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Seasonal malaria chemoprevention uptake among caregivers of children under five in Abuja, Nigeria: a mixed-methods study of awareness, determinants, barriers and facilitators

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Research Article

Keywords: Seasonal malaria chemoprevention, SMC uptake, malaria prevention, children under five, mixed-methods study, Abuja

Posted Date: August 12th, 2026

DOI: https://doi.org/10.21203/rs.3.rs-10658256/v1

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Additional Declarations: No competing interests reported.

Abstract

Background

Seasonal malaria chemoprevention (SMC) reduces malaria risk among children under five, but its impact depends on effective uptake. This study examined SMC uptake and the factors influencing participation among caregivers in Abuja, Nigeria. Understanding these factors is essential for improving SMC uptake and programme effectiveness.

Methods

A mixed-methods cross-sectional study was conducted among caregivers of children under five in Abuja. Quantitative data (n = 317) were collected using an interviewer-administered questionnaire, while qualitative data were obtained through six focus group discussions (n = 27). Quantitative data were summarized descriptively, with predictors of SMC uptake identified using multivariable logistic regression ($p < 0.05$). Qualitative data were analyzed using thematic analysis.

Results

Most (81.7%) caregivers had heard of SMC but only 60.6% reported uptake. Caregivers who had heard of the SMC programme had substantially higher odds of reporting uptake (AOR = 17.95, 95% CI: 6.96–46.27). Caregivers with health insurance coverage also had higher odds of SMC uptake (AOR = 1.95, 95% CI: 1.03–3.70), whereas employed caregivers had lower odds of uptake than unemployed caregivers (AOR = 0.24, 95% CI: 0.13–0.44).Qualitative findings highlighted persistent information gaps, inconsistent drug availability, inconvenient distribution schedules, and concerns about side effects as barriers to uptake. Home delivery, perceived effectiveness, and reduced transportation and access-related costs were reported as facilitators.

Conclusion

Despite relatively high awareness of SMC, substantial gaps in participation remained. Strengthening community sensitization, ensuring reliable drug supplies, providing flexible distribution strategies, and improving caregiver education on expected side effects could enhance SMC participation in malaria-endemic settings.

1. Introduction

Malaria remains a major public health challenge, with children under five years of age bearing a disproportionate share of severe disease and mortality. The World Health Organization (WHO) estimated 282 million malaria cases and 610,000 deaths globally in 2024, with the WHO African Region accounting

for 94% of cases and 95% of deaths [1]. Children under five accounted for approximately 75% of malaria deaths in the region, while Nigeria alone contributed an estimated 30.3% of global malaria deaths [1]. These figures underscore the continuing need for effective preventive interventions targeting young children in malaria-endemic settings.

Seasonal malaria chemoprevention (SMC) is a preventive intervention recommended for children aged 3–59 months living in areas with highly seasonal malaria transmission [2–5]. It involves the administration of a full three-day course of sulfadoxine-pyrimethamine (SP) and amodiaquine (AQ) at monthly intervals during the peak malaria transmission season, with the first dose administered under the supervision of a community health worker or drug distributor and the subsequent AQ doses administered by caregivers at home [2–5]. By maintaining antimalarial drug concentrations during periods of high transmission, SMC provides temporary protection against malaria in eligible children [6]. The effectiveness of SMC therefore depends not only on programme availability and community distribution but also on caregivers' willingness and ability to receive and administer the medicines appropriately [7].

Evidence from Nigeria indicates that awareness of SMC does not necessarily translate into complete participation. In Kaduna State, Tom et al. [2] reported that 76.8% of caregivers had heard of SMC, but only 58.4% reported receiving at least one dose during the preceding campaign and just 27.2% reported receiving all four doses. Lack of awareness was the most frequently reported reason for missing SMC, while knowledge of the programme was significantly associated with uptake [2]. These findings suggest that gaps may persist between awareness, understanding, and actual participation.

Programme implementation factors may further influence caregiver participation. Qualitative research conducted across five Nigerian states found that caregivers generally accepted SMC and preferred door-to-door delivery because it was convenient and allowed opportunities to receive explanations from community drug distributors [5]. However, perceived side effects, inadequate understanding of the purpose of SMC, mistrust of medicines, and local drug shortages were identified as barriers to uptake [5]. Similarly, analysis of SMC coverage data from Nigeria, Burkina Faso, and Togo found that caregiver awareness of the importance of administering subsequent doses was associated with adherence, while previous adverse reactions were associated with lower adherence [4]. These findings highlight the importance of caregiver education, confidence in SMC medicines, and reliable programme delivery.

The context in which SMC is delivered may also influence programme outcomes. Analysis of 11,880 caregiver-child pairs across nine Nigerian states found significant urban–rural differences in SMC coverage, receipt of the complete three-day course, coverage across annual cycles, and caregiver knowledge and perceptions. Children living in urban areas had lower odds of receiving SMC and completing the full course than those in rural areas [3]. Such findings indicate that urban settings may require context-specific approaches to SMC implementation rather than assuming that strategies developed for rural communities will achieve similar results.

The Federal Capital Territory (FCT), Abuja, comprises six Area Councils—Abuja Municipal Area Council (AMAC), Bwari, Gwagwalada, Kuje, Kwali, and Abaji—and encompasses diverse urban, peri-urban, and rural communities. Despite the implementation of SMC in the FCT, evidence on caregiver-level uptake and the factors shaping participation remains limited. In particular, there is a need to understand whether awareness translates into uptake and how caregiver perceptions, access to medicines, distribution practices, communication, and other implementation factors influence participation. Quantitative assessment can identify factors independently associated with uptake, while caregivers' accounts can provide contextual explanations for why these factors facilitate or hinder participation.

Therefore, this mixed-methods study assessed SMC uptake among caregivers of children under five years of age in the FCT, Abuja, examined caregivers' awareness and perceptions, identified factors independently associated with uptake, and explored the barriers and facilitators influencing participation. Integrating quantitative and qualitative evidence provides a more comprehensive understanding of caregiver participation and can inform strategies to strengthen SMC implementation in malaria-endemic settings.

2. Methods

2.1 Study design and setting

A mixed-methods cross-sectional study was conducted among caregivers of children under five years of age in the Federal Capital Territory (FCT), Abuja, Nigeria. The FCT is located in North-Central Nigeria and comprises six area councils: Abuja Municipal Area Council (AMAC), Bwari, Gwagwalada, Kuje, Kwali, and Abaji. The setting experiences a tropical climate, with a rainy season from April to September and a dry season from October to March. The climatic conditions create an environment conducive to the breeding of mosquitoes, making malaria a persistent public health concern.

2.2 Study population and eligibility criteria

The study population comprised caregivers of children under five residing within the FCT. Caregivers whose children had participated in the SMC programme and those whose children had not participated were eligible to participate, provided they gave informed consent.

2.3 Sample size and sampling

The minimum sample size for the quantitative component was estimated using Cochran's formula for a single population proportion:

$$n = \frac{Z^2 p(1-p)}{d^2}$$

where *n* is the minimum required sample size, *Z* is the standard normal deviate corresponding to a 95% confidence level (1.96), *p* is the estimated proportion, and *d* is the desired margin of error. Based on a

previous Nigerian study that reported an SMC awareness prevalence of 76.8% [2], *p* was set at 0.768, with a precision of 5%. This yielded a minimum sample size of approximately 274 caregivers. Allowing for a 10% non-response rate, the minimum adjusted sample size was approximately 305 caregivers. This was subsequently increased to 320 caregivers to provide additional allowance for non-response and incomplete data. The study recorded a response rate of [317/320 (99.1%)] which was considered adequate for analysis.

The target sample was proportionately allocated across the six Area Councils of the FCT according to their approximate population distribution [8]: Abuja Municipal Area Council (AMAC), 177; Bwari, 52; Gwagwalada, 36; Kuje, 22; Kwali, 20; and Abaji, 13, giving a total target sample of 320 caregivers. Participants were recruited from selected communities and households within the six Area Councils.

For the qualitative component, six focus group discussions (FGDs) were conducted across the six Area Councils. Participants were purposively selected from the study communities to obtain diverse perspectives on SMC awareness, perceptions, experiences, uptake, barriers, and facilitators. The FGDs comprised five participants from Abaji, five from AMAC, four from Bwari, three from Gwagwalada, five from Kuje, and five from Kwali, giving a total of 27 participants.

2.4 Data collection

Quantitative data were collected using a structured interviewer-administered questionnaire. The instrument captured caregivers' socio-demographic characteristics, knowledge of SMC, perceptions and attitudes towards the programme, participation in SMC, accessibility of services, and barriers and challenges affecting uptake and administration of SMC medicines.

The primary outcome for the quantitative analysis was SMC uptake, defined according to caregivers' report of whether any of their children had participated in the SMC programme. Additional questions assessed caregivers' awareness, perceptions of programme effectiveness, trust in SMC medicines, accessibility, and reasons for non-participation.

Qualitative data were collected through focus group discussions. The qualitative component explored caregivers' experiences and perceptions of SMC, sources and depth of programme awareness, perceived benefits and concerns, facilitators and barriers to participation, experiences with home-based administration and medicine distribution, and recommendations for improving programme implementation.

2.5 Data analysis

Quantitative data were analyzed using IBM SPSS Statistics v.20. Frequencies, percentages, means, and medians, were used to summarize caregiver characteristics and responses to SMC-related questions. Associations between SMC uptake and selected socio-demographic and programme-related characteristics were assessed using Pearson's chi-square test. Variables demonstrating statistically significant associations ($p < 0.05$) in bivariate analysis were considered for multivariable logistic

regression. Binary logistic regression was used to identify independent predictors of SMC uptake. Adjusted odds ratios (AORs) with corresponding 95% confidence intervals (CIs) were reported. Overall model significance was assessed using the omnibus test of model coefficients, while model fit was evaluated using the Hosmer–Lemeshow goodness-of-fit test. Nagelkerke R^2 was reported as a measure of the model's explanatory performance. Statistical significance was set at $p < 0.05$.

Qualitative data were analyzed thematically. Transcripts were reviewed to identify recurrent concepts, which were coded and grouped into themes and subthemes reflecting caregivers' knowledge, attitudes, experiences, barriers, facilitators, and recommendations concerning SMC. Selected verbatim quotations were used to illustrate key themes while preserving participants' perspectives.

Quantitative and qualitative findings were integrated during interpretation. The qualitative findings were used to contextualize and explain the quantitative patterns in SMC awareness, uptake, and associated factors, with areas of convergence and divergence between the two strands identified.

3. Results

3.1 Socio-demographic characteristics of caregivers

Of the 427 questionnaires distributed, 317 were returned, yielding a response rate of 74.2%. The mean age of caregivers was 33.2 ± 8.3 years (median: 31 years). Most [304/317(95.9%)] caregivers were female and [255/317 (80.4%)] were married. More than half [172/317 (54.3%)] had tertiary education, while [119/317 (37.5%)] had completed secondary education. Most [228/317 (71.9%)] caregivers were employed, and the median monthly income was ₦50,000. Detailed socio-demographic characteristics of the participants are presented in Table 1.

Table 1
Socio-demographic characteristics of caregivers (N = 317)

Variable	Category	N	%
Age (years)	Mean ± SD	33.2 ± 8.3	—
	Median	31	—
Sex	Male	13	4.1
	Female	304	95.9
Marital status	Single	34	10.7
	Married	255	80.4
	Divorced	17	5.4
	Widowed	11	3.5
Ethnic group	Yoruba	76	24
	Igbo	78	24.6
	Hausa	89	28.1
	Other	74	23.3
Highest level of education	No formal education	12	3.8
	Primary education	14	4.4
	Secondary education	119	37.5
	Tertiary education	172	54.3
Employment status	Employed	228	71.9
	Unemployed	89	28.1
Monthly income (₦)	Mean ± SD	109,335.3 ± 316,269.4	—
	Median	50,000	—
Health insurance coverage	Yes	106	33.4
	No	211	66.6

Note: Percentages are based on the total sample (N = 317). Age and monthly income are presented as summary statistics.

3.2 Caregivers' knowledge of the SMC program

Most [259/317 (81.7%)] caregivers had heard of the SMC program. Healthcare workers [113/317 (35.6%)] and community sensitization activities [99/317 (31.2%)] were the leading sources of information, followed by family or friends [38/317 (12.0%)] and the media [9/317 (2.8%)]. Overall,

[273/317 (86.1%)] caregivers correctly identified SMC as a program for preventing malaria among children under five.

It should be noted that the knowledge and perception questions were administered to all caregivers, irrespective of their response to the prior awareness question. The denominators in each case are clearly shown.

3.3 Caregivers' perceptions of the SMC program

Caregivers generally expressed favourable perceptions of the SMC program. Most [249/317 (78.5%)] perceived SMC as effective in preventing malaria among children under five, while [249/317 (78.5%)] were satisfied or very satisfied with the program. Similarly, [242/317 (76.3%)] expressed trust in the medications used for SMC.

3.4 SMC participation and barriers to uptake

Overall, [192/317 (60.6%)] caregivers reported that at least one of their children had participated in the SMC program, while [125/317 (39.4%)] reported no participation. Among the 125 caregivers who reported no participation, the most frequently cited reason was lack of awareness [50/125 (40.0%)], followed by fear of side effects [28/125 (22.4%)], lack of access to health facilities [21/125 (16.8%)], cultural or religious beliefs [11/125 (8.8%)], and other reasons [15/125 (12.0%)].

Regarding perceived accessibility, [104/317 (32.8%)] caregivers considered SMC services very accessible, [166/317 (52.4%)] considered them moderately accessible, and [47/317 (14.8%)] reported that the services were not accessible.

Overall, [104/317(32.8%)] caregivers reported experiencing challenges in accessing SMC. Among these caregivers, inconsistent drug availability was the most frequently reported challenge [51/104 (49.0%)], followed by long distances to health centres [25/104 (24.0%)], lack of communication about distribution schedules [22/104 (21.2%)], and other challenges [6/104 (5.8%)]. In addition, [40/317 (12.6%)] caregivers expressed concerns about administering SMC medication at home.

3.5 Factors associated with SMC uptake

In bivariate analysis in Table 2, SMC uptake was significantly associated with marital status, employment status, health insurance coverage, and awareness of the SMC programme (all $p < 0.001$). Uptake was higher among married caregivers [171/255 (67.1%)] than single caregivers [4/34 (11.8%)], among employed caregivers [156/228 (68.4%)] than unemployed caregivers [36/89 (40.4%)], and among caregivers with health insurance [82/106 (77.4%)] than those without insurance [110/211 (52.1%)]. Awareness showed the strongest association with uptake, with [186/259 (71.8%)] of caregivers who had heard of SMC reporting uptake compared with [6/58 (10.3%)] among those who had not. Age, gender, ethnicity, education, and monthly income were not significantly associated with SMC uptake ($p > 0.05$).

Table 2
Association between selected caregiver characteristics and SMC uptake

Variable	Category	No uptake, n (%)	Uptake, n (%)	χ^2	df	p-value
Age group (years)	< 25	20 (55.6)	16 (44.4)	6.02	3	0.111
	25–34	62 (39.7)	94 (60.3)			
	35–44	31 (32.3)	65 (67.7)			
	≥ 45	12 (41.4)	17 (58.6)			
Gender	Male	6 (46.2)	7 (53.8)	0.256	1	0.613
	Female	119 (39.1)	185 (60.9)			
Marital status	Single	30 (88.2)	4 (11.8)	38.694	3	**< 0.001***
	Married	84 (32.9)	171 (67.1)			
	Divorced	6 (35.3)	11 (64.7)			
	Widowed	5 (45.5)	6 (54.5)			
Ethnic group	Yoruba	28 (36.8)	48 (63.2)	6.238	3	0.101
	Igbo	40 (51.3)	38 (48.7)			
	Hausa	32 (36.0)	57 (64.0)			
	Others	25 (33.8)	49 (66.2)			
Education	No formal education	8 (66.7)	4 (33.3)	6.597	3	0.086
	Primary	6 (42.9)	8 (57.1)			
	Secondary	52 (43.7)	67 (56.3)			
	Tertiary	59 (34.3)	113 (65.7)			
Monthly income (₦)	< 50,000	67 (35.8)	120 (64.2)	4.806	3	0.187
	50,000–100,000	34 (47.9)	37 (52.1)			
	101,000–249,000	15 (48.4)	16 (51.6)			
	≥ 250,000	9 (32.1)	19 (67.9)			

Note: Percentages are row percentages. SMC uptake was defined as having at least one child participate in the SMC programme. χ^2 = Pearson chi-square statistic. *$p < 0.05$ was considered statistically significant.

Variable	Category	No uptake, n (%)	Uptake, n (%)	χ^2	df	p-value
Employment status	Employed	72 (31.6)	156 (68.4)	20.97	1	**< 0.001***
	Unemployed	53 (59.6)	36 (40.4)			
Health insurance	No	101 (47.9)	110 (52.1)	18.799	1	**< 0.001***
	Yes	24 (22.6)	82 (77.4)			
Awareness of SMC	No	52 (89.7)	6 (10.3)	74.972	1	**< 0.001***
	Yes	73 (28.2)	186 (71.8)			

Note: Percentages are row percentages. SMC uptake was defined as having at least one child participate in the SMC programme. χ^2 = Pearson chi-square statistic. *$p < 0.05$ was considered statistically significant.

In multivariable logistic regression analysis (in Table 3), the overall logistic regression model was statistically significant ($\chi^2 = 125.924$, df = 6, $p < 0.001$), with a Nagelkerke R^2 of 0.444, indicating substantial explanatory power. The model demonstrated adequate fit to the data (Hosmer–Lemeshow $\chi^2 = 10.840$, df = 6, $p = 0.093$) and correctly classified 80.8% of caregivers.

After adjustment for marital status, employment status, health insurance coverage, and awareness of SMC, awareness remained the strongest independent predictor of uptake. Caregivers who had heard of the SMC programme had substantially higher odds of reporting uptake than those who had not (AOR = 17.95, 95% CI: 6.96–46.27; $p < 0.001$). Employed caregivers had lower odds of SMC uptake than unemployed caregivers (AOR = 0.24, 95% CI: 0.13–0.44; $p < 0.001$), while caregivers with health insurance had higher odds of uptake than those without insurance (AOR = 1.95, 95% CI: 1.03–3.70; $p = 0.041$). Marital status was also independently associated with uptake. Compared with single caregivers, married caregivers had higher odds of SMC uptake (AOR = 11.03, 95% CI: 3.33–36.58; $p < 0.001$), as did divorced caregivers (AOR = 11.01, 95% CI: 2.04–59.47; $p = 0.005$). The association for widowed caregivers was not statistically significant (AOR = 5.05, 95% CI: 0.80–31.89; $p = 0.085$).

Table 3
Multivariable logistic regression of factors associated with SMC uptake

Predictor	AOR	95% CI	p-value
Marital status			
Married vs single	11.03	3.33–36.58	< 0.001
Divorced vs single	11.01	2.04–59.47	0.005
Widowed vs single	5.05	0.80–31.89	0.085
Employment status			
Employed vs unemployed	0.24	0.13–0.44	< 0.001
Health insurance			
Yes vs No	1.95	1.03–3.70	0.041
SMC awareness			
Yes vs No	17.95	6.96–46.27	< 0.001

Model $\chi^2 = 125.924$, df = 6, $p < 0.001$; Nagelkerke $R^2 = 0.444$; Hosmer–Lemeshow $\chi^2 = 10.840$, df = 6, $p = 0.093$; overall classification accuracy = 80.8%.

3.6 Qualitative findings

The qualitative findings provided contextual insights that helped explain the quantitative patterns observed in SMC awareness, uptake, and its associated determinants. Four interrelated themes emerged: awareness and understanding of SMC; perceived benefits and trust as facilitators of uptake; practical and structural barriers to participation; and side effects, misconceptions, and communication gaps affecting continued participation.

3.6.1 Awareness was widespread, but gaps in reach and understanding persisted

Participants described multiple pathways through which caregivers became aware of SMC, especially through healthcare workers, house-to-house distribution, community networks, and media. Community-based delivery appeared to provide an important opportunity for caregivers to learn about the intervention:

"I have seen health workers entering house by house in this Bwari. When they reached my house, I asked them what it is, and they said it's for malaria." (Participant, Bwari)

Caregivers who had encountered the programme generally understood SMC as a preventive intervention for children under five. One participant described it as:

"It is a preventive malaria drug given to children under the age of five, and I have been giving it to my children for two years now." (Participant, Kwali)

However, the qualitative accounts also demonstrated that awareness was not universal. Some caregivers reported prolonged absence of exposure to SMC activities:

"I've never heard about it. I've been living here for over a year now, and I've never seen people come around to distribute any medication." (Participant, AMAC)

Thus, while community-based approaches were important sources of information, gaps in programme reach remained a barrier to participation.

3.6.2 Perceived effectiveness, trust, and social influence facilitated uptake

Caregivers who participated in SMC commonly linked their decision to perceived effectiveness, personal experience, and recommendations from people within their social networks. Perceived effectiveness was sometimes reinforced by reduced illness and healthcare utilization:

"Yes, it has been very effective. My visits to the hospital due to malaria have reduced. If my child eats well and takes the medication, she doesn't fall sick during that period." (Participant, AMAC)

Social experiences and community testimonials also influenced decisions to participate:

"Because of its effectiveness. People I know, including from my church, also said their children didn't have malaria while on the program." (Participant, AMAC)

For some caregivers, participation also reduced the perceived financial and logistical burden associated with seeking treatment for childhood malaria:

"I enrolled them because I liked it. It saved me stress from running to the hospital or labs when they are sick." (Participant, Abaji)

Trust was generally linked to observed benefits, although it remained vulnerable to concerns about adverse effects. One caregiver explained:

"I trust the medication because it has gone very far in helping my family prevent the unforeseen." (Participant, Bwari)

These positive experiences were not universal. A caregiver who reported a subsequent malaria episode described some uncertainty about effectiveness but remained potentially willing to participate again:

"Honestly, my child got malaria two months after taking the medication, which made me doubt its effectiveness. But if they come again this year, I might give my child the drug." (Participant, Abaji)

3.6.3 Convenience of community delivery was offset by practical and structural barriers

Home-based delivery was widely perceived as convenient because it reduced transportation costs and the need to visit health facilities:

"I do not need to pay anything or go anywhere. It is brought to my house." (Participant, Abaji)

Similarly, house-to-house distribution by healthcare workers was viewed as making participation easier:

"Some nurses take the drugs house by house, making it easy for us." (Participant, AMAC)

However, the same delivery model could create barriers when households were unavailable during distribution. This was particularly relevant for caregivers who worked outside the home:

"Sometimes the healthcare workers come very early in the morning when you have gone to work." (Participant, AMAC)

Missed household visits could consequently result in missed opportunities to receive SMC:

"Whenever I am not home and the people distributing the drugs come to my compound, they skip my house for that month." (Participant, Abaji)

In addition, inconsistent availability of medication and difficulties reaching services were reported as barriers:

"Sometimes the drugs are not really available when I need them." (Participant, Bwari)

"If it is very accessible, then every mother can participate freely. But if it is far away from our reach… it will be hard to access." (Participant, Abaji)

3.6.4 Side effects, misconceptions, and communication gaps undermined participation and adherence

Concerns about adverse effects emerged as an important reason for discontinuing or hesitating to administer SMC. Some caregivers described stopping treatment after observing symptoms in their children:

"For me, my child's side effects and my husband's reaction made me stop giving it… now I know it was just a side effect." (Participant, Abaji)

However, appropriate guidance from healthcare workers could help caregivers manage these concerns and continue participation:

"The first time I started administering the drugs, his body became hot and weak, but I was advised by health workers to give ORS, and he was well." (Participant, Kuje)

Participants also described misconceptions surrounding SMC, including concerns about its potential effects on fertility. Although not universally accepted by caregivers, such beliefs could discourage participation:

"Some may say don't give your girl child; they're trying to reduce fertility… but I don't believe those superstitions." (Participant, Bwari)

The findings further indicated that communication about distribution schedules was important, especially for caregivers whose availability was constrained by work and other responsibilities. Participants recommended advance notification and more flexible distribution times:

"They should communicate their schedule… if they tell us when they are coming, we can make arrangements." (Participant, AMAC)

"While they visit homes in the morning, they should also visit in the evenings for those who are not available." (Participant, Kwali)

Caregivers also emphasized the need for clearer education about adverse effects and their management:

"If people understand side effects, they will know what to do and not panic." (Participant, AMAC)

Participants consequently called for broader and more consistent community sensitization through healthcare workers, house-to-house activities, and media platforms:

"They should use media platforms… selected health workers should go to the communities to create more awareness, like with polio immunization." (Participant, Bwari)

3.7 Triangulation of findings

The integration of quantitative and qualitative findings demonstrated convergence across several domains and provided contextual explanations for the observed patterns of SMC uptake. While the quantitative findings established the magnitude and statistical significance of key associations and barriers, the qualitative findings provided insight into how caregivers experienced these factors in practice. Table 4 presents the areas of convergence and complementarity between the two strands of evidence.

Table 4
Triangulation of quantitative and qualitative findings on SMC uptake among caregivers

Domain	Quantitative findings	Qualitative findings	Integrated interpretation
Awareness of SMC	259/317 (81.7%) caregivers had heard of SMC. Awareness was strongly associated with uptake (χ^2 = 74.972, df = 1, p < 0.001); uptake was reported by 186/259 (71.8%) caregivers who had heard of SMC compared with 6/58 (10.3%) among those who had not.	Participants reported learning about SMC through healthcare workers, house-to-house distribution, community members and media. However, some participants reported never having heard of the programme.	Convergence: Although awareness was high overall and strongly associated with uptake, qualitative accounts confirmed that information gaps persisted in some communities and among some caregivers.
Perceived effectiveness	249/317 (78.5%) caregivers considered SMC effective in preventing malaria among children under five.	Participants commonly described SMC as effective and reported fewer malaria episodes and reduced hospital visits after administration.	Convergence: Positive perceptions of effectiveness in the quantitative findings were supported by caregivers' reported experiences and appeared to motivate participation.
Trust and concerns about medication	242/317 (76.3%) caregivers reported trusting the medication, while 71/317 (22.4%) were unsure and 4/317 (1.3%) did not trust it. Fear of side effects was reported as a reason for non-participation by 28/317 (8.8%).	Participants generally expressed confidence in SMC but described fever, weakness and rashes as concerns. Some reported temporarily stopping administration because of side effects.	Convergence: Overall trust was high, but qualitative accounts showed how concerns about adverse effects could undermine confidence and continuation.
Employment and timing of distribution	Employment status was significantly associated with uptake (χ^2 = 20.970, df = 1, p < 0.001). Uptake was reported by 156/228 (68.4%) employed caregivers compared with 36/89 (40.4%) unemployed caregivers. In the adjusted model, employment status remained significantly associated with uptake (AOR = 0.241, 95% CI: 0.131–0.440, p < 0.001), with interpretation dependent on the model's reference coding.	Working caregivers reported difficulty being available when health workers arrived, particularly during early-morning household visits.	Complementarity with an important contextual tension: Although crude uptake was higher among employed caregivers, qualitative accounts identified work-related scheduling conflicts as a barrier to receiving SMC during household visits.

Domain	Quantitative findings	Qualitative findings	Integrated interpretation
Health insurance coverage	Uptake was higher among caregivers with health insurance (82/106; 77.4%) than among those without insurance (110/211; 52.1%; $\chi^2 = 18.799$, df = 1, $p < 0.001$). Health insurance remained associated with uptake in the adjusted model (AOR = 1.949, 95% CI: 1.026–3.700, p = 0.041).	Participants emphasized the convenience and reduced financial burden of home-based delivery, including avoiding transportation costs and visits to health facilities.	Complementarity: The quantitative association with insurance was not directly explored in the qualitative accounts, while qualitative findings highlighted broader access and cost-related advantages of home delivery.
Drug availability	Among the reported access challenges, inconsistent drug availability was the most frequently identified, affecting 51/317 (16.1%) caregivers.	Participants described irregular availability and uncertainty about where to obtain the medication.	Strong convergence: Both datasets identified inconsistent drug availability as an important implementation barrier.
Accessibility and distribution	Overall, 104/317 (32.8%) caregivers reported challenges accessing SMC, while 47/317 (14.8%) considered SMC services not accessible.	Participants reported that home delivery facilitated participation by reducing transportation and logistical barriers, but missed visits, distance and inconvenient distribution times could limit access.	Strong convergence: Accessibility was both a facilitator and a barrier, depending on the reliability and timing of distribution.
Communication and information	Lack of awareness was reported as the most common stated reason for non-participation (50/317; 15.8%). Lack of communication about distribution schedules was also reported as an access challenge by 22/317 (6.9%).	Participants requested clearer information about distribution schedules, broader community sensitization, and education about SMC, its benefits and side effects.	Strong convergence: Communication gaps were evident in both datasets and represent a potentially modifiable barrier to uptake.
Home administration	40/317 (12.6%) caregivers expressed concerns about administering SMC medication at home.	Caregivers valued home administration because it reduced transportation costs and inconvenience, although some expressed concerns about supervision and preferred facility-based administration.	Complementarity: Home administration was simultaneously perceived as a facilitator of convenience and a potential source of concern regarding administration and supervision.

4. Discussion

This study found that awareness of seasonal malaria chemoprevention (SMC) was relatively widespread among caregivers, but awareness did not consistently translate into programme uptake. Awareness emerged as the strongest independent predictor of participation. Also, caregivers who were employed had lower odds of SMC uptake, whereas those with health insurance coverage had higher odds of uptake. The qualitative findings provided important context, showing that caregivers generally viewed SMC as effective and convenient, especially when medicines were delivered to the home. However, concerns about side effects, inconsistent medicine availability, gaps in communication, missed household visits, and inconvenient distribution times could undermine participation. These findings suggest that improving SMC uptake requires not only increasing awareness but also addressing practical and programme-level barriers that influence caregivers' ability and willingness to participate.

The relatively high level of SMC awareness observed in this study is encouraging, with most caregivers having heard of the programme and correctly identifying its primary purpose as malaria prevention. Awareness was somewhat higher than that reported by Tom et al. [2] among caregivers in Kaduna State, where 76.8% had heard of SMC and 54.0% correctly identified it as a preventive intervention. This difference may reflect variation in programme exposure, implementation context, population characteristics, or access to health information, although direct comparison should be made cautiously because of differences in study settings and populations.

Healthcare workers and community sensitization activities were the leading sources of SMC information in the present study. Qualitative accounts similarly showed that caregivers learned about SMC through healthcare workers, house-to-house distribution, community members, and media. This reinforces the importance of community-based and interpersonal communication in SMC delivery. However, some qualitative participants reported never having heard of SMC or having no contact with distribution activities, indicating that information does not reach all households uniformly. This finding is especially relevant in an urban setting, where Ibinaiye et al. [3] reported lower SMC coverage and poorer caregiver knowledge among urban than rural populations across nine Nigerian implementing states. Their findings suggest that urban residence should not necessarily be assumed to confer better access to community-based preventive interventions.

It is important to note that high awareness should not be equated with comprehensive knowledge or programme participation. The present study assessed whether caregivers had heard of SMC and understood its preventive purpose, but qualitative accounts indicated that participation could still be affected by concerns about side effects, uncertainty about distribution, medicine availability, and difficulties being present when distributors visited. This interpretation is consistent with Ogbulafor et al. [5], whose qualitative study across five Nigerian states found that SMC was widely accepted but that perceived side effects, inadequate understanding of its purpose, mistrust, and local medicine shortages remained barriers to uptake. Similarly, Antwi et al. [9] found that differences in SMC uptake were not necessarily explained by caregivers' basic knowledge or perceptions of malaria; rather, physical access

to medicines, trust in programme providers, communication of distribution times, travel distance, and absence during home visits influenced participation.

The reported uptake in the present study was broadly comparable with the 58.4% of caregivers who reported that their children had received at least one SMC dose in the Kaduna study by Tom et al. [2]. However, only 27.2% in that study reported receipt of all four doses, illustrating the distinction between initial participation and sustained engagement with the intervention. Although the present study did not use completion of all scheduled cycles as its primary uptake outcome, evidence from Ibinaiye et al. [4] further demonstrates that caregiver-level factors can influence continuation of SMC: awareness of the importance of administering the Day 2 and Day 3 doses was associated with better adherence, whereas previous adverse reactions were associated with poorer adherence. This provides additional support for the importance of practical knowledge beyond simply having heard of SMC.

These findings suggest that awareness is an important entry point to SMC participation but is not sufficient on its own. The qualitative evidence indicates that caregivers may be willing to participate but still face programme-level barriers that limit their ability to do so. Strengthening SMC delivery therefore requires communication that provides practical and actionable information, alongside reliable medicine availability, timely household visits, and flexible delivery arrangements.

Awareness of SMC was the strongest independent predictor of reported uptake in the adjusted analysis. Caregivers who had heard of the programme had substantially higher odds of reporting uptake than those who had not. This finding is consistent with evidence from Nigeria and other SMC-implementing settings suggesting that caregiver knowledge is important for engagement with the intervention. Tom et al. [2] found that knowledge of SMC was significantly associated with uptake among caregivers in Kaduna State, while Ibinaiye et al. [4] reported that awareness of the importance of administering the Day 2 and Day 3 doses was associated with better adherence to SMC. These findings suggest that information may influence not only initial participation but also caregivers' subsequent engagement with the intervention. The qualitative findings reinforce this interpretation: participants described receiving information through healthcare workers, community distribution, neighbours, and media, while some reported never having heard of SMC. Thus, the quantitative and qualitative findings converge in indicating that exposure to reliable and meaningful SMC information is an important pathway to participation.

The association between marital status and uptake should be interpreted cautiously. Married and divorced caregivers had higher adjusted odds of uptake compared with single caregivers, whereas the association among widowed caregivers was not statistically significant. The relatively small numbers in some marital-status categories and the wide confidence intervals indicate considerable uncertainty around these estimates. None of the studies provided sufficient evidence to establish a comparable marital-status effect, and therefore this finding should not be overinterpreted. Household structure or availability of family support may potentially influence engagement with preventive services, but the

present data do not permit a definitive explanation. Further research with larger and more balanced marital-status groups would be required to clarify this association.

Employment showed an inverse association with uptake after adjustment, with employed caregivers having substantially lower odds of reporting participation. This finding is noteworthy because crude uptake was actually higher among employed caregivers, demonstrating the value of considering the adjusted model alongside the qualitative evidence. The qualitative findings provide a plausible explanation: employed caregivers described difficulties being available when community health workers visited households, particularly during early-morning distribution. This is consistent with Antwi et al. [9], who identified caregivers' absence during SMC home deliveries, poor communication about distribution timing, and other access constraints as barriers to uptake. Ogbulafor et al. [4] similarly emphasized the value of door-to-door delivery because it accommodates caregivers' daily activities. Thus, the qualitative findings provide an important complementarity to the quantitative association, suggesting that employment may reduce opportunities to receive SMC during scheduled household visits rather than necessarily reflecting lower willingness to participate.

Health insurance coverage was also independently associated with higher odds of SMC uptake. However, this association should be interpreted cautiously because the qualitative component did not directly explore or establish a relationship between health insurance and SMC participation. The qualitative findings instead highlighted broader financial and logistical advantages of home-based delivery, particularly reduced transportation costs and the convenience of receiving medicines at home. This contextual evidence is compatible with the broader importance of reducing access barriers identified by Antwi et al. [9], who found that physical access to SMC medication was an important determinant of uptake. Nevertheless, the present qualitative findings should not be presented as confirmation of the insurance–uptake association.

Caregivers generally held favourable views of SMC, with most perceiving the intervention as effective, expressing satisfaction with the programme, and reporting trust in the medicines used. The qualitative findings provide further support for these positive perceptions, as caregivers described fewer malaria episodes and reduced hospital visits following SMC administration and generally expressed confidence in the medication. Similar positive perceptions have been reported in other SMC settings. Chatio et al. [10], for example, found that parents in northern Ghana perceived SMC as effective in reducing malaria among children and expressed willingness for the intervention to continue. Likewise, Kangah et al. [11] reported positive perceptions, attitudes and adherence during implementation of SMC in Côte d'Ivoire. These findings suggest that favourable experiences with malaria prevention can contribute to community acceptance of SMC.

However, the qualitative findings in the present study also demonstrate that positive overall perceptions do not eliminate concerns about medication safety. Caregivers described fever, weakness and rashes following administration, and some reported temporarily stopping the medication because of perceived side effects. This is consistent with evidence from other SMC settings. Ogbulafor et al. [5] identified

perceived side effects, mistrust and concerns about the safety or effectiveness of medicines as barriers to uptake in Nigeria. Similarly, Ibinaiye et al. [4] found that previous adverse reactions to SMC medicines were associated with poorer adherence to subsequent doses. Evidence from Mali also illustrates the potential scale of this issue: Diarra et al. [12] reported that 61.9% of parents experienced side effects following SMC administration, although acceptance of the intervention remained high, with 93.4% supporting continued administration in the following year. Thus, the presence of medication concerns does not necessarily imply rejection of SMC but may influence confidence and continued administration when caregivers experience or perceive adverse effects.

The findings also highlight the importance of trust-building through effective community engagement. Sitoe et al. [13] found that community distributors provided additional information, helped build trust, and reduced anxiety and distrust regarding SMC medicines, while engagement of community leaders helped prevent misinformation and foster community ownership. This complements the present qualitative findings, in which healthcare workers and community-based distribution were important sources of information. Ogbulafor et al. [5] similarly reported that community drug distributors were generally trusted and that caregivers preferred door-to-door delivery because it provided opportunities to ask questions and receive explanations from distributors.

The evidence suggests that maintaining high acceptance of SMC requires more than communicating its effectiveness. Caregivers need clear and trusted information about both benefits and medication-related concerns. Communication should explain expected adverse effects, appropriate responses when they occur, and when caregivers should seek assistance, while community distributors and other trusted local actors should be equipped to address concerns during household visits. This approach may help preserve confidence in SMC and reduce the risk that concerns about adverse effects translate into interruption or non-participation.

5. Implication for policy and practice

The findings suggest that improving SMC uptake requires interventions that extend beyond general programme awareness. SMC communication should provide clear, practical information on eligibility, distribution schedules, expected side effects, and appropriate responses to adverse events, using healthcare workers, community distributors, and community-based sensitization channels. Programme managers should also ensure consistent medicine availability and strengthen mechanisms for reaching households missed during routine distribution. Distribution strategies should be sufficiently flexible to accommodate caregivers who may be away from home during working hours. These measures could improve access, confidence, and participation in SMC programmes in malaria-endemic settings.

6. Limitations of the study

The following limitations should be considered when interpreting the findings of the study. First, the cross-sectional design limits causal inference. Although several socio-demographic and programme-

related factors were associated with SMC uptake, their temporal relationship with uptake cannot be established; therefore, the observed associations should not be interpreted as causal. Second, quantitative information on SMC participation, awareness, perceptions, and experiences was largely self-reported and may have been affected by recall or social desirability bias. Caregivers may have had difficulty recalling previous SMC participation or may have provided responses perceived as favourable to the programme. The use of structured interviewer-administered questions provided a consistent approach to data collection but could not eliminate these biases. Third, although the quantitative sample was proportionately allocated across the six Area Councils, the final household-level recruitment process could not be reconstructed in sufficient detail to establish that every eligible caregiver had a known and equal probability of selection. The findings should therefore be interpreted primarily within the study population and setting, and generalization to all caregivers in the FCT or other Nigerian settings should be made cautiously. Fourth, the qualitative component included 27 participants across six focus group discussions, with group sizes ranging from three to five participants. Although purposive selection was used to obtain perspectives from all six Area Councils, the qualitative findings are not statistically representative of caregivers, and the small and uneven group sizes may have limited the range of perspectives captured in some areas. Fifth, qualitative findings were based on participants' reported experiences and perceptions and were not independently verified against programme records. Nevertheless, the qualitative component provided valuable contextual explanations for the quantitative findings, particularly regarding awareness, perceived effectiveness, medication concerns, accessibility, drug availability, and distribution challenges. Finally, the study was conducted in the FCT, where malaria transmission patterns, SMC implementation arrangements, healthcare access, and population characteristics may differ from those in other Nigerian settings. Accordingly, the findings may not be directly generalizable to areas with different epidemiological, programme, or health-system contexts.

This study has several strengths. The mixed-methods design enabled quantitative assessment of factors associated with SMC uptake while qualitative findings provided contextual explanations for caregivers' experiences, perceptions, and barriers to participation. The integration of both components strengthened interpretation of findings, especially regarding the roles of awareness, employment, accessibility, medication concerns, and programme implementation. The study included caregivers across all six Area Councils of the FCT, providing geographic coverage of the study setting. In addition, the use of an interviewer-administered structured questionnaire and a predefined qualitative guide promoted consistency in data collection.

7. Conclusion

SMC uptake among caregivers was moderate despite relatively high awareness of the programme. Awareness was the strongest independent predictor of SMC uptake, with caregivers who had heard of the programme having substantially higher odds of participation. Employed caregivers had lower odds of uptake, whereas those with health insurance coverage had higher odds of participation. Qualitative findings further showed that caregivers generally valued SMC and perceived it as effective and convenient, but medication concerns, inconsistent drug availability, communication gaps, and difficulties

receiving medicines at convenient times could limit participation. Strengthening caregiver education, reliable medicine supply, and flexible, predictable distribution strategies may improve participation and programme delivery in malaria-endemic settings.

Abbreviations

AMAC
Abuja Municipal Area Council
AOR
Adjusted Odds Ratio
AQ
Amodiaquine
CI
Confidence Interval
FCT
Federal Capital Territory
FGD
Focus Group Discussion
SD
Standard Deviation
SMC
Seasonal Malaria Chemoprevention
SP
Sulfadoxine–Pyrimethamine
WHO
World Health Organization

Declarations

Ethical approval

This study was conducted in full accordance with the ethical principles outlined in the Declaration of Helsinki. Ethical approval was obtained from the Federal Capital Territory (FCT) Health Research Ethics Committee (FHREC/2025/01/62/10-03-25) and the Nile University Ethics and Research Committee (0020/25).

Consent to participate

Written informed consent was obtained from all participants, ensuring they understand the study's purpose, procedures, potential risks, and benefits, and their right to withdraw at any time without any repercussions.

Consent to publish

Not applicable

Competing interests

The authors declare that they have no competing interests.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Author Contribution

NAE and SA conceptualized the study, designed the methodology, supervised data collection, and contributed to the first draft of the manuscript. NAE additionally secured study resources and obtained ethical approval. SA provided validation and a supervisory role throughout the study. LOP contributed to research design and performed the quantitative and qualitative data analyses and interpretation, as well as discussion of findings. LOP also drafted the manuscript, and participated in its revision. All authors have read and approved the final version of the manuscript.

Data Availability

The datasets supporting the conclusions of this article are included within the article (and its additional files).

Code availability

Not applicable

Clinical trial number

Not applicable

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Supplementary Files

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- SMCDATASET2.xlsx