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Implementation of perennial malaria chemoprevention in infants at district-level in Togo: mixed methods assessment of health system readiness

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ABSTRACT

Introduction: In June 2022, WHO recommended the administration of Perennial Malaria Chemoprevention (PMC) alongside Expanded Immunization Programmes for children under two years. We investigated the health systems readiness for PMC implementation in Togo.

Method: As part of the multi-country MULTIPLY project, we conducted a mixed methods implementation research study in the 27 health facilities of Haho district in Togo. All district health care providers (n=188) and a sample of community health workers (n=43) were invited to respond to a self-administered Knowledge-Attitudes-Practices questionnaire. Structured observations in 4 health facilities and 19 semi-structured interviews were conducted. Descriptive analysis was conducted on quantitative data. Qualitative data was analysed thematically, using an inductive approach. We report here on the implementation context for PMC, its infrastructural feasibility and its acceptability among health care workers (HCWs).

Results: Overall, respondents perceived PMC as relevant in the context of high malaria burden and had a good knowledge about malaria and its prevention. HCWs foresaw good community acceptability of PMC. Although some HCWs did not understand the rationale of PMC if children are not sick, they also believed PMC would be effective, in line with their perceptions of preventive malaria treatment during pregnancy. Several challenges were foreseen such as distance barriers for accessing health facilities, difficulties in accessing drinking water, supplies for PMC administration, or lack of dedicated health workforce and area for PMC administration.

Conclusion: At district-level in Togo, overall pre-intervention acceptability of PMC was encouraging. Structural and operational challenges were identified as possible barriers to implementation feasibility.

Abbreviations: CHW, Community Health Worker; EPI, Expanded Immunization Programmes; HCP, Health Care Provider; HCW, Health Care Worker; IPTi, Intermittent Preventive Treatment of malaria in infants; IPTp, Intermittent Preventive Treatment of malaria during pregnancy; KAP, Knowledge-Attitudes-Practices; PMC, Perennial Malaria Chemoprevention; SMC, Seasonal Malaria Chemoprevention; SP, Sulfadoxine-Pyrimethamine.

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1. Introduction

In 2021, malaria was responsible for 247 million infections and 619,000 deaths, occurring in sub-Saharan Africa in more than 96% of cases (World Health Organization, 2022a). Children under five years of age are the most affected, accounting for 80% of malaria-related deaths (World Health Organization, 2022a). Preventive strategies to reduce the incidence of malaria and its complications among young children in sub-Saharan Africa are a global priority.

In 2010, the World Health Organization (WHO) recommended intermittent preventive treatment of malaria in infants (IPTi) with sulfadoxine-pyrimethamine (SP) in areas of moderate to high malaria transmission[3] that are not covered by seasonal malaria chemoprevention (SMC) (Organisation Mondiale de la Santé, 2022a; World Health Organization, 2011). This was intended as a pragmatic intervention, administered in a systematic and integrated manner within the first year of the Expanded Programme on Immunization (EPI). IPTi consists in the administration of SP at 10 weeks, 14 weeks and 9 months of age along with Penta2, Penta3 and measles1 vaccinations (Organisation Mondiale de la Santé, 2022a; World Health Organization, 2011).

The impact of IPTi on reducing the risk of clinical malaria, anaemia and hospitalization among infants was shown as early as 2001 in a randomized controlled trial (Schellenberg et al., 2001) then confirmed in 2021 in a meta-analysis, including 10 trials conducted between 1999 and 2013, involving over 15,000 infants across sub-Saharan Africa (Esu et al., 2021). IPTi was well tolerated, with few adverse events (Schellenberg et al., 2001; Crawley et al., 2012; Aponte et al., 2009) and it was shown to be cost-effective for public health programs (Conteh et al., 2010).

Sierra Leone adopted IPTi in 2017. By 2020, it was the only country in sub-Saharan Africa to have routinely deployed this strategy at national level (Lahuerta et al., 2021). Concerns of policymakers and public health actors about the risks of SP resistance, and fear of low community acceptability and difficulties in integrating IPTi into EPI are among the reasons why IPTi was not adopted by most countries, and not implemented, even in pilot projects (Audibert and Tchouatieu, 2021). In the few countries that piloted IPTi, operational and individual-level barriers have impeded scale-up. The operational barriers included difficulties in accessing health services, particularly EPI (Audibert and Tchouatieu, 2021) as well as structural challenges such as the availability of essential supplies and medication, and access to drinking water necessary for IPTi administration in its current form (Lahuerta et al., 2021; Audibert and Tchouatieu, 2021; Mubyazi et al., 2011; Gaye, 2021). Human resource challenges were related to the lack of qualified personnel (Audibert and Tchouatieu, 2021; Mubyazi et al., 2011; Gaye, 2021; Faye et al., 2011; De Sousa and Affo, 2011), poor motivation due to lack of remuneration (Mubyazi et al., 2011; Gaye, 2021; Faye et al., 2011; De Sousa and Affo, 2011; De Sousa et al., 2012) and instability due to high staff turnover (Lahuerta et al., 2021; Audibert and Tchouatieu, 2021; Mubyazi et al., 2011). These different operational obstacles raise the question of the feasibility of IPTi, i.e., *"the capacity to operationalize it in a specific context" (*Pineault and Daveluy, 1986*)*. The individual-level barriers related to parents' limited understanding of the strategy and lack of endorsement from community leaders (Audibert and Tchouatieu, 2021; Mubyazi et al., 2011; De Sousa and Affo, 2011; Pool et al., 2006; Mushi et al., 2008). Providers also expressed concern about increased workload and time associated with the need to systematically weigh the child - a non-routine practice - to determine the dose of SP to be administered to children (Gaye, 2021; De Sousa et al., 2012) and the difficulty and time required to administer the drug (De Sousa et al., 2012; Pitt et al., 2012). These individual limitations, whether community-based or emanating from the health system, question the acceptability of IPTi, i.e., *"the perception by beneficiaries or implementers that it is appropriate"* (Sekhon et al., 2017).

In June 2022, WHO renewed the recommendation for this preventive strategy, renaming it Perennial Malaria Chemoprevention (PMC), and extending it to the 2nd year of a child's life (World Health Organization, 2022b). The experience of IPTi implementation, or rather lack of, suggestthat implementing this new PMC recommendation requires an in-depth assessment of its *a priori* feasibility and acceptability. It also calls for describing the conditions of successful implementation, and understanding how contextual factors might influence the delivery of PMC within real health systems conditions (World Health Organization, 2022b). Overall, assessing the readiness (*"the degree to which those involved are individually and collectively ready, motivated, and technically capable of executing the change"* (Holt et al., 2010)) of health systems, in their different components or "building blocks" as recommended by WHO (World Health Organization, 2010), will inform countries considering the adoption of the PMC strategy.

In this paper, we aim to describe the readiness of a rural district health system in Togo, before the introduction of a PMC pilot project. We describe the implementation context, the feasibility of the strategy at the infrastructural level, and its acceptability by health care professionals and district focal points. Findings are geared towards supporting decision makers and operational actors considering the future implementation of PMC strategies, informing them of potential facilitators on which to build on and possible challenges to overcome.

2. Materials and methods

2.1. Study design

We conducted an implementation study as part of a larger evaluation programme in the context of the MULTIPLY project (MULTIple doses of IPTi Proposal: a Lifesaving high Yield intervention). MULTIPLY was launched in May 2021, and aims at introducing PMC in Togo and Mozambique and to extend its implementation in Sierra Leone (Multiply Internet, 2022). These countries were selected according to 2 criteria: SMC had already been implemented, to be able to evaluate issues related to the integration of several malaria control strategies and the Ministry of Health (MoH) shared willingness to implement PMC after the project finished. Sierra Leone was automatically selected as the only African country to have adopted PMC at the time. In each country, between one and three districts were selected in collaboration with the MoH and the Malaria Control Programme managers. District selection criteria included high malaria prevalence estimates, and number of births. As part of the PMC effectiveness evaluation conducted within MULTIPLY, two non-contemporary cohorts were established in selected health facilities: a cohort of children receiving the Standard of Care (SOC cohort without PMC) and a cohort of children receiving the MULTIPLY PMC intervention. Health facilities were selected on the basis of geographical accessibility and feasibility for establishing the two cohorts within a short period of time (e.g. patient volume of 2nd EPI visits and PENTA2 coverage).

In Togo, the MULTIPLY PMC strategy consists of introducing 4 doses of SP during the child's first 2 years of life, integrated with routine immunizations at 6 and 12 weeks (together with Penta 2 and 3 vaccine), and at 9 and 15 months (measles 1 and 2 vaccine). PMC implementation started in one district in May 2022.

Implementation research activities were conducted between November 2021 and February 2022, prior to the implementation of the MULTIPLY strategy. We used a cross-sectional mixed-methods convergent design (Creswell, 2014), based on a Knowledge-Attitudes-Practices (KAP) survey, observations, and individual interviews. Data were collected from health care workers (HCWs), i.e., both health care professionals (HCPs) and community health workers (CHWs), as well as key informants (national and district team linked to malaria prevention).

[3] Areas where the prevalence of the *P. falciparum* parasite is greater than 10% and/or the annual parasite incidence is greater than 250 cases per 1000 inhabitants (World Health Organization, 2022b)

2.2. Study setting

Malaria is endemic in Togo, with an incidence estimated at 237.5 cases per 1,000 people at risk in 2021 (World Health Organization, 2022a). MULTIPLY is implemented in the rural district of Haho, located in the country southern area of Plateaux region. In a study conducted in February 2022 during the rainy season, malaria infection prevalence of children aged 10–23 months in Haho district was 32.1%, and despite free treatment for children, prevalence of clinical malaria was 15.4% (Arikawa et al., 2023). In 2021, approximately 7,500 births were recorded in the district for 315,000 inhabitants. Workforce in Haho district in 2022 was 188 HCP and 525 CHW for 27 health facilities (Ministère de la Santé et de l'Hygiène Publique, 2020).

2.3. Study population and sampling

All HCP from the Haho district were invited to participate in the KAP survey. In addition, 10% of the CHWs assigned to each of the 27 health facilities were randomly selected to be invited for participation. Observations were conducted in the 4 cohort health facilities. Individual interviews were conducted among the 4 facility-in-charge and 2 or 3 HCWs per health facility, present on the day of the visit, thus combining purposive and convenience sampling. In addition, national and district institutional key informants involved in malaria control and management were also invited to participate.

2.4. Concepts studied

To guide data collection and analysis, a conceptual framework of health district readiness to implement PMC was developed based on the literature (Dearing, 2018; Fassier et al., 2015; Helfrich et al., 2009; Holt et al., 2010; Moore et al., 1991; Pineault and Daveluy, 1986; Schaefer and Welton, 2018; Sekhon et al., 2017; World Health Organizatio, 2015). It was constructed along a continuum of three assessment levels: implementation context, infrastructural feasibility, and individual acceptability (*see* Fig. A).

Implementation context refers to the extent to which an intervention, in this case the PMC strategy, is compatible (Fassier et al., 2015) with the particular geographical and socio-cultural environment in which it is deployed (Dearing, 2018), as well as with the intervention institutional setting – which takes into account the health system financing, equipment and material, and health workforce of the district (Holt et al., 2010; Fassier et al., 2015; Dearing, 2018), as well as the management capacities (Dearing, 2018; Helfrich et al., 2009), leadership and governance (Schaefer and Welton, 2018), and the ability to communicate and collaborate within district stakeholders (Dearing, 2018).

The feasibility of an intervention, whether perceived or operational feasibility, is a result of specific barriers that may impede its implementation and/or the facilitators that may support it (Pool et al., 2006). In the context of our study, we focused on the *a priori* perception of the infrastructural feasibility of introducing the PMC strategy in the district health facilities, according to their material (Dearing, 2018; Fassier et al., 2015; Helfrich et al., 2009; Holt et al., 2010; World Health Organizatio, 2015), organisational (Fassier et al., 2015; Helfrich et al., 2009), and functional capacities (World Health Organizatio, 2015).

At the individual level, the acceptability of the PMC strategy was assessed through 7 dimensions as proposed by the Theoretical Framework of Acceptability of Sekhon (affective attitude, burden, ethicality, intervention coherence, opportunity costs, perceived efficacy, and self-efficacy); we described the prospective acceptability of PMC among respondents, i.e., before participating in the intervention delivery (Sekhon et al., 2017).

2.5. Data collection method and tools

Building on this health district readiness conceptual framework, we used 3 main study tools, each providing different perspectives on the concepts investigated (see Table A). The tools were created by an international, multidisciplinary team of malaria and implementation research specialists.

The KAP questionnaire consisted of 45 questions in which most variables were assessed using a 4-level Likert scale ("Strongly agree" to "Strongly disagree"). It was a self-administered paper-based questionnaire, to which participants responded independently and anonymously. The completed questionnaires, sent to the project team by the district team, were entered into REDCap.

Observations and interviews were carried out and analysed by a multidisciplinary Franco-Togolese team of socio-anthropologists and public health researchers. A 21-item observation grid was completed during the health facility visit, covering such topics as geographical location and accessibility, health workforce, service delivery, equipment available (scales, microscope), where children were vaccinated, where medical products (medicines and vaccines) were stored, among others. At the end of the visit, an additional observation questionnaire was

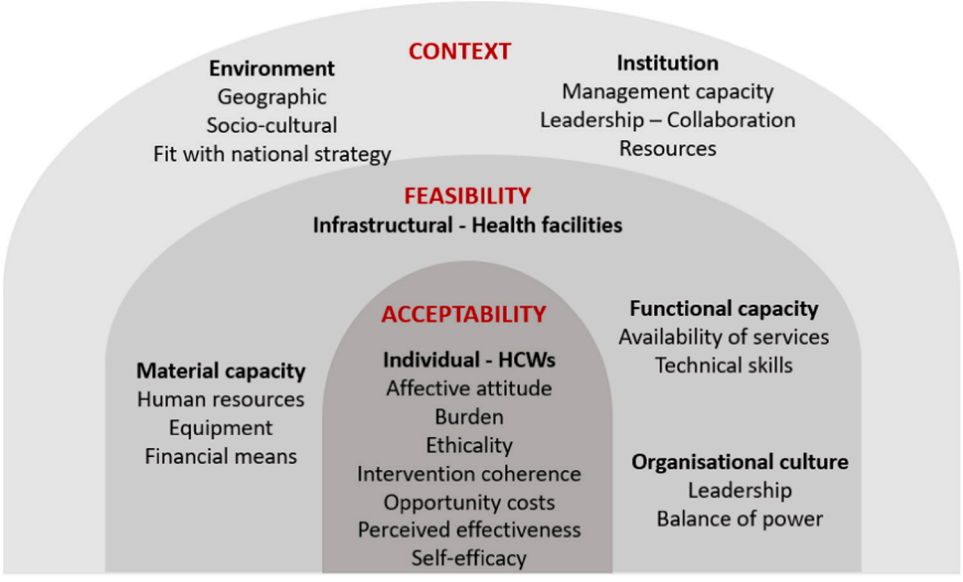

Fig. A. Conceptual framework for the study of health district readiness for PMC implementation.

Table A
Articulation of the different data sources for the readiness analysis.

DATA SOURCE	TOOLS - POPULATION	RESULTS								
		READINESS								
		CONTEXT		FEASIBILITY			ACCEPTABILITY			
		Environment	Institutional	Material	Functional	Organisational	Affective attitude	Coherence	Burden	Perceive effectiveness
Observation	Observation grid	X	X	X						
	FIC* questionnaire		X	X	X					
Interviews	Health Care Provider	X	X	X	X	X	X	X	X	X
	CHW**	X	X	X	X	X	X	X	X	X
	Institutional***	X	X	X	X	X	X	X	X	X
KAP study	Knowledge			X				X		
	Attitudes	X		X					X	X
	Practices								X	X

*FIC: Facility in charge
**CHW: Community Health Worker
*** National and district teams

administered face-to-face to the facility-in-charge. All observation data was collected on paper and then entered into a REDCap database. Individual qualitative interviews were conducted based on a semi-structured interview guide; they explored the role and experiences of respondents in the prevention of malaria in infants, the difficulties and opportunities encountered in their activity and their expectations with regards to PMC. Interviews were conducted in French on-site or remotely exclusively for key informants. Interviews were recorded with respondent authorization; audios were stored on a secure server based at University of Bordeaux and transcribed verbatim.

All participants provided written informed consent to participate. Data were anonymized using numeric identification codes.

2.6. Analysis

We conducted a mixed-methods analysis, which first consisted of a primary and independent analysis of quantitative, observational, and qualitative data. Then, following a convergent design (Creswell, 2014), the results of this primary analysis were merged, compared, and combined into a structured interpretation of the district's readiness, based on the conceptual framework for analysis outlined in Fig. A. Qualitative data were the sole data source for the analysis of certain themes, or were used to support contextual data or refine the interpretation of quantitative results (Östlund et al., 2011). Table A below summarizes the different data available and their use for analysis.

For the KAP data, descriptive analyses were performed, using mean and standard deviation for the continuous variables and number and frequency associated with their 95% confidence interval for the categorical variables. Univariate analysis was conducted using chi-square test and Fisher exact test to identify differences between HCPs and CHWs, with a significance level of 5%. We calculated a 23-point knowledge score, giving 1 point for each correct answer to questions on causes (n=6), symptoms (n=9), and means of prevention (n=5) and 2 points for basic knowledge (e.g., mosquito bite). The knowledge of HCWs around malaria and its prevention informed on their perception of PMC as a relevant strategy. The HCWs' attitudes results provided insight into their perceptions of the context (difficulty of access to care), the feasibility (sufficient staff and material) and the acceptability of PMC, its potential effectiveness, and the anticipated burden of delivering and implementing the strategy. Practices data informed on the acceptability and feasibility of the PMC strategy (*see* Table A).

The observation data were described as case studies for each health facility, presenting the health facility context and the feasibility of PMC in terms of staffing levels, environmental and institutional context as well as the material and functional capacities of each facility (*see* Table A).

For the qualitative data, we performed thematic coding using N'Vivo software version Release 1.6.1, according to a multi-level codebook designed based on the interview guide. Thematic summaries were produced and the interpretation was carried out using an hypothetico-deductive approach based on the readiness framework (Pope and Mays, 2006): we explored the context for PMC (access to care and the institutional framework), its infrastructural feasibility (organizational culture, functional and material capacities) and acceptability (understanding, effectiveness, burden and ease of use perceived prior the implementation) (*see* Table A).

Findings from each data source were triangulated and are presented below following our main research questions: the implementation context for PMC, such as perceptions of childhood immunization services delivery and malaria prevention as key contextual drivers; the acceptability of the PMC strategy, including the perceptions of the need for and effectiveness of PMC; and the feasibility of PMC *such* as the anticipated workforce and governance issues related to the introduction of this strategy at district-level (Creswell, 2014).

2.7. Regulatory and ethical agreements

This implementation research was approved by the Ethical Investigation Committee of the Clinical Hospital of Barcelona and the Bioethics Committee for Health Research (Spain) and by the Bioethics Committee

for Health Research in Lomé (Togo) (Agreement N°34/2021/CBRS).

3. Results

3.1. Characteristics of respondents

Four of the 188 HCPs and 5 of 52 CHWs invited to participate in the KAP survey were unavailable on the day of the survey, yielding a participation rate of 97.9% and 90.4%, respectively. Thus, the final sample (n=231) consisted of 184 HCPs and 47 CHWs. Participants were 55.4% male and their average age was 37 years. The HCWs interviewed were predominantly working in the public sector (81.0%), in peripheral care units (40.6%) (*see* Table B). Nineteen individual interviews were conducted with 4 facility-in-charges, 8 HCPs, 2 CHWs, and 5 key informants at national and district level. The sample was 74% male; the 5 women were exclusively HCPs (*see* supplementary file).

3.2. Perceptions of childhood immunization services delivery

While more than 81.4% respondents to the KAP questionnaire felt that the community was supportive of child immunization services, the lack of transportation limited their access to care and 60.2% of HCWs perceived distance as an obstacle (*see* Table C.1), which was illustrated in the interviews as follows: *"People come from 14 km away on foot to come to the center" (midwife)*.

For 95.7% of HCPs, immunization helped reduce infant mortality and 84.8% perceived that children were immunized according to the EPI schedule (*see* Table C.2).

3.3. Knowledge and perceptions of malaria prevention in children

Although only 16.5% of KAP respondents reported having received malaria training in the past 2 years (*see* Table B), their average score for general malaria knowledge was 16.7/23 (14.5/20), indicating good knowledge among HCPs about the causes, symptoms, and prevention of malaria. Most respondents (66.2%) were familiar with the definition of the acronym IPTi (*see* Table C.2) and the PMC strategy seemed understandable to all HCWs interviewed, as explained by a facility-in-charge: *"It aims to reduce the prevalence of malaria in children under 2 years of age and therefore reduce mortality as well"(Facility in charge)*.

The use of bednets and SP were perceived as effective for malaria prevention by respectively 93.5% and 85.3% of HCWs (*see* Table C.2).

Table B
Sample description of health care workers (N=231).

	N	%
Gender		
Male	128	55.4
Female	103	44.6
Age (mean and standard deviation in years)	37	9
Profession		
Community Health Worker	47	20.4
State qualified nurse	40	17.3
Health Care Aide / Assistant	25	10.8
Matron / Birth attendant	21	9.1
Midwife	21	9.1
Pharmacist / Pharmacy Manager	16	6.9
Medical Assistant	11	4.8
Laboratory technician	10	4.3
Physician	3	1.3
Other	37	16.0
Type of health facility		
Medical and Social Centre	67	29.0
Peripheral Care Unit (PCU)	94	40.6
District Hospital	35	15.2
Other	35	15.2
Activity sector		
Public	187	81.0
Private non-profit (faith-based)	25	10.8
Private for profit	13	5.6
Other	6	2.6
Type of contract		
Civil servant/permanent contract	140	60.6
Volunteer	55	23.8
Temporary/short-term contract	34	14.7
Other	2	0.9
Length of time in the district (mean and standard deviation in years)	7.4	7.1
Malaria training in the last 2 years		
Yes	38	16.5
No	193	83.5

Table C1
Perception of the implementation context by health care workers (N=231).

	N	%	95% CI
Distance is a barrier to vaccination			
1-All in agreement	64	27.7	[21.9–33.5]
2-All right	75	32.5	[26.4–38.5]
3-Disagree	57	24.6	[19.1–30.2]
4- Strongly disagree	35	15.2	[10.5–19.8]
Distance is an obstacle (1+2)	139	60.2	[53.5–66.5]
Distance is not an obstacle (3+4)	92	39.8	[33.5–46.5]
Parents support vaccination			
1-All in agreement	92	39.8	[33.5–46.1]
2-All right	96	41.6	[35.2–47.9]
3-Disagree	34	14.7	[10.1–19.3]
4- Strongly disagree	9	3.9	[1.4–6.4]
Parents in favour of vaccination (1+2)	188	81.4	[75.6–86.1]
Parents against vaccination (3+4)	43	18.6	[13.9–24.4]
Children are vaccinated according to the EPI schedule			
1-All in agreement	105	45.4	[39.0–51.9]
2-All right	91	39.4	[33.1–45.7]
3-Disagree	20	8.7	[5.0–12.3]
4- Strongly disagree	15	6.5	[3.3–9.7]
Compliance with EPI schedule (1+2)	196	84.8	[79.4–89.1]
Non-compliance with EPI schedule (3+4)	35	15.2	[10.9–20.6]
Parents take their child promptly to the health facility if they have a fever (n=231)			
1-All in agreement	62	26.8	[21.1–32.6]
2-All right	102	44.2	[37.8–50.6]
3-Disagree	39	16.9	[12.1–21.7]
4- Strongly disagree	28	12.1	[7.9–16.3]
Early consultation at the HF (1+2)	164	71.0	[64.6–76.6]
Late consultation at HF (3+4)	67	29.0	[23.3–35.4]

3.4. Perceptions of the need for and effectiveness of PMC

HCPs perceived that malaria was the first reason for attending health facilities, as well as the first cause of death in children. The burden of malaria disease underlay most positive views and perceptions of PMC: *"It is very relevant, since we just said that malaria is the first cause of consultation, especially in children under 5 years old. So, reducing this incidence would be good for the community" (Facility in charge)*.

Almost all (93.5%) respondents to the KAP questionnaire agreed that PMC could be an effective strategy for reducing malaria prevalence and mortality in infants, with more than half (55.4%) "Strongly agreeing" (*see* Fig. B). This perceived effectiveness of the PMC strategy seemed to be partly related to the perceived positive impact of IPT during pregnancy (IPTp): *"Since all pregnant women who are put on IPTp do not come back for malaria, I am confident that this treatment will work"* (*Facility in charge*).

Of note, HCPs were more likely to perceive IPT as effective than CHWs (96.2% versus 83.0%; p=0.003) (*see* Table D).

Contrasting perceptions of the need for chemoprophylaxis against childhood malaria were expressed. On the one hand, half of respondents to the KAP questionnaire (51.5%) agreed with the fact that "if an infant does not have malaria, it is not necessary to give him or her a malaria drug" (*see* Fig. B). On the other hand, in individual interviews, one midwife explained, *"It's a good thing [taking these drugs]. It helps the body not to get sick,"* while a matron said, *"Hey, we don't give [this medicine] like*

Table C2
Knowledge, attitudes and practices of health care workers (N=231).

	n	%	95% CI
Knowledge			
Knowledge of the definition of the acronym IPTi			
Yes	153	66.2	[60.1–72.3]
No	78	33.8	[27.7–39.9]
Knowledge score (Mean-TE) (n=227)	16.73	2.9	[16.4–17.1]
Score >80	75	32.5	[26.1–38.8]
Attitudes			
Vaccination helps reduce child mortality			
1-All in agreement	160	69.3	[63.3–75.2]
2-All right	61	26.4	[20.7–32.1]
3-Disagree	3	1.3	[-0.2–2.8]
4- Strongly disagree	7	3.0	[0.8–5.2]
Vaccination effective (1+2)	221	95.7	[91.9–97.8]
Vaccination not effective (3+4)	10	4.3	[2.2–8.1]
Mosquito nets (ITNs) are effective in preventing malaria			
1-All in agreement	149	64.5	[58.3–70.7]
2-All right	67	29.0	[23.2–34.9]
3-Disagree	13	5.6	[2.7–8.6]
4- Strongly disagree	2	0.9	[-0.3–2.1]
ITN effective (1+2)	216	93.5	[89.3–96.2]
ITN not effective (3+4)	15	6.5	[3.8–10.7]
SP is effective in preventing malaria			
1-All in agreement	89	38.5	[32.3–44.8]
2-All right	108	46.8	[40.3–53.2]
3-Disagree	19	8.2	[4.7–11.8]
4- Strongly disagree	15	6.5	[3.3–9.7]
SP effective (1+2)	197	85.3	[79.9–89.5]
SP not effective (3+4)	34	14.7	[10.5–20.1]
Malaria control programs are not effective			
1-All in agreement	22	9.5	[5.7–13.3]
2-All right	30	13.0	[8.7–17.3]
3-Disagree	67	29.0	[23.2–34.9]
4- Strongly disagree	112	48.5	[42.0–54.9]
Malaria programs effective (1+2)	52	22.5	[17.4–28.6]
Malaria programs not effective (3+4)	179	77.5	[71.4–82.6]
Practices			
Informing parents about malaria prevention measures (n=214)			
Systematically	196	91.6	[88.0–95.2]
Not systematically	18	8.4	[4.8–12.0]
Notification of vaccination in the registry (n=167) *			
Always	161	96.4	[94.0–98.8]
Sometimes	4	2.4	[0.4–4.4]
Never	2	1.2	[0.0–2.6]
Notification of vaccination in the booklet (n=170) *			
Always	160	94.1	[91.1–97.2]
Sometimes	4	2.4	[0.4–4.3]
Never	6	3.5	[1.1–5.9]

*Excluding "don't know" and "not applicable" responses

that […] The person has to be sick and we give him medicine (Matron).

3.5. Health workforce issues for the introduction of PMC

Looking ahead to when PMC would be implemented, nearly 60% of HCWs anticipated that administering PMC during an immunization visit would be easy (*see* Fig. B). Additional workload was anticipated

Table D
Knowledge, attitudes and practices of CHWs and HCPs.

	CHWs (n=47)		HCPs (n=184)		
	n	%	n	%	p
Remoteness is a barrier to vaccination					**0.01**
Yes	36	76.6	103	56.0	
No	11	23.4	81	44.0	
Parents support vaccination					0.5
Yes	40	85.1	148	80.4	
No	7	14.9	36	19.6	
Children are vaccinated according to the EPI schedule					0.7
Yes	39	83.0	157	85.3	
No	8	17.0	27	14.7	
Parents take the child to the center quickly in case of fever					**0.04**
Yes	39	83.0	125	67.9	
No	8	17.0	59	32.1	
There are enough staff for the vaccination					**0.01**
Yes	33	70.2	92	50.0	
No	14	29.8	92	50.0	
The equipment is sufficient to ensure quality of care					**<0.001**
Yes	14	29.8	109	59.2	
No	26	55.3	58	31.5	
NA	7	14.9	17	9.2	
Knowledge of the IPTi acronym					**0.01**
Yes	24	51.1	129	70.1	
No	23	48.9	55	29.9	
Malaria knowledge score					**0.05**
average and sd	15.8	3.6	17	2.8	
Perceived effectiveness of SP					**<0.001**
Yes	28	59.6	169	91.8	
No	19	40.4	15	8.2	
Perceived effectiveness of bednets					0.8
Yes	44	93.6	172	93.5	
No	3	6.4	12	6.5	
IPTi is perceived as effective					**0.003**
Yes	39	83.0	177	96.2	
No	8	17.0	7	3.8	
IPTi is necessary if a child is not sick					0.4
Yes	27	57.4	92	50.0	
No	20	42.6	92	50.0	
The IPTi is perceived as easy to administer					0.08
Yes	23	48.9	116	63.0	
No	24	51.1	68	37.0	

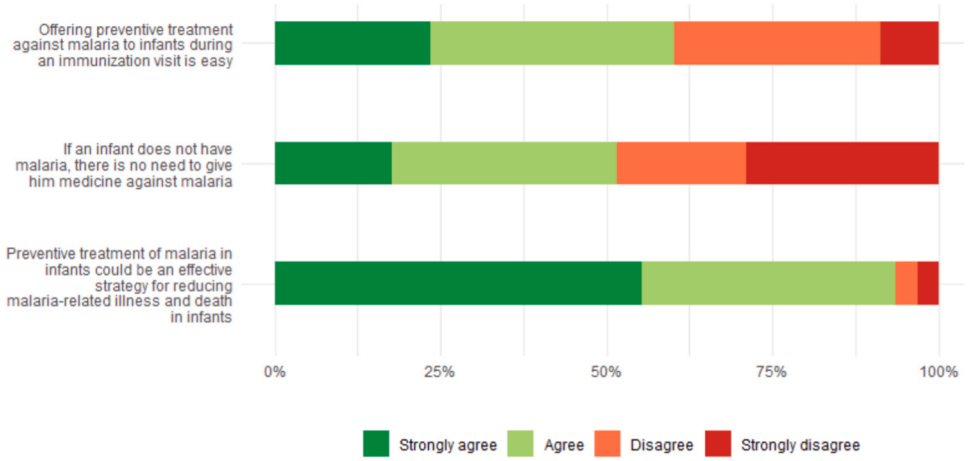

Fig. B. Pre-intervention acceptability of IPTi/PMC.

regarding the time required to administer the treatment, *"Because you can't just take a product, shove it down a child's throat quickly and walk away. You have to cuddle the child, you have to take a bit of time. So time is going to increase" (Midwife*). Moreover, in a context where HCWs reported that they systematically recorded vaccination acts in the EPI register (96.4%) and in the vaccination card (94.1%) (*see* Table C.2), including additional data in the register, for an additional procedure such as PMC, was perceived as an issue. "*It's extra work […] now you're going to give IPTi, you have to record this, you have to put this in the register, you have to do the data management and provide a report; it's another job that's going to be added" (Hygiene Assistant)*.

This fear of work overload and lack of human resources was repeatedly reported. Almost half of the KAP respondents (45.9%) perceived that they did not have sufficient staff to carry out immunization activities (*see* Table C.3). This difficulty was compensated for by the dedication and cohesion of the team: *"What works well [in providing EPI] is that we manage to organize ourselves, i.e., someone from the maternity ward joins the hygiene assistant and if possible, someone from medicine joins in" (Midwife)* or by late hours overstepping on their off-duty time*: "All those who come, we'll vaccinate them anyway. Even if we have to continue until 3 or 4 pm, we continue" (Facility in charge)*. Task shifting to less qualified staff was mentioned as a strategy to support EPI. CHWs were perceived as motivated and efficient volunteers that would play a key role in the delivery of the PMC. According to the facility-in-charges interviewed (2/4), CHW compensation, provided by the district, needed to be supported and reinforced by *"moral and financial incentives" (Facility in charge)*.

Three of the four health facilities assessed reported budgetary difficulties, particularly with regards to the payment of temporary staff (14.7% of the sample, see Table B), as explained by one facility-in-charge *"My budget is 95% contract staff"*. This limited their capacity to strengthen their health teams. From the district's point of view, recruiting qualified staff was also perceived as difficult *"I was forced to accept trainees in all the facilities, to alleviate some of the human resource problems" (District team)*.

3.6. Service delivery issues related to the introduction of PMC

Observations and interviews highlighted several factors that could limit the operational feasibility of implementing the PMC strategy. Observations underlined that none of the health facilities had a suitable space dedicated to EPI, whether for the weekly fixed-strategy immunization sessions or for the outreach sessions (4–8 per month) conducted outdoors. Although few vaccine stock-outs were reported in the month prior to the study, only 59.4% of HCWs felt they had enough supplies to provide quality care for children under 5 (*see* Table C.3). In all the health facilities assessed, access to water was limited because it came from a borehole and could not be used to administer preventive treatment. Health facilities did not have spoons or cups to administer PMC. With their budget coming from user-fees, the facility-in-charges did not think they could buy this equipment.

Table C3
Anticipated feasibility factors perceived by health care workers.

	n	%	95% CI
Sufficient staff to provide vaccination (n=231)			
1-All in agreement	68	29.4	[23.6–35.3]
2-All right	57	24.7	[19.1–30.2]
3-Disagree	75	32.5	[26.4–38.5]
4- Strongly disagree	31	13.4	[9.0–17.8]
Sufficient staff (1+2)	125	54.1	[47.7–60.5]
Insufficient staff (3+4)	106	45.9	[39.5–52.3]
Presence of sufficient equipment to ensure quality of care (n=207)*			
Yes, always	47	22.7	[17.0–28.4]
Yes, most of the time	76	36.7	[30.1–43.3]
No rarely	58	28.0	[21.9–34.1]
No, never	26	12.6	[8,0−17,1]
Sufficient material (1+2)	123	59.4	[52,7–66,1]
Insufficient equipment (3+4)	84	40.6	[33,9–47,3]

3.7. Leadership and governance issues related to the introduction of PMC

Interviewees reported that Haho district had a good coordination team, that would support the introduction of the PMC strategy. The technical support provided by the district management team, through supervision and monthly meetings, allowed for cohesion and capacity building among facility-in-charges*: "For the monthly meeting, […] it's mostly about sharing experiences, capitalizing on each other's experiences to improve" (District team)*. The district director of health was perceived as very active in the field, with strong leadership skills, and in regular contact with the facility-in-charge; half of them reported daily contacts, "*even on weekends, he receives people at his home" (Facility in charge)*. Despite their hierarchical superiority and decision-making power, facility-in-charges were perceived as open to dialogue*: "If he [facility in charge] says something that suits us, and it is a good thing, we will accept it, but if it does not suit us, we can say that we refuse"* (CHW). The district management team unanimously recommended regular supervision during future PMC implementation, as well as maintaining close collaboration and good communication between the various stakeholders.

Some HCWs (22.5%) responding to the KAP questionnaire expressed doubts about the long-term effectiveness of a new malaria control program (*see* Table C.2). This was explained among others by the experience of pilot malaria control projects that were not followed by scale-up, as phrased by a district team member: *"We tried a pilot project but it remained a pilot, it did not… We had done a mass treatment on a project […] When we had done it, we stayed for a few months without a case. But as people come out [of the setting] and come back, the cases gradually came back" (District team)*.

4. Discussion

The readiness assessment study conducted within Haho district in Togo, based on a mixed methods implementation research, showed that PMC was perceived as an acceptable strategy by most of the participating health care and management teams. While most HCPs did not envision any major constraints in the administration of PMC, it was associated with likely additional workload. Despite reported perceptions of an organized, structured, and committed health district team, access difficulties and structural limitations were highlighted, which would need to be addressed to support the future feasibility of the PMC strategy.

All respondents perceived the relevance and effectiveness of the PMC strategy, and this was strongly associated with the perception of high malaria burden in the area. It has been shown that the perception of the effectiveness of a strategy is a factor that facilitates its acceptance and adherence (Pitt et al., 2012). In a context of a renewed global awareness of the high burden of malaria in children and the gaps in the implementation of prevention programs, including post-COVID-19 (Zawawi et al., 2020), this finding is very encouraging for the future deployment of PMC in other highly affected settings.

The need to administer malaria chemoprevention to infants was not always well understood by respondents, and this seemed to be related to the level of initial malaria training. In-depth PMC training for HCPs and CHWs, and repeated refresher sessions, may be key facilitators for PMC acceptability and adoption, especially since the recent recommendation of malaria vaccine may further complexify prevention messages (Organisation Mondiale de la Santé, 2022b).

In terms of health workforce and health system financing, the lack of dedicated EPI staff reported by HCPs and the financial difficulties encountered by facility-in-charges in recruiting staff were underlined as potential obstacles to the feasibility of the PMC strategy. Lack of human resources has been the main obstacle to the implementation of several

malaria chemoprevention strategies such as SMC, IPTp or IPTi (Audibert and Tchouatieu, 2021; Mubyazi et al., 2011; Faye et al., 2011; Coldiron et al., 2017; Greenwood, 2006; Niang, 2022). The involvement of CHWs has been hampered by the difficulties associated with their compensation, which is yet key in ensuring the quality of services (Audibert and Tchouatieu, 2021; Faye et al., 2011; Niang, 2022).

One of the reasons for the extra workload anticipated by HCWs in introducing the PMC strategy was the time required to administer SP to children. The WHO list of essential medicines recommends only adult formulations of SP (eEML - Electronic Essential Medicines List Internet, 2023); tablets must be cut, crushed and dissolved before administration to infants (Audibert and Tchouatieu, 2021; De Sousa et al., 2012; Pitt et al., 2012) which was shown to increase the workload (Pitt et al., 2012; Helfrich et al., 2009) and the duration of immunization sessions (Gaye, 2021). Within the MULTIPLY project, the delivery of a dispersible form of SP suitable for infants should contribute to limit the increase in workload and duration of immunization sessions. And yet, this reported fear of increased workload should be addressed when deploying PMC, especially in contexts where health workforce is structurally insufficient. Indeed, in Togo, in 2021, there was 4.56 nurses, midwives and medical doctors per 10, 000 population, versus the 44.5 health workers goal set by WHO (Nursing and midwifery personnel per 10 000 population Internet, 2023). Introducing a new intervention in existing services, at constant workforce level, may reduce the quality of care, by increasing workflow (Asamani et al., 2015) and shortening consultation times, which in turn would reduce patient satisfaction (Kpebo et al., 2022). Preliminary findings from the process evaluation carried out within the MULTIPLY project suggest that work organization is a key implementation issue: in certain health facilities, PMC has sometimes been administered by mothers/caregivers, thereby improving workflow and reducing the workload of HCPs.

Related to service delivery, structural limitations reported in this readiness assessment, such as lack of specific space for EPI services delivery, access to clean water, basic supplies or equipment, could hinder the implementation of the PMC strategy (Audibert and Tchouatieu, 2021; Mubyazi et al., 2011). Mechanisms to support health facilities in procuring drinkable water and adequate equipment for the dispensing of treatment will be key to any PMC deployment strategy.

In Haho district, difficulties in accessing health care facilities are persistent, especially during the rainy season. Distance to health facilities has been identified as the main obstacle to immunization in rural areas in Togo (Ekouevi et al., 2018). Beyond the fixed EPI strategies carried out within health facilities, outreach EPI that includes PMC delivery would contribute to reaching remote communities; assessing the acceptability of this PMC delivery model within the community will be key, especially in a post-COVID-19 context, marked by reduced contacts with the health care system in many low-income countries (Fejfar et al., 2023).

Regarding leadership and governance, the study findings suggest the commitment and the will of the Haho district team to implement PMC. Several recommendations mentioned by the district team are aligned with the literature on the supportive factors for the introduction, implementation and evaluation of a new public health strategy: for example, maintaining a dynamic and supportive collaboration with the project team (Niang, 2022; Kweku et al., 2009), formative and technical supervision, particularly among CHWs (Coldiron et al., 2017; Greenwood, 2006), and good communication between stakeholders (Niang, 2022). The commitment and organizational preparedness of field teams have been described as essential pre-requirement to successful implementation of new health interventions (Weiner et al., 2008). At the same time, our results show that if most respondents perceived the effectiveness of conventional malaria control methods such as bed nets (93.5%), only 77.5% of HCPs perceived that malaria control programs were effective in reducing child mortality. The commitment and mobilization of HCPs towards the PMC strategy thus would need to be strongly supported during the implementation to enhance practice changes (Skivington et al., 2021).

There are several limitations to this study. Observation and interviews were conducted within only 4 of the 27 health facilities in Haho district, those where the MULTIPLY cohort study would be conducted. These facilities were purposively selected, based on accessibility and EPI coverage data, and as such may not be representative of all district facilities. Furthermore, the KAP questionnaire was self-administered; some of the questions using double-negation, particularly those assessing the need for malaria chemoprevention in healthy children or the perceived effectiveness of malaria control programs, may have been difficult to understand, thereby introducing an information bias. A prevarication bias, related to professional credibility with respect to questions on the perceived effectiveness of PMC in particular, cannot be excluded. These biases could partly explain the difference between the high perception of the PMC strategy's effectiveness and the low proportion of respondents who said they needed to implement it. In addition, although it was constructed based on published literature, the conceptual framework used to guide the analysis is not validated and therefore potentially not exhaustive. Finally, due to the structure of the sample size for the KAP survey, stratified analyses on HCW professional category were not performed here; but we did observe several differences in knowledge and perceptions between HCPs and CHWs suggesting the need to investigate these differences further. This assessment of the health systems readiness essentially relied on data provided by health care workers; taking into account the views of community members and parents/caregivers, i.e. potential beneficiaries of PMC, would provide additional insight into the challenges and opportunities for implementers.

Despite these limitations, the high participation rate in the quantitative survey and the absence of refusals to participate in the interviews have minimized the risk of selection bias. Representativeness of the population studied and the use of a mixed-methods analysis through the triangulation of three data sources (observations, interviews, and KAP survey) reinforce the validity of our results. In addition, although Haho district has its own specific features, some of its characteristics are certainly similar and/or comparable to other West African districts, whether in terms of health system organization, malaria prevalence or vaccination coverage rates. Our study results thereby can be directly usable to implementers and decision-makers in other areas of the subregion who can anticipate on potential obstacles and factors facilitating PMC implementation.

5. Conclusion

The readiness assessment carried out in this rural district of Togo highlighted several encouraging factors for the future the implementation of the PMC strategy: the perceived need to control malaria in infants, the strong *a priori* acceptability and perceived effectiveness of PMC and the support of the district team. However, structural barriers were identified, requiring the strong investment by the district and national healthcare teams in order to support the operational feasibility of the strategy. Among the key facilitators emerging from this assessment were the need for appropriate training of HCPs, financial and moral support for the HCWs in charge of implementation, regular supervision of activities by the district team, and regular communication between the various stakeholders. In the same spirit as the PMC Community of Practice, which is contributing to sharing experiences and lessons learned in the implementation of PMC, our study findings may inform national malaria programmes in similar settings that have adopted PMC as policy, such as Mozambique, and are considering the implementation of PMC at district level.

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Research teams

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CRediT authorship contribution statement

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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.ssmhs.2024.100012.

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