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# Knowledge, beliefs and adherence to antimalarial medications among patients in the Ga East Municipality of Ghana

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Treatment adherence is necessary for several reasons, including preventing the development of resistance and avoiding progression to a severe form of the disease. This study explored patients' beliefs and their impact on adherence to antimalarial medications (orthodox and herbal medicines). A cross-sectional survey was conducted over three weeks in the Ga East Municipal District of Ghana. The study involved 346 participants and employed comprehensive questionnaires to gather data, which was analyzed using STATA version 14. Despite the high prevalence of malaria in the district, adherence to antimalarial medication remained a challenge. The study revealed varying opinions among participants regarding the safety and efficacy of different antimalarial treatments. The research highlighted the connection between patients' beliefs, age, knowledge, and adherence. Younger individuals showed higher adherence rates, emphasizing the need for age-specific interventions. Comprehensive knowledge also correlated with better adherence, highlighting the role of education. The study recommended the development of tailored educational campaigns that address misconceptions and foster trust between healthcare providers and patients. Innovative interventions, such as mobile phone-based reminders and incentives, were suggested to improve adherence. The research emphasized the importance of holistic malaria prevention strategies, including robust educational initiatives, targeted interventions in hotspot districts, and widespread distribution of insecticide-treated nets. The study's insights offer actionable recommendations to enhance malaria control efforts in the Ga East Municipal District and beyond.

## KEYWORDS

Ghana, malaria, treatment, drugs, compliance

## Introduction

Malaria remains a significant global public health concern, with *Plasmodium falciparum* accounting for the highest morbidity and mortality rates, particularly in sub-Saharan Africa (World Health Organization, 2023). The disease is transmitted by female *Anopheles* mosquitoes, progressing from liver-stage infection to erythrocytic invasion, which triggers clinical manifestations such as fever, chills, and headaches. If left untreated, malaria can lead to severe complications, including organ failure and death (García, 2010). In 2021, approximately 247 million malaria cases were recorded globally, with sub-Saharan Africa bearing the brunt of the disease, accounting for 95% of cases and 96% of deaths (World Health Organization, 2022). In Ghana, including the Ga East Municipal District, malaria remains highly endemic, necessitating comprehensive control and treatment strategies (Peprah et al., 2018).

Artemisinin-based Combination Therapies (ACTs) have been Ghana's first-line treatment for uncomplicated malaria since 2004 (Guidelines for Case Management of Malaria in Ghana, 2020). Although ACTs are highly effective, resistance linked to mutations in the *kelch13* gene poses a growing threat to their efficacy (Kozlov, 2021). Ensuring adherence to prescribed antimalarial regimens is crucial to preventing disease progression, reducing transmission, and mitigating drug resistance (Gast and Mathes, 2019). However, poor adherence remains a challenge worldwide, influenced by side effects, financial constraints, misconceptions, and forgetfulness (Shahin et al., 2019). Patient beliefs play a critical role in medication adherence. Perceptions of the efficacy and safety of orthodox versus herbal antimalarial treatments significantly influence treatment behaviors (Afolabi et al., 2020). Understanding these beliefs is essential for designing targeted interventions to improve compliance. While Ghana has a longstanding tradition of using herbal remedies for malaria, concerns persist regarding their safety, efficacy, and regulatory oversight (Amponsah et al., 2015). Although public health guidelines permit the use of herbal treatments following a confirmed malaria diagnosis, self-medication and reliance on unregulated herbal products may contribute to poor adherence to prescribed therapies (Awuah et al., 2018; Donkor et al., 2021).

This study assesses patients' knowledge, beliefs, and adherence to antimalarial medications in the Ga East Municipal District. Specifically, it aims to evaluate patients' understanding of malaria and its treatment, investigate their beliefs about antimalarial drugs, and explore the relationship between these beliefs and adherence to treatment. Given the recent introduction of the RTS, S/AS01 malaria vaccine, findings from this study could inform strategies to enhance vaccine uptake and reinforce malaria prevention efforts (World Health Organization, 2023). This research contributes to broader efforts to improve malaria treatment adherence and public health outcomes in endemic regions by addressing knowledge gaps and misconceptions. Patient, provider, cultural, historical, and healthcare system factors all influence pharmaceutical usage

patterns, despite the absence of easy answers (World Health Organization, 2022; World Health Organization, 2023).

A study conducted in Ghana (Amponsah et al., 2015) found that other factors, such as awareness of the medicine and its benefits, were identified as causes of medication non-adherence (Amponsah et al., 2015). However, adherence to treating illness in general and antimalarial treatment, in particular, is not always perfect (Amponsah et al., 2015; Awuah et al., 2018). Another study (Awuah et al., 2018) found that inadequate health information and specific individuals' attitudes towards the use of medications, particularly ACTs, side effects, and the issue of recall, particularly among the elderly, were the primary factors influencing adherence to ACT use in the research region. A person's beliefs about medication are essential for sticking to the treatment. Studies show that when patients are aware of the harmful effects of malaria, they are more likely to follow the prescribed treatment and prevention measures (Amponsah et al., 2015; Arora et al., 2021).

## Methodology

### Study design and period

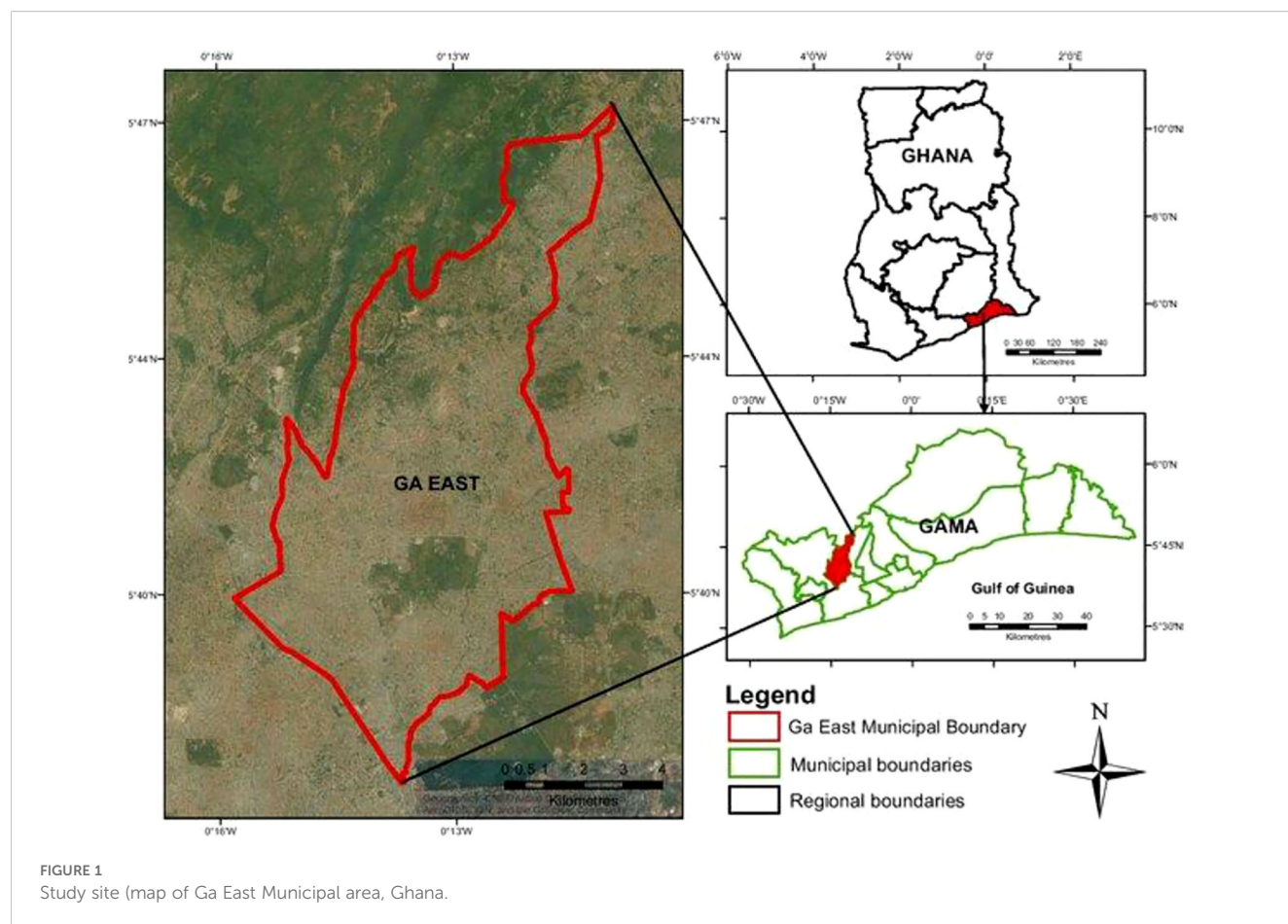
This research employed a cross-sectional survey comprising 58 questions that assessed patient demographics, personal malaria history, perceptions of malaria, views on orthodox and herbal medicines for malaria treatment, and health education and communication. The data was collected over three weeks.

### Study area

The Ga East Municipal Assembly is one of Ghana's 261 Metropolitan, Municipal, and District Assemblies (MMDAs), comprising part of the 29 MMDAs in the Greater Accra Region. The high number of malaria cases in this area led to its selection for study. The municipality is located in the northern part of the Greater Accra Region, with its administrative center in Abokobi. The municipality has twenty health facilities, including one District Hospital, one Polyclinic, two Quasi-Governmental Health Centres, and sixteen Private Health Centres.

### Population for study

The population for this study consisted of patients with malaria infections who had been prescribed antimalarial medication for the previous two years at various health facilities in the Ga East Municipality of Ghana's Greater Accra Region (Figure 1). The target population is roughly twenty-eight thousand three hundred and thirty-eight (28,338) people. Following data collection at a few chosen health centers, the population was estimated to be 10% of the entire Ga East Municipal population.



## Sample and sampling technique

The researcher visited selected households randomly within the designated communities in the municipality, administering questionnaires until the required sample size was achieved. The total estimated sample size was 346.

These patients were diagnosed with malaria infections from a target population of twenty-eight thousand three hundred and thirty-eight (28,338).

## Sample size determination

Based on the population of the Ga East Municipal District, the sample size was determined with a 95% confidence level, allowing for a margin of error of  $\pm 5$ . The population for this study were patients diagnosed with malaria and prescribed antimalarial medication in the Ga East Municipal District. The formula for estimating the sample size for a proportion in a single population was used below to determine the appropriate sample size (Naing et al., 2006).

$$n = Z^2 \cdot p \cdot (1 - p) / d^2$$

The calculation was based on approximately 10% of the population. The following assumptions were made: a 95%

confidence level and a 5% margin of error. The sample size formula I used to determine the size is shown below. Where:

Z is the standard normal deviation corresponding to the desired confidence level (for a 95% confidence level,  $Z = 1.96$ ). p is the estimated proportion of individuals with the characteristic of interest in the population (10%, or 0.1) d is the desired margin of error (0.05)

Plugging in these values, we get:

$$n = (1.96)^2 \cdot 0.1 \cdot 0.9 / (0.05)^2$$

$$n = 345.96$$

Based on these assumptions, the minimum sample size required for this study is 345.96

Rounding up to the nearest whole number, the recommended sample size would be 346 patients.

## Inclusion and exclusion criteria

To respect the participant's right to participate or exclude themselves from the research, their consent was sought after an

explanation of the purpose and details of the study. This ensured that the right respondents were asked if they had been infected and diagnosed with malaria. The study included participants who lived in the research area, could communicate clearly, and were 18 years of age or older.

Those who responded “No” (whether they had had malaria and had been treated in the past years) were also excluded. This process was repeated until the researcher obtained the required sample size.

## Data collection instrument and procedure

The study used a standardized questionnaire (see Appendix A) to collect the required data. The questionnaire had 58 questions structured into five (5) main sections: sections A, B, C, D, and E. Section A involved the respondents’ biodata, while the rest contained questions arranged systematically and related to the three research objectives. The items for the construction were based on the Likert scale points. Trial samples of 10 questionnaires were initially distributed to test participants’ understanding of the questionnaire.

## Data entry, cleaning and analysis

Data collected from participants was recorded in the SurveyMonkey application. The entries were rechecked to ensure that the correct information was recorded. Where an error was found, it was cross-checked with the questionnaires obtained. A comprehensive descriptive analysis was conducted following data entry, incorporating statistics such as frequencies and percentages. Inferential statistical methods were applied. Logistic regression, odds ratios (OR), and adjusted odds ratios (AOR) were utilized to explore the factors influencing participants’ beliefs and adherence to antimalarial medication. The data gathered from the survey were meticulously analyzed using STATA version 14.

## Results

As shown in [Table 1](#), a little over 90% of the participants fell within the 18- to 45-year-old age bracket. There were slightly more females (53.76%) than males.

TABLE 1 Demographic data of respondents.

Variable	Category	Frequency (N=346)	Percentage (%)
What is your age?	18-30 years	232	67.05
	31-45 years	82	23.70
	46-60 years	27	7.80
	>60 years	5	1.45
What is your gender?	Male	160	46.24
	Female	186	53.76
What is your level of education?	No formal education	0	0
	Primary education	0	0
	Secondary education	13	3.76
	Tertiary education	333	96.24
What is your employment status?	Employed	247	71.39
	Self-employed	30	8.67
	Student	56	16.18
	Unemployed	13	3.76
What is your religion?	Christianity	326	94.22
	Islam	6	1.73
	I prefer not to say	4	1.16
	Other (please specify)	10	2.89
What region of Ghana do you come from?	Greater Accra	101	29.19
	Volta	76	21.97
	Ashanti	45	13.01

(Continued)

TABLE 1 Continued

Variable	Category	Frequency (N=346)	Percentage (%)
	Central	31	8.96
	Western	18	5.21
	Eastern	14	4.05
	Western North	5	1.45
	Upper East	20	5.78
	Bono East	10	2.89
	Oti	20	5.78
	Northern	6	1.74
What ethnic group do you belong to?	Ga	101	29.19
	Frafra	10	2.89
	Akan	106	30.64
	Mole-Dagbani	6	1.73
	Gurunsi	6	1.73
	Kasena	4	1.16
	Guan	20	5.78
	Ewe	76	21.97
	Sefwi	5	1.45
	Kusase	4	1.16
	Kotokoli	8	2.31

## History of malaria infection of respondents

As shown in [Table 2](#), about three-quarters of the respondents have had malaria at least once in the past 12 months, while the remaining (26.07) were not sure they had.

## Assessing the knowledge of respondents on antimalarial medication

The data presented in [Table 3](#) indicate that approximately 99% of respondents were aware of how malaria is contracted. Additionally, nearly 70% of respondents could distinguish between orthodox malaria medication and herbal medication.

## Level of Knowledge on Antimalarial Medications

As shown in [Figure 2](#) (above), a little over three-quarters of the participants had at least good knowledge of antimalarial medication use. About a quarter had satisfactory knowledge, whilst 7.6% had poor knowledge of antimalarial use.

Data presented in [Table 4](#) revealed that a little over half of the respondents believe that herbal antimalarial medication possesses more risks compared to orthodox medicines.

## Beliefs on antimalarial medications

[Figure 3](#) presents the findings on respondents' beliefs regarding the use of antimalarial medication. Approximately 19.0% of the participants hold poor beliefs about the use of antimalarial medicines, 40.9% have satisfactory beliefs, and 40.1% have reasonable beliefs.

As shown in [Table 5](#) below, many of the respondents (94.5%) believed that orthodox antimalarial medications were more effective than herbal antimalarial medications (64.74%).

## Medication adherence of participants to antimalarial therapy

The results presented in [Table 6](#) indicate that almost all the respondents (99.42%) believed it was essential to complete the entire course of antimalarials. However, about two-thirds of respondents admitted to having missed a dose of antimalarial medication.

TABLE 2 History of malaria diagnosis.

Variable	Category	Frequency (N=346)	Percentage (%)
Have you been diagnosed with Malaria in the past 12 months?	Yes	340	98.27
	No	6	1.73
If yes, how many times have you been diagnosed with malaria in the past 12 months?	1-5 times	156	51.49
	6-10 times	16	5.28
	More than 10 times	52	17.16
	Not sure	79	26.07
Where did you receive your diagnosis and treatment?	Local District hospital	50	14.45
	Private healthcare facility	131	37.86
	A local clinic or health center	14	4.05
	Hospital	81	23.41
	Traditional healers or herbalists	2	0.58
	Self-diagnosed	57	16.47
	Not sure	11	3.14

TABLE 3 Assessing the knowledge of antimalarial medication.

Variable	Category	Frequency (N=346)	Percentage
What is your understanding of malaria as a disease?	Spread through cough or sneeze.	0	0.00
	Spread through kissing or touching infected persons	4	1.16
	Spread through mosquitoes' bites.	342	98.84
	Hereditary	0	0.00
Can you describe what antimalarial does to your body?	It helps kill the parasites that cause malaria	220	63.58
	Make your body stronger and less likely to get infected by mosquitoes.	26	7.51
	Boost the immune system.		
	The blood taste bad to prevent mosquito bites	98	28.32
Are you able to differentiate between orthodox and herbal antimalarials?	Yes	242	69.94
	No	63	18.21
	Not sure	41	11.85
What are the consequences of not adhering to antimalarial medication as prescribed?	Develop resistance to the medication, making it less effective in the future.	160	46.24
	Experience more severe symptoms of malaria.	95	27.45
	Increased recurring of malaria after initial treatment.	91	26.30
	Increased risk of spreading malaria to others if you are bitten by infected mosquitoes.	0	0.00
In your opinion, which of the antimalarial medications is considered safer?	Orthodox	210	60.69
	Herbal	14	4.05
	Both are equally safe.	96	27.75
	Not sure	26	7.51

(Continued)



TABLE 3 Continued

Variable	Category	Frequency (N=346)	Percentage
In your opinion, how would you rate the severity of malaria in the community?	Very Severe	25	7.23
	Moderately severe	129	37.28
	Slightly severe	57	16.47
	Not severe	86	24.86
	Not sure	49	14.16
In your opinion, which population group seems most susceptible to malaria?	Children under the age of 5	161	46.53
	Pregnant women	32	9.25
	Elderly individuals	6	1.73
	People with weakened immune systems	97	28.03
	Not sure	50	14.45
In your opinion, how worried about getting malaria?	A great deal	84	24.28
	A lot	46	13.29
	A moderate amount	50	14.45
	A little	116	33.53
	None at all	50	14.45
In your opinion, how important is early diagnosis and treatment of malaria?	Not important at all	2	0.58
	Somewhat important	23	6.65
	Moderately important	10	2.89
	Very important	311	89.88

## Factors that influence beliefs on antimalarial therapy

As shown in [Table 7](#) below, the participants' age and level of knowledge were factors that affected their beliefs about antimalarial therapy.

## Association with antimalarial medication adherence

According to [Table 8](#) (below), the respondents' age, level of knowledge, and beliefs were strongly associated with medication adherence.

In the tables above, "Ref" stands for the reference category. In statistical analysis, particularly in logistic regression, one category of a categorical variable is chosen as the reference category for comparison with other categories. The reference category serves as a baseline against which different categories are compared.

This study, along with the one carried out by Amponsah et al., focuses on assessing various aspects of malaria awareness, knowledge, beliefs, and adherence to antimalarial medications among respondents (Amponsah et al., 10).

Malaria has been a persistent public health threat despite the devastating impact of malaria on health and the economy. It was, therefore, imperative to assess respondents' knowledge of malaria

infections, treatments, and their adherence to proper medication. Results indicate that 98.8% of respondents understand malaria and the transmission mode ([Table 2](#)). About 60.7% consider orthodox medications safe, 4.1% consider Herbal medications safe, and 27.8% consider both safe ([Table 3](#)). In the groups most susceptible to vulnerability, 46.5% considered children to be vulnerable, 9.3% considered pregnant women, 1.7% considered elderly individuals, 28.0% considered immunocompromised persons, and 14.5% were unsure ([Table 3](#)). Considering the severity of malaria in the community, approximately 7.2% considered it very severe, 37.3% considered it moderately severe, 16.4% considered it slightly severe, 24.8% considered it not severe, and 14.2% were unsure whether malaria was severe in the community ([Table 3](#)). About 46.5% believe children are most susceptible to malaria, and 9.3% believe pregnant women are most vulnerable. In comparison, 28.0% believe immunocompromised people are most susceptible ([Table 3](#)). A quarter, 24.3%, are greatly worried about malaria infection, while a third are slightly worried ([Table 3](#)). The majority, 89.9%, recognized that early malaria diagnosis is essential, while 6.7% believed that early diagnosis may be necessary ([Table 3](#)). From the study, respondents had diverse knowledge of malaria infections, treatment and adherence to medication. This came to light when the results showed that few knew some variables. In contrast, others were unsure, despite 76.8% of their level of antimalarial use being rated as either good (47.8%) or very good (27.0%), as illustrated in [Figure 2](#).

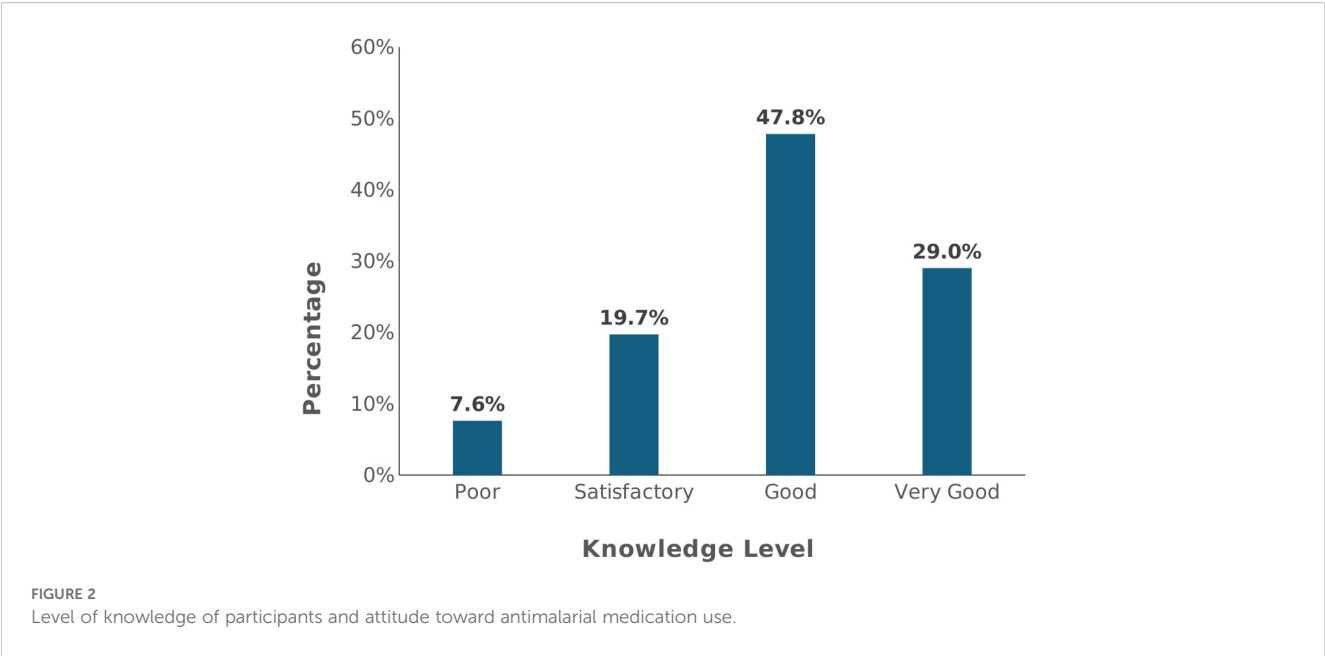


TABLE 4 Attitude towards orthodox and herbal antimalarial use.

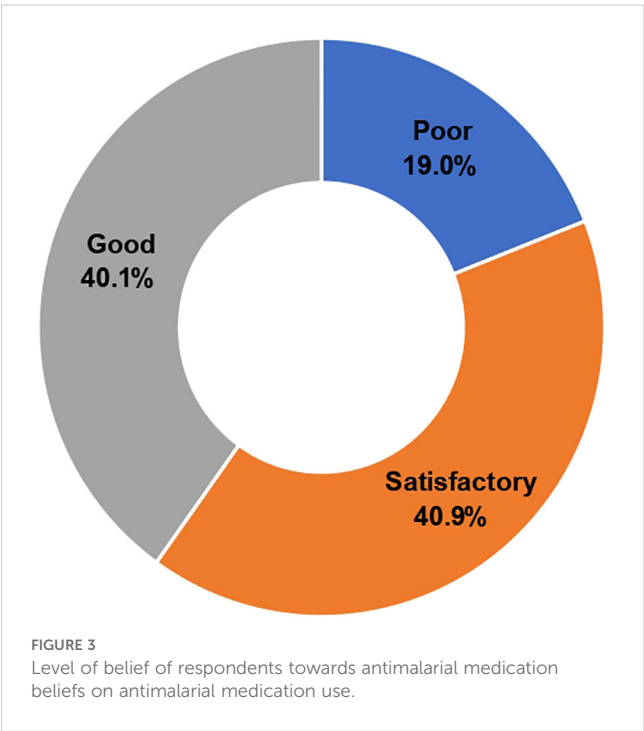
Variable	Category	Frequency (N=346)	Percentage (%)
How would you rate your trust in orthodox antimalarial medication?	Very trustful	218	63.01
	Moderately trustful	99	28.61
	Slightly trustful	20	5.78
	Not trustful	5	1.45
	Not sure	4	1.16
How would you rate your trust in herbal antimalarial medication?	Very trustful	36	10.40
	Moderately trustful	108	31.21
	Slightly trustful	106	30.64
	Not trustful	57	16.47
	Not sure	39	11.27
How do you rate your personal experiences with orthodox antimalarials?	Very satisfied	126	36.73
	Satisfied	185	53.94
	Not Satisfied	28	8.16
	No experience	4	1.17
How do you rate your personal experiences with herbal antimalarials?	Very satisfied	17	5.00
	Satisfied	102	30.00
	Not Satisfied	85	25.00
	Dissatisfied	22	6.47
	Very dissatisfied	5	1.47
	No experience	109	32.06
How much influence does your family, friends or community have on your choice of antimalarial medication (Orthodox or Herbal)?	Very high influence	22	6.41
	High influence	72	20.99

(Continued)



TABLE 4 Continued

Variable	Category	Frequency (N=346)	Percentage (%)
	Moderate influence	45	13.12
	Slight influence	83	24.20
	No influence	121	35.28
How would you rate your level of trust in healthcare professionals when with antimalarial medication?	Very High	77	22.45
	High	185	53.94
	Neutral	67	19.53
	Low	7	2.04
	Very Low	7	2.04
How confident do you think you are in understanding of information provided about antimalarial medications by the healthcare professional?	Very good	83	24.20
	Good	190	55.39
	Neutral	60	17.49
	Poor	10	2.92
How much does your cultural beliefs influence your preference?	Strongly	21	6.12
	Moderately	43	12.54
	Slightly	39	11.37
	Not at all	229	66.76
	Don't Know	11	3.21
Which antimalarial possesses more risks	Orthodox	23	6.71
	Herbal	184	53.64
	Both are the same	53	15.45
	Don't Know	83	24.20



Discussion

The study found that 91.1% of the respondents' beliefs regarding the use of antimalarial medication were either satisfactory or reasonable. That is, 40.9% have satisfactory beliefs about the use of antimalarial medicines, while 40.1% have reasonable beliefs about antimalarial medications. About a fifth of the participants have poor beliefs about antimalarial medication use. On their central belief, 94.5% of the respondents believed that orthodox antimalarial medications effectively treat malaria. In comparison, 64.7% believe that herbal antimalarials are effective at treating malaria, with 27.8% unsure. About 74% of the respondents believe that the benefits of orthodox or herbal antimalarial medications outweigh their side effects. Considering the safety of orthodox antimalarials in pregnancy, 58.7% believe they are safe, 17.9% think they're not, and 23.4% are unsure. About 14.7% of respondents believe that herbal medications are safe in pregnancy, 52.0% think they are not secure, and 33.2% are not sure. A third, 134 (38.7%), believe that orthodox antimalarials can provide prophylaxis, 45.4% do not, and 15.9% are unsure. The Amponsah et al. study participants demonstrated a good understanding of the recommended antimalarial drugs, their

TABLE 5 Beliefs on antimalarial medication use.

Variable	Category	Frequency (N=346)	Percentage (%)
Do you believe that Orthodox Antimalarial medications are effective in treating Malaria?	Yes	327	94.51
	No	11	3.18
	Not sure	8	2.31
Do you believe that Herbal Antimalarial Medications are effective in treating Malaria?	Yes	224	64.74
	No	26	7.51
	Not sure	96	27.75
Does one's socio-economic status influence his/her ability to buy antimalarial medication?	Yes	183	53.35
	No	134	39.07
	Not sure	26	7.58
Have you ever experienced any Side Effects from Orthodox or Herbal Antimalarial medications?	Yes	107	30.92
	No	190	54.91
	Not sure	49	14.16
In your opinion, what are the side effects that you experienced from taking orthodox antimalarial medications?	Nausea/Vomiting	57	16.47
	Headache	21	6.07
	Dizziness	98	28.32
	Fatigue	96	27.75
	Rash/Itching	26	7.51
	Diarrhea	30	8.67
	Tinnitus	7	2.02
	Metallic Taste	11	3.18
	None	0	0.00
In your opinion, what are the side effects that you experienced from taking herbal antimalarial medications?	Nausea/Vomiting	58	16.76
	Headache	45	13.01
	Dizziness	35	10.12
	Fatigue	54	15.61
	Rash/Itching	32	9.25
	Diarrhea	38	10.98
	Penile erection	1	0.29
	Increased Appetite	3	0.87
	None	80	23.12
Do you think the benefits of Orthodox or Herbal Antimalarial medications outweigh their side effects?	Yes	256	73.99
	No	41	11.85
	Not sure	49	14.16
Do you believe that Orthodox Antimalarial Medications are safe for pregnant women?	Yes	203	58.67
	No	62	17.92
	Not sure	81	23.41
Does the severity of the malaria influence choice of medication	Yes	210	61.22
	No	86	25.07

(Continued)

TABLE 5 Continued

Variable	Category	Frequency (N=346)	Percentage (%)
	Not sure	47	13.70
Do you believe that Herbal Antimalarial Medications are safe for pregnant women?	Yes	51	14.74
	No	180	52.02
	Not sure	115	33.24
Do you believe that Orthodox Antimalarial Medications can prevent future malaria infections?	Yes	134	38.73
	No	157	45.38
	Not sure	55	15.90
Do you believe that Herbal Antimalarial Medications can prevent future malaria infections?	Yes	72	20.81
	No	192	55.49
	Not sure	82	23.70

TABLE 6 Antimalarial medication adherence.

Variable	Category	Frequency (N=346)	Percentage (%)
Do you believe that it is important to complete full course of antimalarial?	Yes	344	99.42
	No	2	0.58
	Not sure	0	0.00
Have you ever stopped taking your antimalarial medications before completing the course?	Yes	187	54.05
	No	144	41.62
	Not sure	15	4.34
Have you ever missed a dose of antimalarial medication?	Yes	228	65.90
	No	107	30.92
	Not sure	11	3.18
If you answered "Yes" to the question what were the reasons for missing a dose?	I forgot	138	39.88
	I ran out of the medication	53	15.31
	I Felt better and stopped taking it	85	24.56
	I experienced side effects so I stopped.	70	20.23
How do you remember to take your antimalarial medication?	Set an alarm	85	24.57
	Take it at the same time every day	109	31.50
	Use a reminder app	20	5.78
	Keep it in a visible place	45	13.01
	Ask someone to remind me	35	10.12
	I don't have a specific method	52	15.03
Do you believe that missing doses of orthodox or herbal antimalarial medication can increase the risk of developing resistance to the medication?	Yes	247	78.90
	No	54	15.61
	Not sure	45	13.01
Are you aware of the concept of drug resistance?	Yes	273	78.90
	No	46	13.29
	Not sure	27	7.80

(Continued)

TABLE 6 Continued

Variable	Category	Frequency (N=346)	Percentage (%)
Have you ever experienced a recurrence of malaria symptoms after taking herbal antimalarial medication?	Yes	108	31.21
	No	191	55.20
	Not sure	47	13.58
Have you ever experienced a recurrence of malaria symptoms after taking orthodox?	Yes	108	31.21
	No	191	55.20
	Not sure	47	13.58
Have you received any education about malaria and its treatment from healthcare?	Yes	289	83.53
	No	45	13.01
	Not sure	12	3.47
If yes, was the information you received sufficient?	Yes	258	74.57
	No	33	9.54
	Not sure	55	15.90

dosages, efficacy, and side effects. However, there were knowledge gaps regarding certain aspects of malaria (Amponsah et al., 2015; Awuah et al., 2018).

Additionally, about a fifth (20.8%) believe that herbal antimalarials can be used as prophylactics, 55.5% do not think so, and nearly a quarter (23.7%) are unsure. Amponsah et al. focused

on beliefs such as the influence of spiritual beliefs on healing and trust in medications (Amponsah et al., 2015; Donkor et al., 2021). The study also examined the impact of patients' opinions and beliefs on adherence to antimalarials.

High patient adherence to antimalarial treatment is crucial in ensuring the effectiveness of the drug. It was observed that almost all

TABLE 7 Association between belief and predictors.

Variable	Category	COR	CI	AOR	CI
Age	<18 years	Ref		Ref	
	18-30 years	2.34	1.5 – 3.55	0.55	0.08 – 3.70
	31-45 years	3.38	2.10 – 5.43	3.33	1.61 – 6.88
	46-60 years	9.60	4.87 – 18.90	6.31	2.39 – 22.96
	>60years	2.24	0.14 – 36.58	0.95	0.18 – 5.19
Gender	Male	Ref		Ref	
	Female	1.83	1.20 – 2.78	0.79	0.32 – 14.41
Level of education	Secondary education	Ref		Ref	
	Tertiary education	2.02	1.34 – 3.04	1.11	0.48 – 2.58
Employment Status	Employed	Ref		Ref	
	Self-employed	0.8	0.39 – 1.65	0.46	0.16 – 1.32
	Student	0.67	0.30 – 1.51	0.53	0.16 – 1.75
	Unemployed	7.12	1.43 – 35.41	3.21	0.43 – 23.94
Level of Knowledge	Poor	Ref		Ref	
	Satisfactory	0.18	0.04 – 0.78	0.62	0.13 – 2.81
	Good	1.24	0.56 – 2.73	1.67	0.59 – 4.77
	Very Good	2.12	0.20 – 21.89	2.37	1.10 – 5.10

TABLE 8 Association between medication adherence and predictors.

Variable	Category	COR	CI	AOR	CI
Age	<18 years	Ref		Ref	
	18–30 years	2.89	0.85 – 9.83	3.78	1.04 – 13.68*
	31–45 years	3.49	1.52 – 8.00	3.00	0.78 – 11.59
	46–60 years	5.28	2.35 – 11.83	4.49	1.15 – 17.50*
	>60years	1.84	0.63 – 5.40	1.25	0.67 – 2.32
Gender	Male	Ref		Ref	
	Female	1.83	1.20 – 2.78	1.24	0.31 – 4.96
Level of education	Secondary education	Ref		Ref	
	Tertiary education	0.27	0.09 – 0.92	1.05	0.23 – 4.75
Employment status	Employed	Ref		Ref	
	Self-employed	0.58	0.14 – 2.38	0.46	0.16 – 1.32
	Student	2.63	0.97 – 7.08	0.53	0.16 – 1.75
	Unemployed	3.84	1.75 – 8.44	3.21	0.43 – 23.94
Level of Knowledge	Poor	Ref		Ref	
	Satisfactory	0.35	0.12 – 1.01	0.33	0.09 – 1.25
	Good	1.38	0.81 – 2.34		
	Very Good	2.20	0.99 – 4.87	2.77	1.14 – 6.72*
Belief	Poor	Ref		Ref	
	Satisfactory	1.08	0.33 – 3.52	0.755	0.394 – 1.444
	Good	6.53	1.89 – 22.60	6.31	1.92 – 20.69*

respondents (99.4%) believe that completing antimalarial therapy is necessary. Half of the respondents, 54.1%, stopped taking their antimalarial medication before completion, while 41.6% did not. About two-thirds, 65.9%, have missed a dose of their antimalarial medication, while nearly a third, 30.9%, have never missed a dose. Approximately one-third of a quarter, or 78.9%, have heard of drug resistance, 13.3% have not, and 7.8% are unsure. About 31.2% have had recurrent malaria infection symptoms after orthodox medication use, while 55.2% have not, and 13.6% are not sure. About 23.4% have had recurrent malaria infection symptoms after herbal medication use, while 48.3% have not, and 28.3% are not sure.

The results indicate that the age of respondents influenced their belief in antimalarial medication therapy. It was found that respondents aged 31 to 45 years were 3.3 times more likely to hold reasonable beliefs about antimalarial medication use than participants under 18 years (AOR = 3.33; CI = 1.61 – 6.88). Additionally, respondents aged 46 to 60 were 6.3 times more likely to hold reasonable beliefs about antimalarial medication use than participants under 18 years (AOR = 6.31; CI = 2.39 – 22.96). The level of knowledge was associated with the belief in antimalarial medication. Excellent knowledge increased the odds of having a reasonable belief by 2.3-fold compared to having a poor level of understanding (AOR = 2.37; CI = 1.10 – 5.10). Regarding the factors

influencing adherence to antimalarial medication, it was observed that respondents aged 18–30 years were 3.8 times more likely to be adherent compared to those under 18 years of age (AOR = 3.78; CI = 1.04–13.68). Additionally, respondents aged 46–60 were 4.5 times more likely to be adherent compared to respondents under 18 years (AOR = 4.49; CI = 1.15–17.50). Having Very Good knowledge of antimalarial medication was associated with 2.8 times increased odds of being adherent compared to having poor knowledge (AOR = 2.77; CI = 1.14–6.72). Having reasonable beliefs was associated with a 6.3 times increased chance of being adherent compared to having poor beliefs about antimalarial medication use. (AOR = 6.31; CI = 1.92 – 20.69). Amponsah et al. found an overall adherence rate of 57.3% to ACTs. Factors like educational background and patients' beliefs influenced adherence (Amponsah et al., 2015; Arora et al., 2021). Education on medication dosage, effectiveness, and side effects was emphasized.

## Conclusion

A very high percentage of the respondents' beliefs regarding the use of antimalarial medication were either satisfactory or reasonable. A larger number of the respondents believe that orthodox antimalarial

medications are effective in treating malaria, much higher than those who believe in the effectiveness of herbal alternatives. It was observed that almost all respondents (99.4%) believe that completing antimalarial therapy is necessary. Nearly half of the respondents stopped taking their antimalarial medication before it was completed. The results indicate that the age of respondents influenced their belief in antimalarial medication therapy and treatment adherence.

## Limitations

1. Because of the limitations in establishing causality, it can be challenging to interpret the associations found in cross-sectional studies.
2. Responder Bias: Participants may not accurately report their behaviors or experiences, especially on sensitive topics.
3. Sampling Bias: The chosen sample might not accurately reflect the entire population, resulting in distorted outcomes.
4. Recall Bias: A common phenomenon where the participant's ability to accurately remember and report past events becomes flawed over time.
5. Due to sampling biases and the one-time nature of data collection, the findings may not be generalized to other populations or periods.

## Recommendations

1. There is a significant need to enhance malaria prevention awareness by strengthening malaria education and promoting behavioral change.
2. To improve program effectiveness, malaria control and prevention should be strengthened in hotspot districts in the appropriate months.
3. Interventions should focus on specific demographic groups, such as younger individuals, to improve adherence rates. Tailored educational campaigns considering age-specific needs could be beneficial.
4. Implementing behavioral interventions, such as reminders and incentives, can positively influence adherence. Mobile phone-based reminders, similar to those in a successful intervention study, could effectively improve adherence rates.

## Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

## Ethics statement

The studies involving humans were approved by School of Pharmacy Ethics Committee of the University of Ghana. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study. Written informed consent was obtained from the individual(s) for the publication of any potentially identifiable images or data included in this article.

## Author contributions

MA: Writing – original draft, Writing – review & editing. VW: Writing – original draft, Writing – review & editing. BN: Writing – original draft, Writing – review & editing.

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The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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