

Research Article

Analysis of Knowledge, Practices and Determinants of Formal Healthcare-seeking for Malaria Among Mothers of Children Under Five in Benin in 2023

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Abstract

Introduction: Malaria remains a major public health problem in Benin, especially among children under five, despite the implementation of proven prevention and management strategies. Given the persistent malaria burden, this study was conducted to analyse the knowledge and practices of mothers of under-five children regarding malaria, as well as the determinants of formal healthcare-seeking. **Methods:** This was a cross-sectional analytical study conducted among mothers of under-five children, selected from three villages in the commune of Zogbodomey, Benin. Data collected from mothers using a digitised questionnaire were used to classify knowledge, attitudes and practices as "good" or "insufficient" based on the mean scores obtained. Determinants of healthcare-seeking were explored using univariate and multivariate regression at a 5% significance level. **Results:** The majority of the 208 mothers (92.79%) had good knowledge about malaria, and 100% exhibited positive attitudes towards its prevention. However, only 66.83% actually adopted good practices. After adjustment, the variables that remained significantly associated with healthcare-seeking were: knowledge of malaria transmission modes (OR= 4.64; 95% CI= [1.03-20.90]), and mother's occupation such as trader (OR=0.37; 95% CI= [0.18-0.75]), farmer (OR= 0.27; 95% CI= [0.09-0.82]) and craftswoman (OR= 0.23; 95% CI= [0.08-0.65]). **Conclusion:** Although the overall level of knowledge and attitudes among mothers is satisfactory, it does not yet translate into sustained, positive practices against malaria. Strengthening health education and promoting continuous behavioural support appear essential to enhance malaria control for children under five in Benin.

Keywords

Malaria, Knowledge, Attitude, Practice, Determinant, Children Under Five, Benin

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1. Introduction

Malaria remains one of the leading causes of morbidity and mortality in children under five years of age, particularly in sub-Saharan Africa. In 2023, approximately 263 million malaria cases and 597,000 malaria deaths were recorded, with 76% of the deaths occurring in children under five [1]. In Benin, among children under five, malaria accounts for around 39% of new cases, 41% of reasons for consultation in health centres, and 29% of hospitalisations, with an estimated mortality rate of 106 deaths per 100,000 children in 2023 [2, 3].

Recent downward trends in malaria prevalence, which fell from 31.3% in 2019 to 27.4% in 2021 and then to 23.5% in 2022, appear to be the effects of government commitment through major interventions such as the free distribution of long-lasting insecticidal nets (LLINs), seasonal malaria chemoprevention for children under five in high-transmission areas, intermittent preventive treatment in pregnant women (IPTp), and, more recently, the introduction of the vaccine [4-8].

However, these achievements remain below national and international targets due to significant challenges such as drug and insecticides resistance, persistent larval breeding sites, inequalities in access to healthcare, socio-cultural and behavioural barriers to the adoption of preventive measures [9-11]. Among these barriers, mothers' knowledge, attitudes,

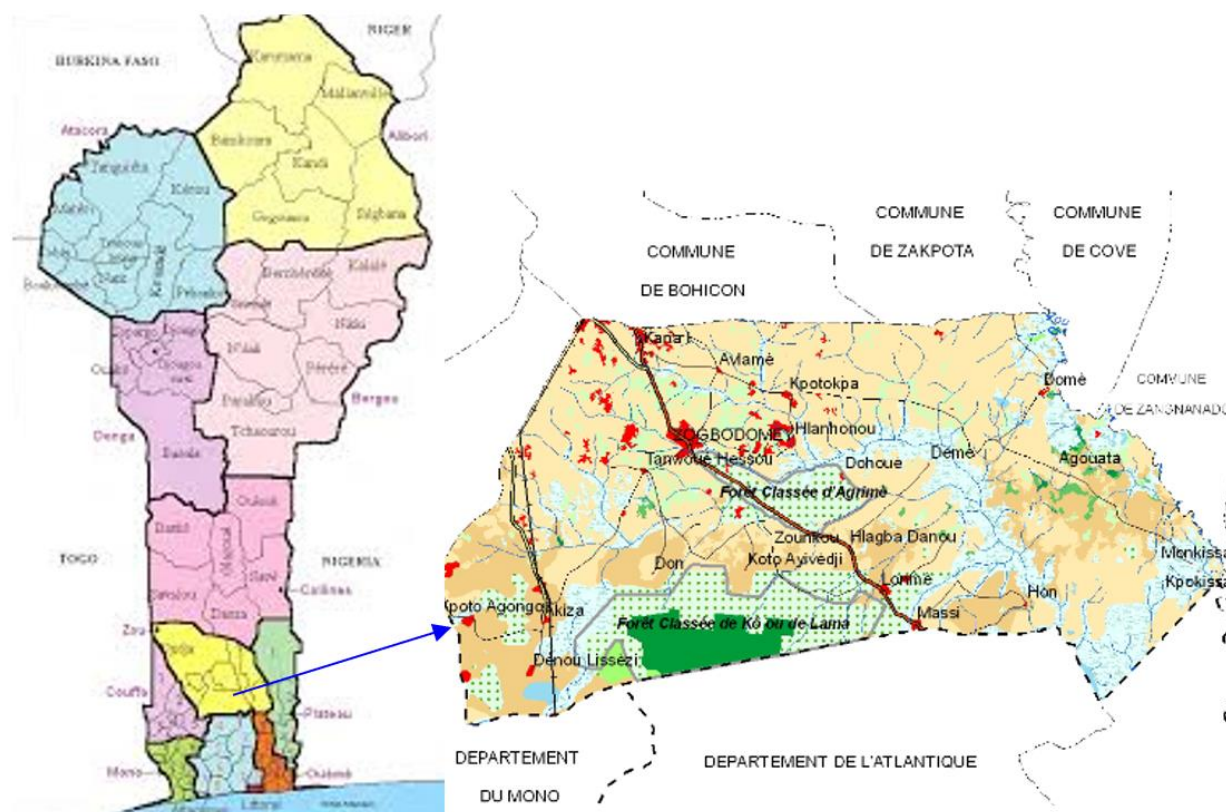
and practices, which are important foundations for healthcare-seeking and the adoption of preventive measures, are poorly documented. Local surveys indicate fairly good general knowledge and positive attitudes, but a persistence of misconceptions or inappropriate practices [12, 13].

In this context, the ownership and adoption of preventive and curative measures in communities remain greater challenges than the introduction of new interventions. It therefore seems necessary to analyse the knowledge, attitudes, and practices of mothers of under-five children regarding malaria, as well as the determinants of formal healthcare-seeking for this disease.

2. Materials and Methods

Study Setting

The study took place in the arrondissement of Zogbodomey, located in the eponymous commune in the department of Zou, Benin (Figure 1). The commune of Zogbodomey comprises eleven arrondissements and covers 825 km². In 2023, the population of Zogbodomey arrondissement was projected at 13490 inhabitants, including 2 347 children aged 0 to 59 months, a group particularly vulnerable to malaria [14, 15].



Source: Commune of Zogbodomey

Figure 1. Geographical map of Zogbodomey's commune (in the right) showing its location on Benin map (in the left).

Zogbodomey has a sub-equatorial climate, marked by abundant rainfall and the alternation of two rainy and two dry seasons, creating favourable conditions for the reproduction of mosquitoes, the vectors of malaria. Several rivers, including the Zou, Oueme, Hounto, and Koto, flow across the area and feed numerous lowlands and the Lokoli marshland, which, along with gallery forests, constitute natural larval habitats and an environment conducive to the proliferation of Anophelines [14].

The housing, which reflects the standard of living of the population, is mostly made of mud bricks, covered with sheet metal or thatch. Their proximity to natural water points or forests, and the persistence within families' practices of fetching water from streams, rivers, or wells, despite the existence of some hand-pump boreholes and village water supplies, increase exposure to mosquito bites and waterborne diseases [14].

Study participants and Eligibility Criteria

The primary target participants of the study consisted of children under five years of age residing in the Zogbodomey arrondissement, with their mothers or caregivers serving as secondary respondents. Participants were recruited in the community.

Inclusion criteria

The following were included in the study:

- 1) Children aged between 0 and 59 months;
- 2) Mothers of children under five living in Zogbodomey for at least six months;
- 3) Mothers of children under five who consented verbally

or in writing.

Non-inclusion criteria

Children under five for whom necessary information could not be reliably obtained were not included.

Study Design

This was an analytical cross-sectional study, collection of data from May to June 2023. Children under five and their mothers present at the time of the survey were included in the study using a probabilistic method with a two-stage random sampling technique. In the first stage, three villages were selected by simple random sampling from the six in the Zogbodomey arrondissement. The second stage involved the random selection of households starting from the centre of the village, where a direction was randomly chosen by spinning a pencil. Following this direction, households were enumerated, and as they were identified, those containing mothers meeting the criteria were included in the study. Sample's minimum size was estimated at 203 children under five using the Schwartz formula and considering a reference prevalence $p=53.60\%$ (level of malaria knowledge in Cameroon in 2021 [16], a precision $i=7\%$, an error risk $(\alpha \approx 1.96)$ and a non-response rate $R_n=5\%$.

$$N = [(\alpha^2 pq) / (i^2)] * R_n$$

This number was allocated proportionally to the population size of children under five in the selected villages. Table 1 shows the population of the drawn villages and the samples.

Table 1. Population sizes of the selected villages in the Zogbodomey arrondissement.

Villages	Number of Inhabitants	Population (children 0-59 months)	Sample Size per Village	Number Surveyed
ATCHIA	844	172	61	70
DOVOGON	815	157	55	62
ZADO-GAGBE	1012	246	87	76
Total	2671	575	203	208

Variables and Data Collection Tools

The dependent variable of the study was "formal healthcare-seeking" defined as seeking curative care in a health facility in case of malaria. Explanatory variables explored by the study were socio-demographic characteristics of the mothers (age, marital status, education level, occupation, ethnicity, access to information, ...) and their knowledge regarding malaria (including modes of transmission, symptoms, and control measures); attitudes regarding the use of mosquito nets and medical management; and practices. Knowledge, attitudes and practices were categorised as

"Good" or "Insufficient" based on the responses, following criteria inspired by World Health Organisation (WHO) recommendations and some studies in sub-Saharan Africa [17].

A mother was considered to have good knowledge, attitudes, or practices if she scored at least 50% correct answers on the items measuring each of these variable groups. Quantitative and qualitative data were collected using a structured questionnaire administered to mothers or caregivers.

Data Processing and Analysis

The questionnaire was digitised and administered using the KoboCollect software. The collected data were exported to

Excel 2019 for review and cleaning to ensure a complete cleansing of the generated database.

The analysis was performed using Stata version 14. Quantitative variables were summarised as means ($\pm$ standard deviations) or medians with their interquartile ranges (Q1; Q3), depending on whether the distribution was symmetrical or not. Qualitative variables were presented as absolute and relative frequencies, accompanied by 95% confidence intervals.

Univariate and multivariate logistic regressions were performed; odds ratios with 95% CI and a 5% significance threshold were used.

Ethical considerations

The study protocol, including ethical aspects, was validated by an IRSP scientific jury. Administrative authorisation was obtained from the Zogbodomey-Bohicon-Za-Kpota health zone. Informed consent was obtained prior to inclusion, and data were collected anonymously in compliance with confidentiality principles.

3. Results

Socio-Demographic Characteristics of Respondents

The surveyed mothers had a mean age of 25.96 ± 5.70 years and were caring for an average of 1.5 ± 0.56 children under five. More than half of them had only one child under five (52.88%).

Most mothers interviewed were aged 20 to 34 years (85.10%), and all were living with a partner. The Fon ethnicity was largely predominant (95.67%), while the traditional (Animist) religion was the most represented (65.38%). Nearly two-thirds of the participants had no formal education (63.94%). Traders were the most frequent occupational category (40.87%), followed by housewives (30.77%), and 76.44% of mothers had already participated in at least one behaviour change communication (BCC) activity on malaria (Table 2).

Table 2. Distribution of mothers of children under five according to their socio-demographic characteristics in Zogbodomey in 2023 (n=208).

Variables	Frequency	Proportion (%)	95% CI Lower - Upper
Mother's age (years)			
≤ 19	11	5.29	2.93–9.33
[20–34]	177	85.10	79.53–89.34
[35–49]	20	9.62	6.26–14.48
Mother's marital status			
Married/Cohabiting	208	100	-
Ethnicity			
Fon	199	95.67	91.85–97.74
Adja	3	1.44	0.46–4.41
Yoruba	6	2.88	1.29–6.31
Religion			
Animist/ Traditional	136	65.38	58.61–71.58
Christian	56	26.92	21.29–33.41
Others*	16	7.69	4.74–12.23
Education Level			
None	133	63.94	57.13–70.22
Primary	37	17.79	13.13–23.64
Secondary	38	18.27	13.55–24.16
Main Occupation			
Trader	85	40.87	34.33–47.73
Housewife	64	30.77	24.82–37.42
Farmer	26	12.50	8.62–17.77

Variables	Frequency	Proportion (%)	95% CI Lower - Upper
Craftswoman	33	15.87	11.47–21.53
Number of children under five in care			
1	110	52.88	46.03–59.62
≥ 2	98	47.12	40.37–53.96
Participation in BCC activities on malaria			
Yes	159	76.44	70.14–81.75
No	49	23.56	18.24–29.85
* = None, Muslim			
** = Behaviour Change Communication			

Description of mothers' knowledge, attitudes, and practices regarding malaria

More than half of the mothers (56.73%) were able to name at least two signs of uncomplicated malaria, with fever being the most frequently mentioned sign (92.79%). Only 20.67% knew at least two signs of severe malaria, with jaundice being the most frequently cited (81.25%). Most respondents identified mosquito bites as the mode of malaria transmission (88.94%) and children and pregnant women as the most vulnerable groups (97.12%). Insecticide-treated nets were the

most known preventive measure (97.60%), followed by environmental sanitation (28.85%) (Table 3).

The respondents' attitude towards malaria was positive, with a good perception of the use of insecticide-treated nets (99.52%) and medical management in case of malaria (100%). Common malaria-related practices among mothers were the use of insecticide-treated nets (88.46%), self-medication (69.71%), and treatment with artemisinin-based combination therapy (ACT) (71.15%) (Table 3).

Table 3. Distribution of mothers of children under five according to their knowledge, attitudes, and practices on malaria in Zogbodomey in 2023 (n=208).

Variables	Frequency	Proportion (%)	95% CI Lower - Upper
Mothers' knowledge of malaria			
Knowledge of signs of uncomplicated malaria			
At least two signs	118	56.73	49.85–63.35
Less than two signs	90	43.27	36.64–50.14
Known signs of uncomplicated malaria			
Fever	193	92.79	88.33–95.62
Weakness/Asthenia	7	3.37	1.60–6.92
Vomiting	70	33.65	27.51–40.40
Refusal to breastfeed	21	10.10	6.65–15.03
Incessant crying	3	1.44	0.46–4.41
Others*	49	23.56	18.24–29.85
Knowledge of signs of severe malaria			
At least two signs	43	20.67	15.66–26.76
Less than two signs	165	79.33	73.23–84.33
Known signs of severe malaria			

Variables	Frequency	Proportion (%)	95% CI Lower - Upper
Jaundice	169	81.25	75.31–86.02
Anaemia	35	16.83	12.30–22.58
Convulsions	2	0.96	0.23–3.80
Prostration	23	11.06	7.43–16.13
Others**	18	8.65	5.49–13.36
Knowledge of causes of malaria			
Good	195	93.75	89.49–96.35
Poor	13	6.25	3.64–10.50
Known causes of malaria			
Mosquito	195	93.75	89.49–96.35
Sun	6	2.88	1.29–6.31
Diet	7	3.37	1.60–6.92
Knowledge of malaria transmission modes			
Good	185	88.94	83.86–92.56
Poor	23	11.06	7.43–16.13
Known modes of malaria transmission			
Mosquito bite	185	88.94	83.86–92.56
Sun	17	8.17	5.12–12.79
Don't know	6	2.88	1.29–6.31
Knowledge of at least one vulnerable group to malaria			
Yes	202	97.12	93.68–98.70
No	6	2.88	1.29–6.31
Knowledge of preventive measures for malaria			
At least two measures	71	34.13	27.96–40.89
Less than two measures	137	65.87	59.10–72.03
Known preventive measures			
LLINs	203	97.60	94.31–99.00
Environmental Sanitation	60	28.85	23.05–35.42
Herbal tea	31	14.90	10.65–20.46
Mosquito coil	17	8.17	5.12–12.79
Other***	13	6.25	3.64–10.50
Source of information on malaria			
Word of mouth	208	100	-
<i>Mothers' Attitudes</i>			
Perception on the use of LLINs			
Effective	207	99.52	96.61–99.93
Ineffective	1	0.48	0.06–3.38
Perception of medical care for malaria			
Good	208	100	-

Variables	Frequency	Proportion (%)	95% CI Lower - Upper
<i>Practices related to malaria</i>			
Use of LLINs			
Yes	184	88.46	83.31–92.17
No	24	11.54	7.82–16.68
First therapeutic recourse			
Self-medication	145	69.71	63.07–75.61
Health Centre	63	30.29	24.38–36.92
Malaria treatment used			
ACT	148	71.15	64.57–76.94
Paracetamol	45	21.63	16.52–27.80
Herbal tea/Quinine	15	7.21	4.37–11.66
* = Don't know, cough, chills, jaundice, mosquito bite mark			
** = Don't know, cough, sore throat, yellow urine, mosquito bite mark			
*** = None, food hygiene, vaccination, reduced sun exposure			

Mothers' knowledge, attitudes, and practices on malaria

Most mothers (92.79%) had good knowledge about malaria, indicating a strong uptake of key prevention and management

messages. Favourable attitudes were almost universal (100%), and 66.83% of mothers had adopted practices considered appropriate (Figure 2).

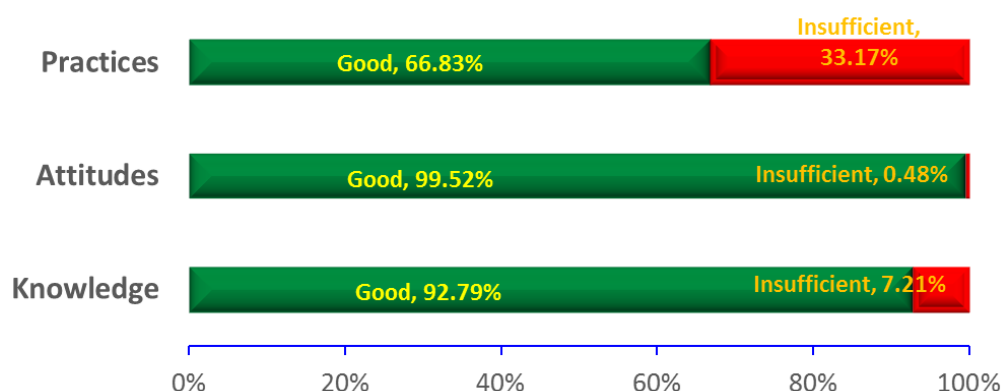


Figure 2. Assessment of knowledge, attitudes, and practices of mothers regarding malaria in Zogbodomey in 2023.

Factors determining formal healthcare-seeking for malaria by mothers of children under five.

Univariate Regression

According to Table 4, the variables associated with formal healthcare-seeking in case of malaria in the child was mother's occupation such as trader (OR=0.34; 95% CI=0.17-0.70; p=0.003), farmer (OR=0.25; 95% CI=0.08-0.75; p=0.014) or

craftswoman (OR=0.23; 95% CI=0.08-0.65; p=0.005); number of children under five in care (OR=0.53; 95% CI=0.29-0.98; p=0.045) and knowledge of transmission modes (OR=5.16; 95% CI=1.17-22.74; p=0.030). Other variables, such as age, education level, and religion, were not associated.

Table 4. Associations between formal healthcare-seeking and characteristics of mothers of children under five in case of malaria in Zogbodomey in 2023 (n=208).

Variables	Formal healthcare-seeking		Odd Ratio (OR)	95% CI Lower - Upper	p-value
	Yes n (%)	No n (%)			
Mother's age (years)					
≤ 19	5 (45.45)	6 (54.55)	3.6	0.75–17.12	0.107
[20-34]	125 (70.62)	52 (29.38)	1.24	0.43–3.61	0.683
[35-49]	15 (75)	5 (25)	1	–	-
Religion					
Animist/ Traditional	93 (68.38)	43 (31.62)	1	–	-
Christian	41 (73.21)	15 (26.79)	0.79	0.39–1.58	0.508
Others*	11 (68.75)	5 (31.25)	0.98	0.32–3.00	0.976
Education Level					
None	93 (69.92)	40 (30.08)	1	–	-
Primary	26 (70.27)	11 (29.73)	0.98	0.44–2.18	0.968
Secondary	26 (68.42)	12 (31.58)	1.07	0.49–2.33	0.859
Main Occupation					
Trader	64 (75.29)	21 (24.71)	0.34	0.17–0.70	0.003
Housewife	33 (51.56)	31 (48.44)	1	–	-
Farmer	21 (80.77)	5 (19.23)	0.25	0.08–0.75	0.014
Craftswoman	27 (81.82)	6 (18.18)	0.23	0.08–0.65	0.005
Number of children under five in care					
1	70 (63.64)	40 (36.36)	1	–	-
≥ 2	75 (76.53)	23 (23.47)	0.53	0.29–0.98	0.045
Participation in BCC activities on malaria					
Yes	112 (70.44)	47 (29.56)	0.86	0.43–1.72	0.680
No	33 (67.35)	16 (32.65)	1	–	-
Knowledge of signs of uncomplicated malaria					
At least two signs	60 (66.67)	30 (33.33)	1.28	0.71–2.33	0.404
Less than two signs	85 (72.03)	33 (27.97)	1	–	-
Knowledge of signs of severe malaria					
At least two signs	31 (72.09)	12 (27.91)	0.86	0.41–1.82	0.703
Less than two signs	114 (69.09)	51 (30.91)	1	–	-
Knowledge of malaria transmission modes					
Good	124 (67.03)	61 (32.97)	5.16	1.17–22.74	0.030
Poor	21 (91.30)	2 (8.70)	1	–	-
Knowledge of malaria preventive measures					
At least two measures	54 (76.06)	17 (23.94)	1	–	-
Less than two measures	91 (66.42)	46 (33.58)	0.62	0.32–1.19	0.153

Variables	Formal healthcare-seeking		Odd Ratio (OR)	95% CI Lower - Upper	p-value
	Yes n (%)	No n (%)			

*None, Muslim

BCC: Behaviour Change Communication

Multivariate Analysis

Inclusion of the seven variables (or variable modalities) associated with formal healthcare-seeking at the 20% threshold in bivariate analysis (followed by adjustment) showed (in Table 5) that only two remained independently associated with seeking care at a health facility: mothers' knowledge of malaria transmission modes and mothers' occupation. Traders

(OR=0.37; 95% I= [0.18-0.75]), farmers (OR= 0.27; 95% CI= [0.09-0.82]) and craftswomen (OR= 0.23; 95% CI= [0.08-0.65]) had a lower probability of consulting a health centre in case of malaria than housewives. Good knowledge of malaria transmission modes was also associated with increased formal healthcare-seeking (OR= 4.64; 95% CI= [1.03-20.90]).

Table 5. Final multivariate model of variables associated with formal healthcare-seeking among mothers of children under five in case of malaria in Zogbodomey in 2023 (n=208).

Variables	Formal healthcare-seeking		Odd Ratio (OR)	95% CI Lower - Upper	p-value
	Yes n (%)	No n (%)			
Knowledge of malaria transmission modes					
Good	124 (67.03)	61 (32.97)	4.64	1.03–20.90	0.045
Poor	21 (91.30)	2 (8.70)	1	–	-
Main Occupation					
Trader	64 (75.29)	21 (24.71)	0.37	0.18–0.75	0.006
Housewife	33 (51.56)	31 (48.44)	1	–	-
Farmer	21 (80.77)	5 (19.23)	0.27	0.09–0.82	0.021
Craftswoman	27 (81.82)	6 (18.18)	0.23	0.08–0.65	0.006

4. Discussion

Mothers' Knowledge regarding Malaria

The results of this study show that most of mothers interviewed had good general knowledge about malaria, particularly regarding its causes, modes of transmission, and preventive measures. These generally high levels of knowledge are consistent with the findings of the Malaria Behaviour Survey in Benin, which also observed a satisfactory understanding of malaria transmission and prevention mechanisms in exposed communities [3]. Similarly, a study conducted in Tanzania among children aged 3 to 59 months by Ngasala et al. reported that over 80% of respondents knew that malaria is transmitted through the bite of an infected mosquito [17]. These findings suggest a significant contribution of commu-

nication activities carried out by health structures to strengthening community knowledge.

However, some shortcomings persist, particularly concerning the recognition of signs of severe malaria, as less than a quarter of mothers were able to name at least two. This deficit in clinical recognition, also observed in the MICS survey in Benin, could limit the promptness of healthcare-seeking and lead to delays in the management of severe cases [18, 19]. The incomplete identification of warning signs could also be explained by a decreased ability of healthcare workers to recognise them given their relative rarity, and by public communication often focused on prevention rather than early detection of severe forms.

Mothers' attitudes regarding malaria

Mothers almost unanimously expressed a positive perception of preventive measures and medical care of malaria. This

favourable attitude reflects a high level of adherence to awareness messages. It concurs with the results of studies conducted in Ghana and Gabon, which also reported a predominantly positive attitude towards malaria control interventions among mothers [20, 21].

Mothers' practices regarding malaria

The observed practices, although generally good, remain mixed. The use of insecticide-treated nets was high (88.46%), as was the recourse to self-medication (69.71%). Similar results have been documented in Gabon by Lendongo Wombo et al., where more than two-thirds (68.50%) of women treated fever at home before attending a health facility [21]. This trend could be explained by the trivialisation of febrile symptoms, economic constraints, or the perception of low risk in the face of a disease considered familiar and manageable.

Determinants of healthcare-seeking at a health facility in case of malaria

The multivariate analysis highlighted two factors associated with healthcare-seeking at a health centre: the mother's occupation and her knowledge of malaria transmission modes. Mothers engaged in income-generating activities (trade, crafts, agriculture) used formal healthcare less often than housewives. This result differs from that recorded in Uganda where, qualitatively exploring factors influencing the adoption of malaria prevention strategies, the authors reveal the significant influence of socio-economic factors on care-seeking behaviour [6]. This suggests that financial autonomy not only enables covering direct and indirect costs related to consultation but also strengthens the woman's decision-making capacity in managing family health. In Ethiopia, it was rather young adults aged 18 to 25 who were more likely to have poor healthcare-seeking behaviours (OR= 3.5, 95% CI 1.73-7.1), while pastoralists made little use of it (OR=0.46; 95% CI= 0.28-0.8) [22].

Good knowledge of transmission modes was also associated with increased utilisation of a health facility. This result aligns with that observed in Tanzania where individuals well-informed about malaria transmission more frequently adopted preventive behaviours and sought medical care more promptly ($X^2 = 9.17$; $p = 0.01$) [17]. The influence of knowledge and attitude on the adoption of prevention practices and their impact on malaria prevalence has also been reported [16], thus confirming knowledge as an essential gateway for changing health behaviours.

These results suggest a reinforcement of community communication programmes focused on prevention, recognition of severe malaria signs, and prompt care-seeking at health facilities. Taking into account the mothers' occupational realities in the design of control strategies seems essential to ensure their full capacity to adopt favourable practices.

Study limitations

This study has some limitations. Its cross-sectional nature does not allow for establishing causal relationships between knowledge, attitudes, and practices. Furthermore, the measurement of practices based on self-reports may be subject to

social desirability bias. However, the methodological rigour adopted, the internal representativeness of the sample, and the consistency of the results with the regional literature reinforce the validity of the conclusions drawn.

5. Conclusions

This study highlights a generally satisfactory level of knowledge and attitudes among mothers of children under five regarding malaria in the commune of Zogbodomey. However, actual practices remain insufficient in nearly one-third of participants, reflecting a gap between knowledge and action. The analysis showed that occupation and knowledge of malaria transmission modes significantly influenced healthcare-seeking at a health centre; this underscores the effect of occupational constraints on mothers' ability to meet their children's health needs, as well as the role of a sound understanding of disease mechanisms in adopting appropriate preventive behaviours. These findings call for strengthening community interventions focused on behaviour change, while supporting the socio-economic empowerment of women. Integrating these dimensions into local malaria control strategies appears essential to sustainably reduce malaria morbidity in children under five.

Abbreviations

95% CI	95% Confidence Interval
ACT	Artemisinin-based Combination Therapy
BCC	Behaviour Change Communication
LLIN	Long-lasting Insecticidal Nets
OR	Odd Ratio

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Author Contributions

Lamidhi Salami: Conceptualization, Data curation, Formal Analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Validation, Visualization, Writing – original draft, Writing – review & editing

Vignon Bedie: Formal Analysis, Investigation, Methodology, Software, Visualization, Writing – review & editing

Clemence Metonnou: Formal Analysis, Investigation, Methodology, Software, Visualization, Writing – review & editing

Virginie Mongbo: Formal Analysis, Investigation, Methodology, Software, Visualization, Writing – review & editing

Charles Sossa Jerome: Conceptualization, Methodology,

Supervision, Validation, Visualization, Writing – review & editing

Ghislain Emmanuel Sopoh: Conceptualization, Methodology, Supervision, Validation, Visualization, Writing – review & editing

Edgard-Marius Ouendo: Conceptualization, Methodology, Supervision, Validation, Visualization, Writing – review & editing

Data Availability Statement

The data is available from the corresponding author upon reasonable request.

Conflicts of Interest

The authors declare no conflicts of interest.

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