and 8 from tertiary health facilities and 7 policymakers, comprising 3 officials from the State Ministry of Health (SMOH) and 4 from the Federal Ministry of Health (FMOH).

Healthcare worker participants included Community Health Extension Workers (CHEWs), nurses, and medical doctors actively engaged in vaccination programs. Policymakers were selected based on their direct involvement in immunization and malaria control policy development and implementation.

Data Collection Procedures

We used a mixed-methods approach to gain an indepth understanding of the factors influencing malaria vaccine uptake.

For the quantitative component, structured questionnaires were administered to mothers of children under five. These questionnaires explored their knowledge, attitudes, and practices regarding malaria and malaria vaccination, as well as perceived barriers and enablers to vaccine uptake. The tools were pretested in a non-study facility to ensure clarity, cultural relevance, and ease of understanding, and adjustments were made based on feedback from the pilot.

For the qualitative component, we conducted semi-structured key informant interviews (KIIs) with healthcare workers and policymakers. Interview guides were tailored to each group to explore personal beliefs, professional experiences, institutional practices, and policy-level factors affecting malaria vaccination. Trained qualitative researchers conducted all interviews in private settings, creating a comfortable environment that encouraged participants to share their thoughts openly and honestly. Interviews were audio-recorded with consent, transcribed verbatim, and translated into English when

necessary. Thematic analysis was then carried out using Dedoose software, following an iterative coding process to identify key themes and patterns.

To ensure quality, all data collectors received comprehensive training on study protocols, ethical practices, and interviewing techniques. Daily supervision and debriefing sessions helped monitor consistency and completeness, while completed questionnaires were reviewed on-site to minimize missing or inconsistent data.

Data collection occurred between April and July 2025, timed to coincide with routine immunization schedules to ensure access to eligible participants. All data were collected at selected health facilities representing primary, secondary, and tertiary care, with a focus on institutions offering routine childhood immunization services. Confidentiality was strictly maintained: no personal identifiers were recorded, and all electronic data were stored on secure, password-protected devices accessible only to the research team.

Data analysis

This study adopted a convergent mixed-methods design, integrating quantitative survey data with qualitative interviews guided by the Consolidated Framework for Implementation Research (CFIR). Quantitative and qualitative data were analysed separately and merged during interpretation using a joint display.

The quantitative data collected were managed using the secure, web-based Research Electronic Data Capture (REDCap) platform. Prior to analysis, quantitative datasets were cleaned, checked for completeness, and validated for consistency. Quantitative analysis was undertaken in STATA (version 17.0), where descriptive statistics were generated, followed by bivariable and multivariable modelling as appropriate. Binary logistic regression was conducted to determine associations between key variables, with statistical significance set at a 5% level (95% confidence interval).

For the qualitative aspect, all the qualitative interviews were audio-recorded and transcribed verbatim by trained transcribers, typed into MS word, and stored on a computer. Each of these transcripts was then critically reviewed by the researcher to ensure accuracy and to correct any errors before they were imported and analyzed using Dedoose, leveraging institutional capacity and established analytic procedures.

Guided by the objectives of the study and in relation to literature, a codebook was developed to guide the data analysis process. Coding was done inductively and deductively, and emerging themes were identified through iterative review. Reliability was strengthened through coder consensus and systematic comparison of thematic categories.

The results of the study were presented using quotes from the interviews to illuminate specific themes. The qualitative data was used to complement and clarify findings from the quantitative data. Where relevant, findings from the qualitative and quantitative components were triangulated to enhance

interpretation, validate emerging patterns, and provide a deeper understanding of contextual drivers and implications for practice.

Ethical approval

Ethical approval for this study was obtained from the Federal Capital Territory Health Research Ethics Committee (FCT-HREC), as well as from the administrations of the respective health facilities where the study was conducted. All participants were provided with detailed information about the study’s objectives, procedures, potential risks, and benefits before participation. Written informed consent was obtained from each participant prior to data collection, and participants were informed that their involvement was entirely voluntary and that they could withdraw at any time without penalty.

Measures were taken to ensure confidentiality and privacy throughout the study. Personal identifiers were not linked to the data, and all information collected was stored securely on password-protected devices accessible only to authorized members of the research team. Interviews and data collection were conducted in private settings to maintain participants’ comfort and encourage open and honest responses.

Results

QUANTITATIVE

Table 1: Background Characteristics of Study Participants

Characteristics	Frequency (n = 373)	Percent
Age group (years)*		
<20	4	1.1
20-29	148	39.7
30-39	169	45.3
40-49	46	12.3
>=50	6	1.6
Highest education level		
No formal	18	4.8
Primary	24	6.4
Secondary	110	29.5
Tertiary	221	59.2
Employment Status		
Employed	153	41.0
Self-employed	171	45.8
Unemployed	49	13.1
Average income (₦)**		
<=30,000	197	52.8
>30,000	176	47.2
Religion		
Christianity	258	69.2
Islam	115	30.8
Marital status		
Currently married	346	92.8
Never married	16	4.3
Previously married	11	2.9
Family type		
Monogamous	316	84.7
Polygamous	57	15.3

Residence		
Rural	80	21.4
Urban	293	78.6

*Mean (SD): 31.8 (7.0) years. **Median (IQR): ₦30,000 (₦10,000 – ₦90,000)

The study included 373 participants (Table 1) with a mean age of 31.8 years (SD: 7.0). The majority (45.3%) were aged 30-39 years, with a small proportion (1.1%) under 20 years, and 1.6% were aged 50 years or older. Most participants (59.2%) had tertiary education, while 4.8% had no formal education. About 87% of the participants were in a form of employment (45.8% were self-employed, 41.0% were government-employed), and 13.1% were unemployed. Half (52.8%) of the participants earned less than or equal to ₦30,000 per month (minimum wage in Nigeria as at the time of the study was ₦30,000), with an interquartile range (IQR) of ₦10,000–₦90,000. Christianity was the predominant religion (69.2%). A significant majority (92.8%) were currently married, mostly (84.7%) in a monogamous family, and 78.6% resided in urban areas.

Table 2: Facilitators and Barriers Influencing Willingness to Take the Malaria Vaccine Among study participants

Facilitators and Barriers items	Frequency (n = 373)*	Percent
Factors Influencing Willingness to Take Malaria Vaccine		
If the vaccines help prevent diseases	366	98.1
If the vaccine is beneficial to the baby in the womb	369	98.9
If a doctor, nurse, or other healthcare provider suggests it	367	98.4
If I believe that vaccines are effective	365	97.9
If I believe that diseases are dangerous for a baby already born	354	94.9
If the Federal Ministry of Health recommends it	366	98.1
If a friend/relative/neighbour recommended it	309	82.8
If another pregnant woman recommends it	318	85.3
If for ethical/moral reasons or recommended by local or religious leaders	326	87.4
If an NGO recommends it	352	94.4
Factors Influencing Hesitancy to Take Malaria Vaccine		
If seeing that the vaccine causes side effects to mothers or children who have used it earlier	308	82.6
If I believe that the vaccine is not effective	320	85.8
If there are concerns that the vaccine would weaken your immune system	302	81.0
If there are concerns that the vaccine could be dangerous for a baby in the womb	285	76.4
If it is for medical reasons (immunocompromised, HIV+)	218	58.4
If it is for religious reasons	70	18.8
If it is for ethical or moral reasons	60	16.1
If my husband/household member does not authorize her to get the vaccine	54	14.5
If there is an influence from political leaders	43	11.5
If there is the belief that a disease like Malaria is not dangerous for the mother	47	12.6
If my cultural beliefs do not support it	29	7.8
If I believe that a disease like malaria is not dangerous for a baby already born	46	12.3

If I believe that it is better to suffer from a natural disease than be vaccinated	22	5.9
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**Frequency displayed represents a response of ‘Yes’*

The study identified a range of facilitators and barriers influencing pregnant women’s willingness or hesitancy to take the malaria vaccine. Among the facilitators, key factors driving willingness included the belief that vaccines prevent diseases (98.1%), benefit the baby in the womb (98.9%), and recommendations from healthcare professionals (98.4%). Additionally, most participants were influenced by the perceived effectiveness of vaccines (97.9%), the belief that diseases are dangerous for newborns (94.9%), and endorsements from the Federal Ministry of Health (98.1%). Social influence also played a role, with recommendations from friends/relatives (82.8%) and other pregnant women (85.3%) being significant, alongside ethical/moral support from local or religious leaders (87.4%) and NGOs (94.4%).

Conversely, factors contributing to vaccine hesitancy were concerns over potential side effects (82.6%) and doubts about the vaccine's effectiveness (85.8%). Other prominent barriers included fears of immune system weakening (81.0%), safety concerns for the baby in the womb (76.4%), and medical contraindications such as immunocompromised status (58.4%). Religious (18.8%) and ethical/moral objections (16.1%) were less frequently cited, as were influences from husbands/household members (14.5%) and political leaders (11.5%). Cultural beliefs against vaccination were reported by only 7.8%, while a minority believed that diseases like malaria are not dangerous for the mother (12.6%) or the baby (12.3%), and 5.9% preferred natural immunity over vaccination.

These findings suggest that while there is a high level of willingness to take the malaria vaccine driven by perceived benefits and authoritative recommendations, concerns about safety and effectiveness remain significant barriers that need to be addressed to increase vaccine uptake.

Table 3: Willingness to accept Malaria vaccine among study participants

Items	Frequency (n = 373)*	Percent
I am willing to accept the Malaria vaccine.	367	98.4
I will not take the Malaria vaccine unless compelled by law.	79	21.2
I want to be vaccinated with the Malaria vaccine.	365	97.9
I will spend money to receive a Malaria vaccine.	327	87.7
I will take the Malaria vaccine if it is given to me by the government.	356	95.4
I will encourage my family members and neighbours to vaccinate their children against Malaria.	358	96.0
I support everyone receiving the Malaria vaccine.	353	94.6
I think taking another form of treatment is better than the Malaria vaccine.	54	14.5
I doubt the safety of any form of Malaria vaccine.	47	12.6
I believe that the side effects of the Malaria vaccine outweigh its immunizing advantages.	139	37.3
It is better to be infected with Malaria than take the vaccine.	18	4.8
I am in good health and do not need to be vaccinated against Malaria.	22	5.9
I would prefer to be vaccinated only if the vaccine is imported.	51	13.7
I will receive the vaccine because people around me are doing so.	76	20.4
I will not take the vaccine because I am against vaccination in general.	8	2.1

**Frequency displayed represents a response of 'Yes'*

The study assessed the willingness to accept the malaria vaccine among participants. A large majority (98.4%) expressed willingness to receive the malaria vaccine, with 97.9% indicating that they would like to be vaccinated, and 95.4% willing to accept the vaccine if provided by the government. Additionally, 96.0% of respondents were supportive of encouraging family and neighbours to vaccinate their children, and 94.6% supported universal vaccination.

However, hesitancy remained for some; 21.2% reported they would only accept the vaccine if compelled by law, and 37.3% expressed concerns that the side effects might outweigh the immunizing benefits. A minority indicated they would prefer alternative treatments (14.5%), doubt the vaccine's safety (12.6%), or believed good health negated the need for vaccination (5.9%). Notably, 13.7% preferred imported vaccines, and 20.4% would follow societal trends in deciding whether to get vaccinated. Only 4.8% believed it was better to contract malaria than to be vaccinated, and a small portion (2.1%) were opposed to vaccination in general.

Table 4: Socio-demographic and Health Related-Determinants of Willingness to Take Malaria Vaccine among the Study Participants

Determinants	Willingness to Take Malaria Vaccine		p-value
	Willing (%)	Unwilling (%)	
Age group (years)			
<20	4 (100.0)	0 (0.0)	0.540
20-29	130 (87.8)	18 (12.2)	
30-39	139 (82.2)	30 (17.8)	
40-49	38 (82.6)	8 (17.4)	
Highest education level			
No Formal	16 (88.9)	2 (11.1)	0.842
Primary	20 (83.3)	4 (16.7)	
Secondary	96 (87.3)	14 (12.7)	
Tertiary	185 (83.7)	36 (16.3)	
Employment Status			
Employed	128 (83.7)	25 (16.3)	0.312
Self-employed	150 (87.7)	21 (12.3)	
Unemployed	39 (79.6)	10 (20.4)	
Average income (₦)			
<= 30000	170 (86.3)	27 (13.7)	0.454
> 30000	147 (83.5)	29 (16.5)	
Religion			
Christianity	225 (87.2)	33 (12.8)	0.072
Islam	92 (80.0)	23 (20.0)	
Marital status			
Currently Married	293 (84.7)	53 (15.3)	0.781
Not Married	24 (88.9)	3 (11.1)	
Family structure			
Monogamous	266 (84.2)	50 (15.8)	0.303
Polygamous	51 (89.5)	6 (10.5)	

Residence			
Rural	69 (86.2)	11 (13.8)	0.721
Urban	248 (84.6)	45 (15.4)	
Ever had malaria in pregnancy			
Yes	260 (86.1)	42 (13.9)	0.199
No	56 (80.0)	14 (20.0)	
Satisfaction with quality of antenatal care services			
Dissatisfied	3 (75.0)	1 (25.0)	0.283
Neither	2 (66.7)	1 (33.3)	
Satisfied	312 (85.2)	54 (14.8)	
Knowledge of Malaria vaccine (composite score)			
Good Knowledge	81 (83.5)	16 (16.5)	0.298
Fair Knowledge	209 (86.7)	32 (13.3)	
Poor Knowledge	27 (77.1)	8 (22.9)	
Perception towards malaria vaccine (Composite)			
Positive Perception	227 (90.8)	23 (9.2)	<0.001
Negative Perception	90 (73.2)	33 (26.8)	

Table 4 reports analysis of willingness to take the malaria vaccine across various sociodemographic and health-related determinants revealed several non-significant trends, with one exception being perception towards the vaccine. Age group showed no statistically significant difference in willingness to vaccinate ($p = 0.540$), although individuals under 20 years of age demonstrated the highest willingness at 100%. Among other age categories, willingness was slightly lower, ranging from 82.2% in the 30–39 age group to 87.8% in the 20–29 group. Educational attainment did not significantly impact willingness ($p = 0.842$), though those with no formal education (88.9%) and secondary education (87.3%) were more willing compared to tertiary-educated individuals (83.7%).

Employment status also exhibited no significant association with willingness ($p = 0.312$). Self-employed individuals demonstrated the highest willingness (87.7%), followed by employed (83.7%) and unemployed individuals (79.6%). Income did not yield a significant effect on vaccine willingness ($p = 0.454$); those earning $\leq$ ₦30,000 exhibited slightly higher willingness (86.3%) compared to those earning $>$ ₦30,000 (83.5%). Religious affiliation, though not statistically significant ($p = 0.072$), suggested a trend where Christians (87.2%) were more willing than Muslims (80.0%). Marital status and family structure

also showed no significant effect ($p = 0.781$ and 0.303 , respectively), with currently married individuals (84.7%) and those in polygamous families (89.5%) demonstrating slightly higher willingness.

Residence (rural vs. urban) was not a significant predictor ($p = 0.721$), with a similar proportion of willingness in rural (86.2%) and urban (84.6%) populations. Additionally, having experienced malaria during pregnancy did not significantly influence willingness ($p = 0.199$), though a higher proportion of those with previous malaria (86.1%) were willing compared to those without (80.0%). Satisfaction with antenatal care showed no significant association with willingness ($p = 0.283$). Individuals satisfied with care were more willing (85.2%) compared to those dissatisfied (75.0%) or neither satisfied nor dissatisfied (66.7%). Knowledge of the malaria vaccine, measured by a composite score, was not a significant determinant ($p = 0.298$); however, willingness was higher among individuals with fair knowledge (86.7%) than those with good (83.5%) or poor knowledge (77.1%).

Notably, perception towards the malaria vaccine demonstrated a significant association with willingness ($p < 0.001$). Individuals with a positive perception exhibited markedly higher willingness (90.8%) compared to those with a negative perception (73.2%).

Table 6: Determinants of Willingness to Take the Malaria Vaccine: A Logistic Regression Model

Determinants	B (p-value)	Odds ratio (95% CI)
Age group (years)*	-0.009 (0.717)	0.99 (0.95 – 1.04)
Highest education level		
No formal		1
Primary	-0.692 (0.487)	0.500 (0.071 - 3.520)
Secondary	-0.252 (0.772)	0.777 (0.141 - 4.282)
Tertiary	-0.710 (0.410)	0.492 (0.091 - 2.658)
Employment Status		
Employed	0.267 (0.629)	1.306 (0.442 - 3.857)
Self-employed	0.386 (0.432)	1.472 (0.561 - 3.858)
Unemployed		1
Average income (₦)		
<=30,000	0.377 (0.330)	1.459 (0.682 - 3.118)
>30,000		1
Religion		
Christianity	0.990 (0.009)	2.691 (1.279 - 5.664)
Islam		1
Marital status		
Currently married	0.038 (0.956)	1.038 (0.272 - 3.957)
Never married		1
Family type		
Monogamous	-0.681 (0.189)	0.506 (0.183 - 1.400)
Polygamous		1
Residence		
Rural	-0.027 (0.946)	0.974 (0.450 - 2.109)
Urban		1
Ever had malaria in pregnancy (Yes)	0.389 (0.320)	1.476 (0.685 - 3.179)

Satisfaction with quality of antenatal care services		
Satisfied	-0.531 (0.766)	0.588 (0.018 - 19.350)
Neither	1.233 (0.317)	3.433 (0.306 - 38.490)
Dissatisfied		1
Knowledge of Malaria vaccine (composite score)		
Good	0.405 (0.428)	1.499 (0.550 - 4.086)
Fair	-0.098 (0.860)	0.907 (0.304 - 2.702)
Poor		1
Perception towards malaria vaccine (Composite)		
Positive	1.420 (0.000)	4.138 (2.178 - 7.861)
Negative		1

$R^2=9.1\%$ to 15.9%

In this logistic regression analysis (Table 6) assessing factors influencing willingness to take the malaria vaccine, the Omnibus Test of Model Coefficients shows that the model is statistically significant (Chi-square = 35.361, df = 17, p = .006), indicating that the independent variables collectively improve the model fit. The model explains approximately 9.1% to 15.9% of the variance in the willingness to take the malaria vaccine. These values indicate a modest fit, implying that while the model does capture some factors influencing willingness, additional factors may need to be explored.

Key significant predictors include perception of malaria vaccine (OR = 4.138, 95% CI: 2.178–7.861, p < .001), showing that individuals with a positive perception are over four times more likely to be willing to take the vaccine. Religion is also significant (OR = 2.691, 95% CI: 1.279–5.664, p = .009), indicating almost a threefold increase in willingness for Christians to take the malaria vaccine than Muslims. Other variables such as age, education, employment, and knowledge do not show significant associations with willingness to take the vaccine.

QUALITATIVE

Table 1: Thematic Summary by CFIR Analysis Framework Domain

CFIR Domain	Key Quantitative findings	Qualitative Findings
Intervention Characteristics	• 98.4% willing to accept malaria vaccine • 98.1% believe vaccine prevents malaria • 98.9% believe vaccine benefits unborn child • 85.8% confident in vaccine effectiveness • 82.6% concerned about side effects	High acceptability driven by perceived protection for children and pregnant women • Prior positive experiences with routine childhood vaccines • Safety concerns linked to novelty of vaccine and lack of local evidence • Fear of side effects shaped by COVID-19 vaccination experiences
Outer Setting	• 98.4% influenced by HCW recommendation • 87.4% influenced by family/friends • 82.8% influenced by community leaders • Religion not statistically significant barrier (18.8%)	Community leaders and religious institutions are effective channels for sensitization • Spousal approval (especially husbands) strongly influences women's decisions • Widespread misinformation and rumors about fertility, safety, and population control
Inner Setting	• No strong statistical association between health system factors and willingness	• Weak infrastructure, cold-chain gaps, staffing shortages, and poor accountability • Politicization of staffing and inadequate funding undermine service quality • Lack of clear malaria vaccine policy and operational guidelines
Characteristics of Individuals	• Perception strongly predicts willingness (OR $\approx$ 4.14) • Knowledge level not a significant predictor	• Awareness gaps and misconceptions drive fear and hesitancy • Fear of side effects linked to prior COVID-19 vaccine experiences • Trust in HCWs outweighs formal knowledge in shaping decisions
Process	• High willingness across sociodemographic groups suggests	• Need for early rollout before malaria peak season

readiness for implementation

- Integration into National Immunization Schedule recommended
- Continuous availability to avoid stockouts
- Routine outreach delivery strategies
- Training of HCWs, tracking systems, incentives for caregivers

Results **Theme 1: Intervention characteristics**

This domain encompasses factors related to the malaria vaccine uptake itself, including perceptions of its effectiveness, safety, acceptability, affordability, accessibility, and logistical considerations as reported by participants.

Consistent with the quantitative findings showing strong belief in vaccine benefits for the unborn baby (98.9%) and disease prevention (98.1%), participants described the malaria vaccine as highly acceptable, particularly for protecting children under five and pregnant women.

“...this vaccination, we are very happy to receive it. To me it is very good because sometimes we will have the outbreak of disease and my children are already protected against the diseases” - FGD women

Caregivers frequently referenced positive experiences with previous vaccines such as polio and BCG, which reinforced confidence in immunization generally.

However, qualitative data revealed underlying uncertainties not fully captured by high willingness scores. While most respondents expressed readiness to vaccinate, concerns about vaccine effectiveness and safety mirroring quantitative concerns about side effects (82.6%) and effectiveness (85.8%) were attributed to the vaccine's novelty and lack of local evidence. Participants emphasized that acceptance would be strengthened if the malaria vaccine were integrated with existing malaria control measures, such as insecticide-treated nets, reinforcing its perceived relative advantage.

Challenges related to availability, affordability, and logistics were also prominent. These findings help explain why, despite high willingness (87.7% willing to pay), concerns about access and stockouts remain potential threats to sustained uptake.

Theme 2: Outer setting

This domain captures external factors beyond the health facility that influence malaria vaccine delivery, including community needs, social and cultural norms, economic conditions, and interactions with the broader health system.

Our Qualitative findings contextualized the strong influence of healthcare provider recommendations observed quantitatively (98.4%) and the importance of social endorsement from peers and community members (82.8 - 87.4%). Participants emphasized that effective communication, delivered in local languages and through trusted community leaders, is essential for translating awareness into acceptance.

"Tell the messages in such a way that people will use the language that resonates around them. If you are printing the IC materials, print pictorials that people will like. If you're going to the Muslim community print a woman who is wearing hijab, who is taking the vaccine, let them know that this person is their person" - policymaker

"If there is enough enlightenment to show the advantage of the vaccine, it will, I believe it will give people the courage to want to get their children vaccinated." - FGD Women

Although most survey respondents reported awareness of the malaria vaccine, qualitative narratives revealed that awareness was often superficial, with many viewing the vaccine as a rumour due to the absence of direct experience. Misinformation, particularly fears related to fertility, population control, and adverse outcomes was widespread and strongly shaped by past vaccination campaigns, including COVID-19. These concerns help explain why over one-third of respondents (37.3%) believed side effects might outweigh benefits.

Gender norms and religious influence also emerged as critical external determinants. While religion was not a dominant barrier quantitatively (18.8%), qualitative data showed that spousal approval and religious messaging significantly influence women's decision-making, helping to explain the nuanced role of religion observed in the analysis.

"... sometimes our spiritual leader or religious leader, some of them, they said, is a taboo in the religion to take that vaccine." - FGD Women

"... sometimes in religious places, they will tell you all these things that are free, it always comes with a price, so don't accept it. - FGD Women

Theme 3: Inner setting

This domain refers to the healthcare system context in which the malaria vaccine is delivered, including health facility infrastructure, staffing, logistics, and organizational readiness to implement the vaccination program.

Despite the absence of strong quantitative associations between health system factors and willingness, qualitative findings revealed substantial institutional constraints that may affect malaria vaccine uptake. Participants acknowledged the presence of immunization platforms and malaria expertise but highlighted weaknesses in cold-chain infrastructure, staffing shortages, poor remuneration, and inconsistent accountability.

Politicization of staffing and weak supervision were described as undermining service quality and trust. These system-level issues help explain why high willingness may not necessarily translate into effective coverage. Although healthcare workers expressed strong support for the malaria vaccine, respondents stressed that inadequate funding and the lack of a detailed national malaria vaccine policy threaten implementation readiness.

"I've spoken about funding gaps that we have, so the government should prioritize funding the health sector seriously. The primary Healthcare sector is heavily under-staffed, ... the government needs to fund and engage people that will do the work." - Policymaker

Theme 4: Characteristics of individuals

This domain reflects the characteristics, knowledge, beliefs, and attitudes of individuals involved in malaria vaccination, including caregivers who decide on vaccine uptake for eligible children and healthcare workers who administer the vaccine and influence acceptance through education and engagement.

Qualitative insights expanded on the quantitative finding that perception was the strongest predictor of willingness (OR = 4.14). Participants consistently described perception as shaped by trust, prior vaccine experiences, and interpersonal communication with healthcare workers.

Fear of side effects especially linked to COVID-19 experiences was a dominant individual-level barrier, aligning with survey findings where 82.6% cited concern over observed side effects. While knowledge level was not statistically significant in the survey, qualitative data suggested that how information is delivered matters more than how much information is provided. Caregivers preferred conversational engagement, reassurance, and opportunities to ask questions rather than technical explanations.

"Some of us might be thinking, if I give my child, since it's a new vaccine, what is going to happen to my child? So that fear might not allow some mothers to go and take this vaccination." - FGD Women

Healthcare workers were identified as pivotal influencers of individual beliefs, reinforcing quantitative findings that provider recommendation was one of the strongest facilitators of willingness.

"...with the information passing from us to them and also information passing to community leaders, fine it will be easier for them" - HCW

Theme 5: Process

This domain encompasses the activities, strategies, and implementation processes used to deliver the malaria vaccine, including community sensitization, health worker training, outreach services, scheduling, and monitoring to ensure effective uptake.

Qualitative findings highlighted critical implementation processes necessary to sustain the high willingness observed quantitatively. Policymakers and health workers emphasized the importance of

timely rollout before peak malaria transmission, continuous vaccine availability, and integration into the National Immunization Schedule.

Participants described a dual delivery strategy routine facility-based vaccination complemented by outreach campaigns as essential for reaching underserved populations. Stockouts were repeatedly cited as a major threat to trust and uptake, despite strong initial willingness. Training of healthcare workers, demand generation, tracking systems for multi-dose completion, and incentive mechanisms were recommended to ensure sustained participation and adherence.

Discussion

This study explored the factors influencing the willingness to accept the malaria vaccine following its introduction after the pilot phase. The study examined the perspectives of mothers of under-five children, focusing on their preferences, concerns and vaccination practices. Additionally, the study assessed the roles and practices of key stakeholders involved in vaccination processes within the country. The use of a mixed-methods approach enriched the data and findings, providing deeper insights into key factors influencing the acceptability of the malaria vaccine.

This study provides deep and important insights into the facilitators and barriers influencing the willingness of mothers of children under five in the FCT to accept the malaria vaccine. Overall, the willingness to accept the malaria vaccine was remarkably high, with over 98% of participants expressing readiness to have their children vaccinated and to recommend the vaccine to other mothers. This high acceptance level was consistent across both the quantitative and qualitative findings, highlighting a strong foundation for successful malaria vaccine rollout in the settings where this study was conducted.

These findings are consistent with studies conducted in other sub-saharan African contexts including Ethiopia, Guinea, Sierra Leone, and Nigeria where high levels of willingness to accept the malaria vaccine have been reported among caregivers of under-five children. Similar to findings by Ajayi et al. (2023), and Asmare et al. (2022), perceived benefits of the vaccine, particularly the safety of the vaccine and better health outcomes, were key drivers of acceptance. However, unlike some facilities where knowledge predicted uptake, this study found that perception rather than knowledge was the strongest determinant of willingness. This aligns with broader vaccine acceptance literature suggesting that trust and beliefs often outweighs factual knowledge in shaping health behaviour (Bugase et al. 2024).

Background Characteristics of Study Participants

This study population was predominantly composed of women in their reproductive years, with most participants aged 20–39 years, married, and residing in urban areas. The relatively high level of tertiary education observed among participants suggests a population with potentially greater access to health information and services. Despite this, over half of the respondents reported earning at or below the national minimum wage, highlighting underlying economic constraints that may influence healthcare access and decision-making.

The largely urban composition of the study population may partly explain the high levels of awareness and willingness observed, as urban residents often have better access to healthcare services and information compared to rural populations. However, the findings also suggest that willingness to accept the malaria vaccine transcends socioeconomic and demographic boundaries, indicating a broadly favorable environment for vaccine introduction.

Facilitators and Barriers Influencing Willingness to Take the Malaria Vaccine

The study identified a strong interplay between facilitators and barriers shaping willingness to accept the malaria vaccine. Perceived benefits of the vaccine, particularly its role in preventing disease and protecting both unborn and newborn children, emerged as the most prominent drivers of acceptance. This aligns with existing evidence from sub-Saharan Africa, where perceived vaccine effectiveness and anticipated child health benefits consistently influence vaccine acceptance among caregivers (Fadi et al. 2024)

Recommendations from healthcare workers and endorsement by national authorities, such as the Federal Ministry of Health, were also key facilitators. This underscores the critical role of trusted institutions and providers in shaping health behaviors, reinforcing findings from broader vaccine acceptance literature that highlight trust as a central determinant of uptake. Social influences, including recommendations from peers, family members, and community leaders, further contributed to willingness. These findings reflect the collective nature of decision-making in many settings, where community norms and shared experiences play a significant role in shaping health choices.

Despite these strong facilitators, important barriers persist. Concerns about side effects and doubts about vaccine effectiveness were widely reported, reflecting underlying uncertainties associated with the introduction of a new vaccine. These concerns are likely influenced by prior experiences with vaccination campaigns, particularly during the COVID-19 pandemic, where misinformation and skepticism were prevalent. Fears related to immune system weakening and potential harm to the unborn child further highlight the need for targeted risk communication strategies.

Willingness to Accept the Malaria Vaccine

The study found an exceptionally high level of willingness to accept the malaria vaccine, with over 98% of participants expressing readiness to be vaccinated and to recommend the vaccine to others. This high level of acceptability suggests strong potential for successful vaccine uptake in the study setting.

However, the findings also reveal a critical gap between expressed willingness and potential uptake. A notable proportion of participants indicated conditional acceptance, with some willing to take the vaccine only if mandated by law or influenced by social norms. Additionally, concerns about side effects outweighing benefits among over one-third of respondents suggest that hesitancy remains beneath the surface despite high overall acceptance. These findings highlight the complexity of vaccine acceptance,

where stated willingness does not always translate into actual behavior. Addressing underlying concerns and ensuring sustained confidence in the vaccine will be essential to converting willingness into uptake.

Socio-demographic and Health-Related Determinants of Willingness

The analysis revealed that most socio-demographic and health-related factors were not significantly associated with willingness to accept the malaria vaccine. This suggests that acceptance is broadly distributed across different population groups, indicating widespread readiness for vaccine introduction.

Notably, knowledge of the malaria vaccine did not significantly influence willingness, suggesting that awareness alone may not be sufficient to drive acceptance. Instead, perception emerged as a more critical determinant, highlighting the importance of attitudes, beliefs, and trust in shaping health behaviors.

Although religion was not statistically significant in the bivariate analysis, observed trends and qualitative findings suggest that religious and cultural contexts may still play a nuanced role in influencing decision-making, particularly through community narratives and leadership influence.

Determinants of Willingness to Take the Malaria Vaccine (Logistic Regression Model)

The multivariable analysis further emphasized the central role of perception in influencing willingness to accept the malaria vaccine. Individuals with a positive perception were significantly more likely to express willingness, reinforcing the importance of trust, confidence, and perceived benefits in shaping vaccine acceptance.

Religion also emerged as a significant predictor, with Christians demonstrating higher odds of willingness compared to Muslims. While this finding should be interpreted with caution, it may reflect differences in community-level messaging, trust networks, or exposure to health information. The qualitative findings support this interpretation, highlighting the influence of religious leaders and community narratives on vaccine-related decisions.

The lack of significant associations with other variables, including age, education, income, and knowledge, suggests that willingness is not strongly determined by traditional socio-demographic factors. Instead, behavioral and perceptual factors appear to play a more dominant role. The modest explanatory power of the model further indicates that additional contextual and system-level factors may influence vaccine acceptance.

IMPLICATIONS OF THE STUDY

The findings from this study has critical implications as regards policy, program design, and implementation of the malaria vaccination in Nigeria.

First, the high level of willingness reflects a great opportunity for rapid and successful rollout after the pilot phase has been completed. Policy makers need to capitalize on the level of readiness by ensuring

quick rollout and an efficient implementation, particularly before the peak transmission seasons of malaria.

Secondly, beyond increasing knowledge and awareness, communication strategies for the malaria vaccine should focus on shaping positive perceptions and building trust. Communication and community engagement efforts should target and address concerns about vaccine safety, side effects and its effectiveness. The messages should be culturally sensitive, address misinformation, misconceptions and myths identified in this study. They should be communicated in local languages through trusted and credible channels including community leaders, health care workers, and other influential stakeholders. Their influence can be leveraged to counter misinformation and help reinforce positive norms around vaccination, as well as increasing the demand for vaccination.

Third, HCWs should be identified and positioned as central drivers of vaccine uptake. As such HCWs should be trained and equipped with accurate information and communication skills to enable them build trust and invariably influence caregivers decisions effectively.

Another major implication of the study is that in order to translate willingness to actual uptake there is a need to strengthen the health system; ensuring the consistent availability of the vaccine, improving cold-chain infrastructure, addressing staff shortages and strengthening of accountability mechanisms. Lastly, to enhance the effectiveness and sustainability of the program, the malaria vaccine should be integrated into the national immunization schedule alongside existing malaria prevention strategies such as the insecticide treated nets

LIMITATIONS

This study has several limitations. Firstly, the cross-sectional design limits the ability to establish casual relationships between identified factors and willingness to accept the malaria vaccine.

Secondly, the study was conducted in selected facilities within the FCT, which may limit the generalizability of findings to other regions; and may not be reflective of the acceptability of the entire people of FCT and the country at large.

Third, the reliance on self reported data introduces a possibility of social desirability bias, as participants may have overstated their willingness to accept the vaccine.

Finally, this study assessed the willingness rather than the uptake of the vaccine, and there might be a gap between intention and behaviour due to systemic and contextual barriers.

This study has several strengths. First, the use of a convergent mixed-methods design allowed for a comprehensive understanding of both measurable determinants and contextual factors influencing vaccine acceptance. Second, the inclusion of multiple stakeholder groups, including mothers, healthcare workers, and policymakers, provided a multi-level perspective on the issue. Third, the application of the

Consolidated Framework for Implementation Research (CFIR) enhanced the rigor of qualitative analysis and facilitated systematic interpretation of findings.

Conclusion

In conclusion, this study demonstrates a high level of willingness to accept the malaria vaccine of under-five children in Abuja. However, concerns about safety, side effects, effectiveness, and health system readiness and misconception remain key barriers that could hinder uptake.

Strengthening trust, leveraging healthcare providers and community leaders, and ensuring reliable vaccine delivery systems will be essential for the successful implementation of the malaria vaccination program.

Bridging the gap between willingness and uptake will require a multifaceted approach that includes targeted risk communication, trust-building, and community engagement. In addition, strengthening health system readiness through reliable vaccine supply, integration into routine immunization services, and the use of trusted healthcare and community structures will be essential.

Ultimately, successful implementation will depend not only on vaccine availability but also on sustained efforts to address concerns and create an enabling environment that supports informed and confident decision-making among caregivers. Translating high willingness into actual uptake will depend on addressing trust, misinformation, and health system readiness.

Abbreviations

ACTs

Artemisinin-based Combination Therapies

CHEWs

Community Health Extension Workers

CFIR

Consolidated Framework for Implementation Research

FCT

Federal Capital Territory

FCT-HREC

Federal Capital Territory Health Research Ethics Committee

FMOH

Federal Ministry of Health

HCWs

Healthcare Workers

ITNs

Insecticide-Treated Nets

IPTp

Intermittent Preventive Treatment in Pregnancy

KIIs

Key Informant Interviews

NMEP

National Malaria Elimination Programme

NMSP

National Malaria Strategic Plans

NEMC

Nigeria End Malaria Council

REDCap

Research Electronic Data Capture

SMOH

State Ministry of Health

Declarations

Funding Declaration

This study was funded by the Royal Society of Tropical Medicine and Hygiene (RSTMH). The funder had no role in the design of the study, data collection, data analysis, interpretation of results, or writing of the manuscript.

Ethics approval and consent to participate

Ethical approval for this study was obtained from participating hospitals and the Federal Capital Territory National Health Research Ethics Committee (FCT NHREC). The study was conducted in accordance with relevant national and institutional ethical guidelines. Written informed consent was obtained from all participating mothers of children under five years prior to enrolment.

Consent for publication

Not applicable. No individual personal data, images, or videos are included in this manuscript.

Availability of data and materials

The datasets generated and/or analysed during the current study are not publicly available due to institutional data protection policies but are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

Temitope conceptualized the study, developed the proposal, and led overall study coordination. Herself, and other authors contributed to data collection, analysis, interpretation, and manuscript preparation. All authors read and approved of the final manuscript.

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