www.malarianomore.org

malaria NO MORE

The Malaria Matchbox Toolkit Report

Table of Contents

List of Abbreviations 4

Executive Summary 5

1. **Malaria Situation: Global and Indian Scenario** 9
   - 1.1 Malaria programme and strategies in India 9
2. **Community's Role in Malaria Programming** 11
   - 2.1 Community, rights and gender barriers in Malaria response 12
3. **Assessment of CRG Barriers: A Malaria Matchbox Toolkit** 13
   - 3.1 Unit of analysis: Pilot assessment in Meghalaya 13
4. **Vulnerable & high risk communities for malaria prevention and control** 19
   - 4.1 Communities most affected by malaria 19
   - 4.2 Communities with limited or no access to malaria services 21
5. **Determinants of malaria outcomes** 23
   - 5.1 Human-related biological factors 23
   - 5.2 Physical and environmental factors 25
   - 5.3 Socio-cultural factors 27
   - 5.4 Access to malaria services and information 31
6. **Assessment of Toolkit** 35
   - 6.1 Assessment of modular questions 35
   - 6.2 Limited source of data 38
   - 6.3 Assessment of stakeholder environment 39
   - 6.4 Gap analysis 41
   - 6.5 Key challenges 41

7 **Recommendations** 43

8 **Conclusions & Next Steps** 45

References 47

List of Tables

Table 1: State profile of Meghalaya 14
Table 2. District-wise distribution of Jhumia population in Meghalaya 30
Table 3. Key populations and vulnerabilities identified by civil society and NGOs 41

List of Figures

Figure 1. Desk review for CRG barrier assessment 16
Figure 2. Multi-stakeholder evidence-based problem-solving approach to CRG barriers in malaria response 18
Figure 3. Vulnerable and high-risk population/ communities in malaria 22
Figure 4. Climate, a moderating factor to influence land use effect on malaria transmission 26
Figure 5. Moderating effect of climate on occupational characteristics, increasing risk of malaria 27
Figure 6. Gaps in ASHA's perceptions and community's response on vector control tool utilisation 33
Figure 7. The relationship among various risk factors in malaria 37
Figure 8. Complex relationship of ethnicity, physical environment, and socio-cultural factors in malaria 38

List of Abbreviations

ACT: Artesunate Combination Therapy
AIDS: Acquired immune deficiency syndrome
CBO: Community-based organisation
CHC: Community Health Centre
CRG: Community, rights, and gender
DHIS: District Health Information System
FLA: Farm Land Area
FBO: Faith-based organisation
GoI: Government of India
HIMS: Health Management Information System
HIV: Human Immunodeficiency Virus
ITN: Insecticidal Treated Nets
IRS: Indoor Residual Spraying
LLIN: Long-lasting insecticidial net
MoHFW: Ministry of Health and Family Welfare
NACP: National AIDS Control Programme
NFME: National Framework for Malaria Elimination
NGO: Non-Government Organisation
NVBDCP: National Vector Borne Disease Control Programme
RDT: Rapid Diagnostic Test
SGH: South Garo Hills
WGH: West Garo Hill
EKH: East Khasi Hills
MNM: Malaria No More
SCs: Scheduled Caste
STs: Scheduled Tribe
NFHS: National Family Health Survey
NSPME: National Strategic Plan for Malaria Elimination
ASHAs: Accredited Social Health Activists
PHCs: Primary Health Centre
PIP: Programme Implementation Plan
MiP: Malaria in Pregnancy
WWM: Women with Malaria
MDR: Multi-Drug Resistant
NHM: National Health Mission
NACP: National AIDS Control Programme

Executive Summary

According to the *World malaria report 2017,* "India accounts for 6% of global malaria burden with 1.2 billion people at risk of malaria". Globally, local communities have been known to play a key role in addressing malaria. Improved community ownership necessitates improved community demand and uptake of prevention, diagnosis and treatment services, increased equity within malaria elimination and a strengthened primary health care approach to malaria control. It therefore makes strong economic sense to invest in understanding how local knowledge, beliefs and practices influence an intervention's effectiveness.

In the context of malaria, health service acceptance and utilisation, especially services for vector control, determine transmission rates by influencing vector density, extrinsic incubation periods and probability of a person being bitten by the vector Anopheles mosquito. Health seeking behaviour patterns and their acceptance/ utilisation on macro level are determined by a country's policies and strategies, overall economic profile, land use patterns, population density and marginality, calling for greater attention at micro-level. Community, rights and gender (CRG) barriers in malaria response remain embedded within the national approach through policy-strategy-programming and get addressed at community level through a multi-stakeholder approach.

Malaria No More (MNM) designed a Malaria Matchbox Toolkit to help countries address human rights and gender barriers in malaria response by identifying critical audiences that comprise "Who", "How" and "What" aspects of disease response. The Toolkit has four modules designed to analyse and address human rights and gender related barriers to malaria services. This was piloted for assessment in Meghalaya, which is a high malaria endemic state in north-eastern India with a reported 16,454 malaria cases in 2017. The Toolkit assessment comprised of a multidimensional team of experts from MNM, with support from the National Vector Borne Disease Control Programme (NVBDCP), Government of India and State Vector Borne Disease Control Programme, Government of Meghalaya. Data was sourced from a scientific literature desk review, National and State NVBDCP reports and published documents. A Knowledge–Attitude–Practice (KAP) survey was designed to understand malaria response that was garnered through focus group discussions with stakeholders.

Policy tracking and policy and strategy analysis were conducted to assess health policy inclusivity and its alignment with malaria prevention and control strategies, translating strategy into action through an evaluation report assessment, pertaining to malaria programme and interventions. The review focused on identifying population groups and communities most affected by malaria with biological, behavioural, socio-cultural and environmental vulnerability determinants; access to malaria services and information and community's acceptance and utilisation of services. A mixed method KAP Survey

was conducted in the three districts of Meghalaya, namely South Garo Hills, West Garo Hills and East Khasi Hills to understand malaria response. Post the review, a state-level workshop was held in Shillong in June, 2018 to obtain feedback on the Toolkit, advance CRG barrier knowledge in Meghalaya, identify necessary actions to address barriers and increase stakeholder inclusivity.

Common trends seen in malaria transmission included different rates of transmission in tribal and non-tribal populations; risk of Plasmodium falciparum infection being higher among forested tribal populations; children, especially under-5 years being at highest risk of malaria infection in forested areas; age vulnerability varying from tribe-to-tribe; and adult populations being at higher risk for malaria in urban populations. At village-level, sub-centres were seen as most proximal primary care facilities at community level, serving as a bridge between community and primary health centres. Communities in flood prone areas, terraces submerged in water, forests and tea gardens were found to be more vulnerable in terms of delayed treatment or not seeking care from government providers. In forest and tea tribes, tendency to self-treat was found to be higher among caregivers of children under 5, resulting in delayed treatment. Also, occupational slash and burn cultivators in forested areas, commonly referred to as jhum cultivators were prone to delayed treatment and limited access to health services.

Malaria distribution was also mostly determined by different factors affecting mosquito and malaria parasite reproduction and proliferation. While poverty impacts malaria response, malaria itself is a potential risk factor for poverty. More than 70% of ailment spells in India are treated in the private sector and >80% of health financing is borne by patients themselves. The risk too is higher because the private health sector and markets are mostly unregulated. Initial treatment choice for febrile illness is self-medication (>15%), traditional healers and untrained village practitioners (>20%-<40%), government (40%-80%) and private (>10%-<40%) health services.

While malaria services are provided free-of-cost in government health facilities and at community level with the Accredited Social Heath Activist (ASHA), services are chargeable in the private sector. Occupation and residence are closely linked to malaria and to curb socio-cultural barriers, improving community knowledge by using culturally appropriate health education materials; making traditional healers partners in malaria control; promoting within-village rapid diagnosis and treatment; increasing insecticidal treated nets (ITN) distribution and promoting their use as potential strategies to decrease infection rates in these communities, are seen as solutions for existing challenges in malaria response for marginalised populations.

Data from state HMIS revealed gaps in fever prevalence, malaria testing and access to diagnostic services for malaria. The gap has remained constant between 2012-2017. Despite these gaps, access to malaria treatment has improved considerably in the same period and in 2017, nearly all malaria cases were treated with antimalarials. The Malaria Matchbox Toolkit is useful in extracting data critical to the assessment of

community, CRG barriers in malaria response. Assessment of the Toolkit comprises assessment of modular questions in country/ province perspective; identification of methodological limitations and risk to data driven decision making; and analysis of stakeholder environment, including the capacity of local community-based organisations in understanding and finalising decisions and actions based on identified barriers. The first three modules aim to identify human rights and gender related barriers to malaria response, identifying most affected and those at highest risk; and delineating biological, socio-cultural, environmental and programmatic factors that determine risk/vulnerability.

*Key challenges included poor awareness amongst members of civil society; limited existing information on ecological studies and big data analysis; and mismatch in estimated and reported malaria burden. R*ecommendations included improving access, building alternative service providers, especially in inaccessible areas and villages with no ASHAs, increasing capacity of NGOs, CBOs and FBOs to provide services, improving programme quality and capacity, strengthening IEC and BCC efforts to make available free malaria services to larger groups of vulnerable population and designing a bottom-up communication strategy with tailored mediums with potential to identify and address *policy gaps.*

1. Malaria Situation: Global and Indian Scenario

The global stride towards malaria elimination is at a crossroads, with an increasing malaria burden across high endemic countries. Despite newly developed tools and technology showing success in eliminating malaria in the post-2000 era, the 2016 global malaria burden mirrored the 2012 malaria situation, nullifying nearly five years of gains. Central to this problem is:

- Malaria risk distribution heterogeneity
- Lack of fidelity in implementing and intensifying actions tailored to that risk.

Despite being the third largest contributor to the global malaria burden, India stands strong with its policy commitment to end malaria in the next decade. India is on track to eliminate malaria, as the country has witnessed a 28% decline in malaria cases and a 73% decline in malaria deaths since 2015.(1)

Quick facts

- India accounts for 6% of the global malaria burden
- 1.2 billion people in India are at risk of malaria
- In 2017, 0.84 million malaria cases and 104 malaria deaths were reported in India
- 10 states in central and north-eastern India reported malaria incidence of
- more than 1 per 1,000 population
- Odisha accounts for highest share of malaria cases in the country
- In the north-eastern region, Meghalaya remains the highest endemic state

1.1 Malaria programme and strategies in India

The programmatic response to malaria began in India in 1953, with the launch of the National Malaria Control Programme. Encouraged by the resounding success of the programme, the Indian government changed its goal to launch the National Malaria Eradication Programme in 1958. Despite the change, programmatic focus shifted back from eradication to control after repeated focal outbreaks and unbalanced transmission resulted in a malaria resurgence throughout the country.

In the post 2000 era, new tools including Artesunate Combination Therapy (ACT), Rapid Diagnostic Test (RDT), Long Lasting Insecticidal Nets (LLINs) and intensified control efforts in high endemic areas with external support (The World Bank and GFATM) resulted in a rapidly declining malaria burden.

With regained hope, the Indian government launched the National Framework for Malaria Elimination in India 2016-2030 (NFME) to eliminate malaria in phases by 2030. Further, India has developed strategies tailored to various risk settings to achieve the NFME's milestones. Districts have been stratified in accordance with malaria incidence and strategies have been developed to eliminate malaria in each district's category, as well as different vulnerable sub-groups including tribal populations, urban slum dwellers and migrants, amongst others.

2. Community's Role in Malaria Programming

Community plays a key role in addressing malaria. Globally, it has been seen that it takes upto three layers of community involvement to ultimately culminate into community ownership in malaria programming. These layers represent:

Community Engagement: Here communities inform and participate in designing programmes and ensuring they address appropriate community issues.

Community Delivery: Community organisations are well placed to deliver services or programmes reaching key populations and programmes, addressing human rights and gender barriers not typically delivered by health care providers.

Community Accountability: Communities monitor programmes and provide feedback on performance and hold appropriate parties accountable.

The overarching impact of community ownership includes:

- Improved community demand and uptake of prevention, diagnosis and treatment services
- Increased equity within malaria elimination
- A strengthened primary health care approach to malaria control through community-driven health system strengthening

Community ownership requires in-depth understanding on how local knowledge, beliefs and practices may influence an intervention's effectiveness. Moreover, community ownership also requires a gender sensitive and rights-based approach that is focused on inclusivity across vulnerable populations.
A gender sensitive programme essentially considers the vulnerabilities related to gender norms (including dressing, division of labour, daily habits and chores including sleeping habits), decision making (including access to education, treatment seeking) and broader contextual factors like gender-driven economic resources, land use, etc.

A rights-based approach prioritises health as a basic right. It ensures a tailored programmatic response to each vulnerable sub-group, irrespective of its civil and political affiliations. This is especially important for strengthening prevention and treatment, for infants, pregnant women and those living in poverty; ensuring access for all to diagnostics, antimalarials as well as vector control services; and creating accountability towards those who are most marginalised and excluded in terms of civil and political rights, e.g. migrants, aboriginals, and bordering population groups, amongst others.

"Community response" describe the means by which communities act on challenges and needs they face. While states have primary responsibility to guarantee health and human rights, when this responsibility is not fulfilled, community actors may need to act outside the formal public health systems to protect health and human rights of people who are neglected and marginalised. In many cases, communities provide services and support that are not otherwise provided, or accessible to most-affected populations.

There is growing consensus that universal health coverage will not be attainable without active engagement and leadership of communities, especially those most excluded and affected by disease. We need to better catalyse, organise and support community action and build stronger community systems that complement and work in synergy with formal health systems.

2.1 Community, rights and gender barriers in Malaria response

The programme's effectiveness relies heavily on the community profile at large, inclusive of its socio-demographic characteristics, economic status, cultural norms and taboos, geographical access and the environment in which it evolves.

Health seeking patterns are determined by myriads of proximal as well as contextual factors at family, societal and environmental levels, regulating the transmission rate of malaria, cost per case, severity and case fatality as well as the intangible impacts of malaria from wage and work-day loss.

The health service acceptance and utilisation, especially services for vector control, determine transmission rates by influencing vector density, extrinsic incubation periods and the probability of a person being bitten by the vector Anopheles mosquito.

Health seeking behaviour patterns and their acceptance/ utilisation on a macro level are determined by factors such as a country's policies and strategies, overall economic profile, land use patterns, population density and marginality. They also require attention at the micro-level as well to address community-specific gender-sensitivity and rights gaps, especially among marginalised communities, conflict regions and in communities where women, children and elderly people are ostracised or denied their basic rights.

Therefore, the community, rights, and gender (CRG) barriers in malaria response remain embedded within the national approach through policy-strategy-programming. These get suitably addressed at a community level through a multi-stakeholder approach that resolves various societal and developmental issues. It simultaneously mitigates the risk that malaria transmission brings by engaging local communities and local resources.

3. Assessment of CRG Barriers: A Malaria Matchbox Toolkit

The Malaria Matchbox Toolkit is designed to help countries address human rights and gender barriers in the malaria response by identifying the critical audiences that comprise "Who", the facilitating aspects that determine "How" and the specific methods that go into shaping "What" aspects of the disease response. This Toolkit has 4 modules designed to analyse and address human rights and gender related barriers to malaria services.

Module 1: Aims to pre-identify "who" (women, men, girls and boys, in all their diversity) are the most affected by malaria and those without access to needed services.

Modules 2 and 3: Attempts to uncover "what" barriers are impacting malaria outcomes. Module 2 focuses on understanding how biological, environmental, social, cultural and gender-related factors impact malaria outcomes and Module 3 identifies barriers to utilisation and access to malaria services.

Module 4: Provides a process to bring together the collected information from Modules 1, 2 and 3 to define what the potential interventions are and what resources are required to address the identified human rights and gender barriers. To do this, Module 4 provides a worksheet organised into seven columns:

1. Key barriers/risk increasing factors
2. Questions relating to barriers
3. Specific populations
4. Action required
5. Activities needed
6. Responsible parties
7. Resources required

3.1 Unit of analysis: Pilot assessment in Meghalaya

Meghalaya is a high malaria endemic state in north-eastern India which has reported 16,454 malaria cases in 2017. 87.6% of the reported malaria cases were caused by Plasmodium falciparum. As many as 12 deaths due to malaria were recorded in 2017 in the state. South Garo Hills district contributed majority of malaria cases in Meghalaya. (2)

The Matchbox Toolkit was piloted for assessment in the state of Meghalaya.

Meghalaya State Profile

Particulars	Description
Area	22,429 Sq. Km
Capital	Shillong
Language	Khasi, Pnar, Garo & English
District	11
Villages	6,839
Population	
Scheduled Caste population	17,355
Scheduled Tribe population	2,555,861
Others (other classes) population	393,673
Total Population	2,966,889
Male population	1,491,832
Female population	1,475,057
Children 0-4 years	406,154
Socio-economic Profile	
Literacy	75.48%
Gross Enrollment Ratio	140.9
Per capita net state GDP	INR 70.693
% Population below poverty line (BPL)	Rural: 12.5; Urban: 9.3
Employment in organised sector	0.063 million
Gender Statistics	
Sex ratio (females per 1,000 males)	989
Sex specific death rates	M: 8.1; F: 6.7
Sex specific Infant Mortality Rates	M: 41; F: 37
Sex specific Gross Enrollment Ratio (Primary)	M: 138.75; F: 134.12
Health infrastructure and human resource	
Medical college	1
District hospitals	11
Sub-divisional hospital	1
Community Health Centre	28
Primary Health Centre	108
Sub-Centers	423
Urban Health Centres	18
Blocks	46
% of Sub-centres with ANM	99.5
% of Sub-centres with Health Worker (M)	6.2
% of Villages having ASHA	88.8
% of Villages with sub-centre within 3 km	72.6
% of PHCs having referral services for pregnancy	36.5

Table 1: State profile of Meghalaya

Progress in malaria control in Meghalaya

- Meghalaya reported 24,727 malaria cases and 62 malaria deaths in 2013
- Malaria cases nearly doubled to 48,603 malaria cases in 2015. In the same year, the number of malaria related deaths increased to 79
- Post 2015, malaria cases and deaths have reduced substantially to 16,454 case deaths in 2017

Assessment team

The Toolkit assessment comprised of a multi-dimensional team of experts of Malaria No More (MNM), with support from the National Vector Borne Disease Control Programme (NVBDCP), Government of India and State Vector Borne Disease Control Programme, Government of Meghalaya. The team included technical, programmatic, data, communication and CRG expertise.

Data collection

Data for the Toolkit assessment was sourced from a scientific literature desk review, National and State NVBDCP records and reports, various published documents; a Knowledge–Attitude–Practice (KAP) survey to understand the malaria response in Meghalaya; and an interview/ focus group discussion with stakeholders.

Desk Review: For the purpose of a desk review, scientific literature, policy and strategy documents, records and reports, documents and secondary data obtained from the State NVBDCP were collected and catalogued. (Figure 1)

Policy tracking and policy and strategy analysis were conducted to assess health policy inclusivity; its alignment with malaria prevention and control strategies; and translating strategy into action through evaluation report assessment, pertaining to malaria programme and interventions in Meghalaya.

As existing scientific literature for CRG barriers for Megahalaya and North Eastern Indian states were insufficient, the scoping review included studies conducted across all Indian states. The review focused on identifying population groups and communities most affected by malaria; the biological, behavioural, socio-cultural, and environmental vulnerability determinants; access to malaria services and information and the community's acceptance and utilisation of services.

Secondary data was assessed to determine the overall malaria trend in the state; the malaria burden among different population groups; most affected geographical regions; and the malaria trend between 2012-2017.

Formative Research: A mixed method KAP Survey was conducted in the three districts of Meghalaya, namely South Garo Hills (SGH), West Garo Hills (WGH), and East Khasi Hills (EKH) to understand malaria response. The survey was conducted in 300 households across 30 villages in the three districts to identify the socio, demographic and economic status of households; knowledge and perceptions about malaria; attitude towards malaria; self-efficacy; exposure to media; contact with community health workers; health seeking behaviour; vector control activity usage and acceptance; and practices towards malaria control and elimination.

Semi-structured interviews were conducted with ASHAs in each selected village. To identify specific vulnerabilities, in-depth interviews were conducted among migrant workers, jhum cultivators, informal service providers and school teachers (one from each category).

SCIENTIFIC LITERATURE

- Method– Scoping review using Arksey O'Malley Framework
- Database Search– PubMed, Google Scholar
- Number of articles included– 97
- Descriptive assessment

DOCUMENTS

- Policy and strategy documents (National Health Policy 2002 and 2017; National Framework for Malaria Elimination in India 2016-2030; National Strategic Plan for Malaria Elimination in India 2017-2022)
- Grant proposals and/or progress updates (The GFATM supported projects, The World Bank supported project)
- Different guidelines for case management and vector control in India under NVBDCP
- Health statistics (The India State Level Disease Burden Initiative 2017– ICMR, IHME, PHFI, National Health Profile 2018, Healthy States, Progressive India– NITI Aayog)

OTHER REPORTS

- Joint Monitoring Mission Report
- Evaluation reports– Household Survey in Meghalaya 2017, The World Bank Formative Research Summary Report, NSSO 71st Round Report, National Family Health Survey (NFHS)– 4
- Programme Implementation Plan (PIP), National Health Mission, Meghalaya

SECONDARY DATA

- Malaria MIS, NVBDCP, Meghalaya
- M4 reports, NVBDCP, Meghalaya: 2012-2017
- Review of malaria death records, NVBDCP, Meghalaya
- HMIS data of Government of India (open data– data.gov.in)
- Analysis– Trend analysis, Stratified analysis for each population sub-group

Figure 1. Desk review for CRG barrier assessment

Group discussion and interview with stakeholders: Due to limited literature and data available on CRG barriers in malaria response in Meghalaya, let alone the entire country, focus group discussions/ interviews were held with government stakeholders and NGOs/ civil society (detailed in annexure) to understand local barriers and challenges and the level of understanding of risk factors. These responses and gaps in knowledge were analysed thematically.

Method of data validation and analysis

A structured multi-stakeholder approach was formulated for evidence-based problem solving for CRG barriers in malaria. Post the assessment that was conducted through a desk review, formative research and stakeholder interviews, Malaria No More conducted a state-level workshop on 11th June, 2018 in Shillong, Meghalaya. This workshop sought to gain feedback on the Toolkit, advance CRG barrier knowledge in Meghalaya, identify necessary actions to address these barriers and increase stakeholder inclusivity in the process. The objectives of the workshop were:

- To enhance human rights and health and gender-related barriers understanding and analysis, key populations and community responses in the context of malaria
- To increase meaningful representation and inclusivity of civil society and community voices within and across the malaria programme through a multi-stakeholder approach
- To identify and prioritise community-centered, rights-based and gender-transformative actions and communication channels to reach vulnerable communities

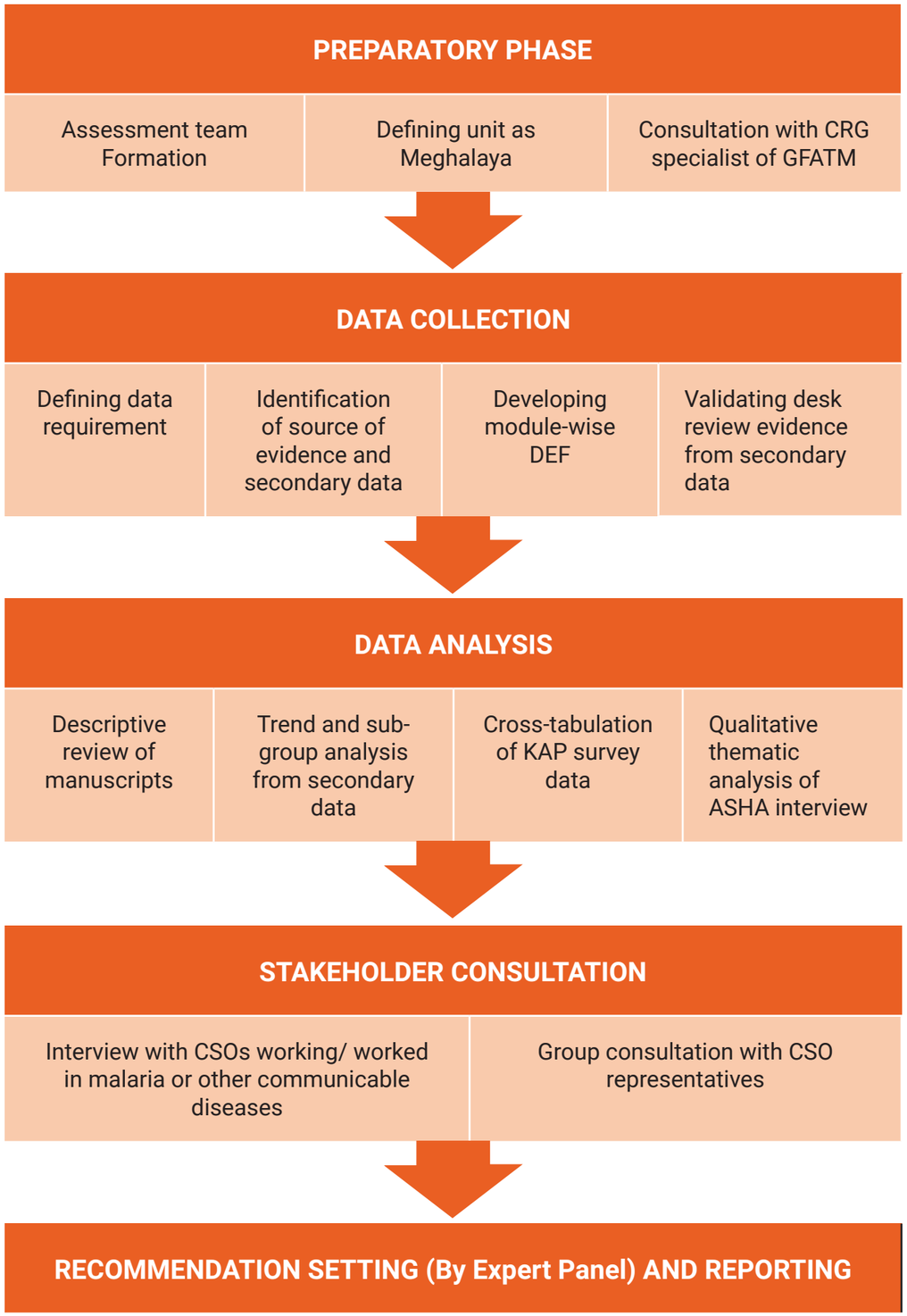


Figure 2. Multi-stakeholder evidence-based problem-solving approach to CRG barriers in malaria response

4. Vulnerable & High Risk Communities for Malaria Prevention and Control

Identifying and mainstreaming vulnerable communities has been a constitutional and policy priority in India. Articles 341 and 342 of the Indian Constitution recognises several communities as Scheduled Castes (SCs) and Scheduled Tribes (STs) and grants special status to them to redress their disadvantages.(3) The Fifth Schedule of the Indian Constitution designates areas with more than 50% tribal population as "Scheduled Areas".

Moreover, the 2017 National Health Policy recognises the homeless, rag-pickers, street children, rickshaw pullers, construction workers, sex workers and temporary migrants as vulnerable groups, and prioritises primary health care in urban areas for these them. The National Health Policy also considered factoring in greater weightage as with higher unit costs for more difficult and vulnerable areas for health care financing.(4)

Similarly, with the national policy, the National Strategic Plan for Malaria Elimination in India 2017-2022 (NSPME), aims to achieve universal coverage for case management and near universal coverage for vector control and behavior change communication, with a focus on vulnerable populations.

Disease-specific vulnerabilities are also considerations for disease strategies under the broader health policy. The NSPME recognises malaria specific vulnerabilities and confers special interventions to mitigate malaria in these groups. Special strategies were coined for tribal populations, mobile and migrant workers, bordering populations and urban slum populations in the NSPME, taking precedence from different schemes for different vulnerable communities under the NVBDCP.(5)

Focus of India's National Health Policy 2017

"...minimising disparity on account of gender, poverty, caste, disability, other forms of social exclusion and geographical barriers."

4.1 Communities most affected by Malaria

The communities heavily exposed to being bitten by an infected female Anopheles mosquito, are at greatest risk for malaria infection. People who have little or no immunity to malaria, such as young children, pregnant women or travelers coming from areas where malaria is not endemic, are more likely to become sick. Poor people living in rural areas who lack access to health care are also at greater risk for the disease. The malaria transmission indicators differ in tribal predominant areas, compared to rural or semi-rural populations. Literature from central states (Odisha, Madhya Pradesh,

Chhattisgarh) and north-eastern India demonstrated tribal communities, especially those living in forested areas, are particularly vulnerable to malaria. The malaria transmission rate, indicated by the annual malaria incidence and slide positivity rate, is much higher in tribal villages than villages in the plains.

Evidence from Odisha revealed in the forest setting, clinical malaria occurred more frequently in children than in adults; however on the plains, all age-groups were equally affected. In forest areas prevalence of malaria infection was highest in children aged 1-5 years and gradually declined with increasing age. Plasmodium falciparum malaria (0.90 episode/person-year) incidence was also highest in children aged 1-5 years, in forested villages. Splenomegaly prevalence in children aged 2-9 years was also higher in the forest (78.5%-81.5%) than in plain communities (36.0%-52.0%), indicating the forest was hyper-endemic and the plains were meso-endemic for malaria.(6)

In another study from the forested tribal villages in Odisha, the highest malaria incidence was recorded in children aged 2-4 years. In Meghalaya, most malaria cases occur in the tribal population and Plasmodium falciparum is the most common variety, contributing to more than 80% of cases.

Age vulnerability to malaria also varies from tribe to tribe. For example, higher prevalence of malaria infection and splenomegaly was recorded among children of Bonda, Kondh and Poroja tribes in Koraput district of Odisha.(7) However, adults in Meghalaya are more affected with malaria than children.

Common trends in malaria transmission

- Rate of malaria transmission is different in tribal and non-tribal populations
- Tribal communities living in forested villages are at higher risk of malaria infection
- Risk of Plasmodium falciparum infection is higher among forested tribal populations
- Children, especially those under-5 years, are at highest risk of malaria infection in forested areas
- Age vulnerability to malaria varies from tribe to tribe
- In forested areas, prevalence of malaria-in-pregnancy is high and heavily contributes to anaemia in pregnancy
- In urban areas, malaria mostly affects poor communities living in overcrowded spaces with poor sanitation
- Adult populations are at higher risk for malaria in urban populations

One of the studies revealed a high malaria prevalence (13.3% - 47.6%) among pregnant women in forested villages in Southern India. Moreover, malaria in pregnancy was also identified as a significant contributor to anemia during pregnancy in the study. In urban areas, populations living in overcrowded slums and poor sanitary conditions are at higher risk of malaria infection. One of the studies from Southern India reflected occupation, number of habitants, presence of separate kitchen, availability of overhead tanks and cisterns, presence of breeding places and roof structure as important determinants regarding malaria transmission. In the impoverished urban areas in eastern India, a higher age average for malarial patients (29.2 years) was detected.

4.2 Communities with limited or no access to malaria services

At the village-level, India has a multi-level, structured public health network with Accredited Social Health Activists (ASHAs) working as frontline health workers.. The sub-centres are the most proximal primary care facilities at the community level and function as a bridge between the community and primary health centres (PHCs). The PHC is the first contact point between village communities and medical officers.

However, the availability of microscopy facility for the diagnosis of malaria in the PHC varies across states. For example, malaria microscopy is less available at the PHC level and mostly available at the community health centres (CHC) in Odisha; while in some north-eastern states, malaria microscopy is available at the PHC level. The CHCs are present at the block level and are referral facilities, which partner with diagnostic facilities and specialists for case management.

Factors determining access to India's public health care and human migrations within and across borders contribute to India's unbalanced transmission rates and regional severity. Some experts also believe that malaria prevalence in certain Indian regions is attributed to limited access to healthcare and poor reporting. In order to address these barriers there is a need for increased resources for disease control, recruitment and greater village-level health worker engagement for early diagnosis and complete treatment, as well as new public-private partnerships for malaria control in severely affected areas.(8)

Communities in flood prone areas, terraces submerged in water, forests and tea gardens are more vulnerable in terms of delayed treatment or not seeking care from government providers. In the forest and tea tribes, the tendency to self-treat is higher among caregivers of children under 5 years of age, resulting in delayed treatment among children.The occupational slash and burn cultivators in forested areas, commonly referred to as jhum cultivation, are especially prone to delayed treatment and limited access to health services.

An overview of policy exclusion and different forms of inaccessibility is provided below in Figure 3.

CRG BARRIERS	VULNERABLE AND HIGH-RISK POPULATION	
SETTINGS	**Urban**	**Rural**
Factors Responsible for increased Vulnerability		
Policy Exclusion	**Asymptomatic malaria cases**	
	National malaria diagnosis and treatment policy recognizes only febrile cases as malaria suspects.	
Geographical inaccess	**Distance to health center >=5 km**	
	Communities mostly resort to either self-treatment or untrained practitioners and healers in villages that are far from health centers.	
Mobility and lack of access	**Migrant workers** / **Rural to urban migrants**	**Seasonal migrant agriculture workers**
	Mobility results in limited perceived access to health services at worksite, exposure to untrained and unregulated vendors.	
Access to limited infrastructure	**Urban slum dwellers**	**Tea garden workers**
	Overcrowding, surrounding breeding friendly environment for vectors, limited public health infrastructure and scarce manpower increase risk.	

Bordering population and aborginials are offen excluded from free service provision and are subjected to increased risk of complications and death due to delay in treatment, increased exposure to low quality or counterfit diagnostics and drugs, risk of drug resistance, unavailability of life saving commodities like LLINs, etc.

Figure 3. Vulnerable and high-risk population/ communities in malaria

5. Determinants of Malaria Outcomes

Malaria distribution is mostly determined by different factors affecting mosquito and malaria parasite reproduction and proliferation.

5.1 Human-related biological factors

Age, sex, race, pregnancy and host immunity are primary biological factors influencing malaria transmission risks. Malaria severity depends on the– Plasmodium species (falciparum causes higher risk of severe disease than vivax); patient age (children under 5 having naïve immune status, excluding infants under 6 months old protected by maternal antibody), genetic constitution and ethnicity (sickle cell trait, fetal Hb, ovalocytes protect against malaria; Asians and whites are at higher risk compared to blacks); malaria specific immunity (partial immunity conferred by Plasmodium– in stable malaria transmission adults are conferred with partial immunity protecting them from severe disease, while children are not protected), previous exposure to antimalarial drugs (lessens risk of severe disease), and parasite load (children with peripheral parasitemia >4-5% are at higher risk of severe disease).(9)

No age is immune to malaria. Historically, malaria epidemics in India have taken a toll on the health of the entire population, regardless of age.(10,11,12,13,14) Children are at higher risk of malarial death in India. In 2015, approximately 28 per thousand deaths in children were attributed to malaria in India. Despite the alarming death rate, this demonstrates substantial progress as there has been a decline from 2 deaths per 1,000 live births in 2000 to 1.1 per thousand live births in 2015.(15)

In Meghalaya, malaria affects all age groups, with the highest burden falling on the adult population. The malaria transmission risk, indicated by the total positivity rate, is the highest in the adults. Sex-biased malaria transmission has also been reported in India. In the hypo-endemic region of Maharashtra, adult males were significantly more affected with malaria than females. The sex-predilection was not present in children aged <10 years.(16) A plausible explanation could be the different health seeking behaviour among sexes. Moreover, studies in other Indian states also reflect a higher occurrence of malaria among males.(17,18,19,20,21,22,23) In Meghalaya, males and females are similarly affected by malaria as a sex-bias was not found in malaria transmission between 2012-2017.(Figure 4)

However, pregnancy and anemia bear a complex relationship with malaria. Evidence has shown pregnant women attract more mosquitos than their non-pregnant counterparts. This is precisely why a high proportion of falciparum malaria is reported among pregnant women. A multi-country study in India, Pakistan, Kenya and Malawi, published in 2018, estimated malaria positivity rate to be 0.1% in India.(24) Moreover, low risk of Plasmodium vivax malaria in pregnancy in India has also been recorded

in different 2017 multicentric study. Despite the low transmission risk, Plasmodium vivax produces negative outcomes in pregnancy cases, potentially resulting in maternal deaths in India.(25) Malaria risk in pregnancy is not homogenous across the country as is sub-microscopic malaria.

In a study from Central India, a polymerase chain reaction detected significantly more Plasmodium infections than traditional light microscopy both from peripheral (3·4 vs 1·2%; OR 2·9, 95% confidence intervals (CIs) 1·9-4·5) and placental (4·2 vs 1·7%; OR 2·5, 95% CIs 1·4-4·8) blood samples. However, sub-microscopic was not associated with negative anemia in pregnancy or negative pregnancy outcomes.(26)

Another study from central India reported peripheral smear positivity for malaria of 1.8 % and placental malaria positivity of 2.2% during pregnancy.(27) In two different transmission settings, prevalence of peripheral parasitaemia due to Plasmodium infection was found to be paralleling the disease transmission. The hospital admission with malaria during pregnancy was also higher in high transmission settings.(28)

Inflammatory cytokines play a critical role as prognostic markers of malaria in women and in pregnancy. A study from the Indian Jharkhand state revealed elevated IL-1β and IL-6 in malaria in pregnancy (MiP) and TNF-α in women with malaria (WWM) might be regarded as prognostic inflammatory markers of infection and pregnancy. Furthermore, based on genotypic distribution, an elevated TNF-α concentration in the mutant homozygote genotype (AA; p = 0.001) followed by heterozygotes (GA; p = 0.0001) and ancestral genotypes (GG; p = 0.0001) was associated with both MIP and WWM subjects.(29)

In a study from Jharkhand, peripheral parasitaemia was revealed and therefore, risk of malaria transmission and severity of disease was higher in 1st/ 2nd pregnancy compared to three or more pregnancies; and at age of pregnancy < 20 years. Tribal pregnant women had higher peripheral parasitaemia compared to non-tribal pregnant women.(30) In another study in Madhya Pradesh, tribal women living in forested areas bore 30% of the burden of malaria in pregnancy (MiP) in Madhya Pradesh, while constituting 18% of the population.

If malaria occurs in pregnancy, it becomes high risk because pregnancy complications have been reported more frequently among cases with MiP. Some of these reported pregnancy complications and were contributors to higher rates of abortion and to having still/premature/low birth weight babies.(31) Placental malaria infestation has also been associated with poor 5-min Apgar score and higher perinatal mortality in Central India.(32) Moreover, infants of infected mothers are reportedly at higher risk of malaria infection.

Malaria causes lysis of Red blood cells resulting in anemia. Anemia occurs more commonly in pregnant women and continues to increase with malaria in pregnancy.

One study evidenced primi mothers (who are having first baby) are more likely to harbour the malaria parasite than multigravida (i.e. women having multiple deliveries). In falciparum cases, the haemoglobin level in primi mothers is low. Contrastingly, increases in parity is associated with increased anemia risk in vivax infected mothers. (33)

In Meghalaya, the proportion of MiP of total malaria cases increased to more than 5% in 2014. The proportion declined to less than 1% in 2017. The malaria positivity rate has remained more or less constant since 2015. (Figure 4)

Groups that are vulnerable to malaria

- No age is immune to malaria
- Age based and sex-biased malaria transmission is present in India, with adult males being at greater risk for malaria transmission
- Pregnant women and children under 5 are at higher risk for complications and severe disease due to malaria
- Malaria in pregnancy is an important child health outcomes including anaemia in pregnancy, abortion, maternal mortality, IUGR, LBW, poor 5-min Apgar score, perinatal mortality, and higher risk of congenital malaria
- Tribal women, especially those who are pregnant, suffer from higher peripheral parasitemia attributed to Plasmodium infection

5.2 Physical and environmental factors

While the relationships between some biological factors (e.g. pregnancy, age, etc.) and malaria has been found to be more relevant there is also a need to understand the modifier effect of environmental and socio-cultural factors, particularly behavioural factors, on the overall vulnerability of a population of at risk.

Plasmodium falciparum is a major cause of malaria, accounting for 80 – 90% of the malarial cases in the tribal areas of the state. These areas have distinct ecological features such as hilly terrain, forest fringe, and forested area or foothill ecosystems where all the malariogenic factors operate at their maximum efficiency.

An important ecological factor influencing malarial risk is land use. A study from Meghalaya highlighted the relationship between land use, climate and malaria.(34) Evidence demonstrated high mosquito growth rates in farm land areas (FLA) due to the relatively higher water temperatures, making it favourable for vector breeding. Cultivated swamps and urban aquatic habitats generally receive more exposure to

sunlight than those in natural swamps. The ambient air temperature in the cultivated swamp and urban areas was significantly higher, resulting in higher risk of farmers being exposed to increased mosquito habitat numbers in farm land.

Some other ecological and physical factors include abandoned wells within 2km of villages, low or completely absent irrigation, and terrain in border areas. Malaria prevalence during the epidemic season (October, November, December) is strongest in the districts where irrigation is low or completely absent. Moreover, evidence suggests SPRs recorded in bordering villages ranged from 26.3-61.1%. A major factor in these terrains is precipitation as heavy rainfall are attributed to extended monsoons in April.

Climate functions both as a compounding factor for influencing land use resulting in a differential effect on the larval habitat. Climate influences overall mosquito breeding and is responsible for increases in mosquito populations in different land use areas in different seasons. In FLA and PLA, the highest numbers of anopheline larval habitats were found during rainy season (25.3% of all) and least during the spring season. However, in ULA, the habitat number was about the same across all the seasons. This means special focus must be placed on the rainy season in FLA and PLA because of increased malaria transmission risk. Although land use can increase focal risks in certain areas, there is a larger regional geographical area in the state at high risk for malaria.

The climate of all the three districts of Garo Hills along with Ri-Bhoi is highly humid and hot compared to other districts in Meghalaya, which is favorable for mosquitos.

Differential Effect on larval habitat

- In FLA and PLA highest numbers of Anophenline larval habitats were found during rainy season (25.3% of all) and least habitats were recorded in FLA and PLA during spring season.
- The association between the occurrence of Anophenline larvae and land cover was significant ($p<0.05$) during the rainy season.

Compound effect on larval habitat

- In ULA, habitat number was about the same in all the seasons, one way ANOVA reveals that larval density of Anopheline was significantly correlated with rainfall.
- The overall association between the occurrence of Anopheline larvae and land cover was significant ($p<0.05$) during the rainy season.
- Anopheles mosquitos was significantly higher inFLA and ULA campared with NFA and OFA. Mosquito growth rate was significantly ($p<0.05$) high in FLA habitat compared to other land because water temperature of FLA was higher.

Regional Vulnerability

- The climate of all the three districts of Garo Hills along with Ri Bhoi is not very healthy, i.e. highly humid and hot as compared toother districts of Meghalaya, which is favorable for mosquitos.

Figure 4. Climate, a moderating factor to influence land use effect on malaria transmission

Aside from land use, climate is also linked to occupational risk. For specific occupations, malaria transmission risks increase during specific seasons. During the early summer months, the residents in forested villages enter the nearby forests as they collect firewood or rear cattle (and are bitten by forest dwelling mosquitoes). During the early monsoon, in the months of June and July, the harvesting rice requires long work hours in waterlogged conditions (resulting in further exposure to mosquito bites).

Among the agricultural workers, jhum cultivators are specifically at higher risk. Jhum cultivation is a form of shifting cultivation, also known as burn and slash cultivation. Jhum cultivator's risk for malaria infection increases in areas with relatively higher humidity and temperature, such as the Garo hills in Meghalaya.

Early Summer

- One study in Naxalbari revealed that during the early summer months, the residents enter the nearby forests as they collect firewood or rear cattle (and are bitten by forest dwelling mosquitoes).

Early Monsoon

- During the early monsoon, in the months of June and July, transplantation of rice requires long hours of working in waterlogged conditions (with further exposure to mosquito bites)

Jhumia Cycle

- Vulnerability for malaria has been shown to significantly associated with mobility rate in areas with higher humidity and rainfall as well as temperature. Jhumia cycle is especially important in this case for mobility rate.

Figure 5. Moderating effect of climate on occupational characteristics, increasing risk of malaria

5.3 Socio-cultural factors

Critical sociocultural factors influencing malaria responses include, but are not limited to, income, occupation, residence and ethnicity. Poverty is a critical precondition for malaria and the way the disease spreads, making control more difficult. Poverty influences the certain individuals value health and malaria. Families victim to poverty delay seeking medical care for various reasons including, but are not limited to, risk of wage loss, inability to spend out of pocket expenses, and limited access to services and information. For example, in the state of Odisha, marginal tribal communities do not seek treatment for malaria or take part in parasite control because they do not

consider mosquito bites as harmful and consider malaria a mild disease. Untreated people are at risk of developing severe disease and are potential sources of malaria infection.(35)

While poverty impacts the malaria response, malaria itself is a potential risk factor for poverty. More than 70% (72% in rural and 79% in urban areas) of ailment spells in India are treated in the private sector and >80% of health financing is borne by patients in India. Risk is higher in India because the private health sector and market are mostly unregulated. The initial treatment choice for febrile illness is self-medication (>15%), traditional healers and untrained village practitioners (>20%-<40%), government (40%-80%) and private (>10%-<40%) health services.

Also despite malaria services being provided free of cost in government health facilities and at the community level with ASHAs, the same services are chargeable in the private sector. Seeking care from private sector is a major reason for out-of-pocket expenses for malaria in India. Purchasing a recommended full dose of anti-malarials can be equated to losing a full day's wage, varying with malaria type, severity, and the population sub-group being affected. Highest loss of wage days is reported for severe malaria (up to 17.86 days for one episode). Loss of wage days is also prevalent in pregnancy and in case of mixed infection.

To avoid wage loss, some patients prefer injectable antimalarials. Injectable antimalarials have a wide cost variation. Cost ratio (ratio of maximum and minimum priced brands of antimalarials) for injectable antimalarials varies from 1.10 to 16.96 while oral antimalarials vary from 1.11 to 2.03. People with the option to select injectable antimalarials in unregulated private market are subject to being financially burdened by a costly antimalarial.

In Southern India, Malaria treatment is attributed to being one of the highest out of pocket expenditures. Increasing out-of-pocket health expenditures among elderly limits their access to essential health services.(36) In Odisha, the average economic opportunity loss from malaria infection is 8.96 man days per malaria patient with an average loss of 3.84 man days to other family members. Mean total loss per malaria episode comes to Rs.334.91. The economic burden was disproportionately higher in the tribal communities.(37)

Prevention methods against malaria, e.g. larval control can be tagged for economic upliftment and ensuring livelihood in communities. A study in Gujarat revealed using larvivorous fishes with composite fish culture may generate income, making the programme self-sustainable. Composite fish culture in unused abandoned village ponds by culturing Guppy along with the food fishes such as Rohu (Labeo rohita), Catla (Catla catla) and Mrigal (Cirrhinus mrigala) and selling of fishes and mosquito control through larvivorous fishes was found to be a self-sustainable locally resourced vector control mechanism. The technology was later adopted by the villagers and food fish culture

was practised in 23 ponds, generating an income of Rs 1,02,50,992 between 1985 and 2008. The number of villages increased from 13 to 23 in 2008, in addition to a gradual increase in income from Rs 3,66,245 in 1985-90 to Rs 55,06,127 in 2002-08 block.(38)

People should protect themselves from mosquito bites with bed nets, protective repellents, and screening and site selection for dwellings, especially where the risk is higher.

Sociocultural practices across communities also play an important role in influencing malaria control operations. A study in central Gujarat among 1781 febrile patients revealed a slide positivity rate of 14.8% and Plasmodium falciparum proportion of 53.9%. The sociocultural practices of 1650 fever cases among which 259 had malaria were analysed and social groups, profession, economic status and personal protection of the respondents were found to be statistically significant determinants of malaria. Malaria incidence was relatively high in scheduled castes, dependents (mainly children and elderly people), farmers and in low-income groups. In the same sample, 63.4% patients took treatment three days after fever onset.(39)

Another study from Rajasthan reported one-third of the respondents had neither taken malaria treatment nor participated in vector control operations. because they did not consider mosquito bites as harmful and believe malaria is a mild disease. Outdoor sleeping habits, sharing beds with children, discomfort using mosquito bed-nets or other protective devices also contributed to the spread of malaria in the study villages.(40)

Research from rural areas revealed there is a widespread belief that mosquitoes do not transmit malaria. Moreover, the bad smell emitted by insecticides keep people from various areas in developing countries from spraying their households. Refusal to allow spraying, nomadism, re-plastering of walls after spraying, absence of personal protection increases mosquitoes density, resulting in increased mosquito bites frequency, and malaria infection.

Multiple studies reveal Scheduled Tribes in rural areas having higher positivity rate for malaria. Specific ethnicity tribes are often found to be vulnerable to malaria especially owing to their occupation. For example, for forest tribes in forested areas, focal outbreak starts from forest shades called the nidus which refers to the point where the outbreak erupts. Vulnerability and occupation are strongly correlated in case of the tea tribes, who are at higher risk because of the absent infrastructure drawn to untrained practitioners.

Moreover, occupation and residence are closely linked to malaria. Evidence reveals construction sites create breeding grounds for various vectors and unprotected laborers

act as potential baits., Immigrant workers at these sites from disease endemic areas with varying immune status introduce new strains of multi drug resistant [MDR] TB, P Falciparum) and chances of getting new infections (Filariasis, Kala-Azar) increase. Additionally, it has been documented that occupation itself can independently increase malaria risks for certain population groups. Occupation is significantly associated with malaria positivity as it exposes certain occupations to mosquitoes.

Mobility is also responsible for spreading malaria from one place to another or from one part of a country to another. Labourers connected with various engineering, irrigation, agricultural and other projects and periodic migration of nomads and wandering tribes are outstanding examples of internal migration. Some of them may import malaria parasites in their blood and reintroduce malaria into areas where malaria has been controlled or eliminated. Imported malaria has become a large public health problem.

In Meghalaya, a specific occupational risk is jhum cultivation. The jhumia population rely of slash and burn cultivation for their livelihood and are also mobile. The state reports suggests their mobility frequency has increased and the duration of jhumia cycle has reduced. This adversely affects the scope of settling and providing stable access to malaria services along with the higher occupational exposure to mosquito bites. The highest proportion of jhumia population is found in the Garo Hills in Meghalaya, which are the highest contributors of state malaria cases.

District-wise Distribution of Jhumia Families			
District	% of jhumia population of total population	Annual area in jhum in sq km	% of total jhum area of the total geographical area
EKH	0.94	.20	1.23
Ri Bhoi	12.11	27.40	1.53
WKH	10.31	46.19	0.88
Jaintia Hills	2.52	11.74	0.31
EGH	32.20	117.15	4.50
WGH	19.77	155.45	4.19
SGH	43.66	67.87	3.67
Total	13.87	442.00	1.97

Table 2. District-wise distribution of Jhumia population in Meghalaya

Tribal community reliance on plant medicine and traditional healers is also an important risk factor causing delayyed treatment in North Eastern India. As many as 68 species of plants belonging to 33 families are used in north-east India to treat malaria.(41-61) A study among tradition healers in Adi, Apatani, Khampti, Mishmis, Niyashi, Monpa, Nocte, and Shredukpens tribes in Arunachal Pradesh, Mizo in Mizoram, Aos in Nagaland, and Nepalese and Lepcha in Sikkim, revealed Verbenaceae, Acanthaceae, Asteraceae, Rubiaceae, Rutaceae, Lamiaceae, and Euphorbiaceae are predominant plant species used for malaria treatment by traditional healers in the tribal areas.(62)

To curb socio-cultural barriers, “improving community-level knowledge about malaria using culturally-appropriate health education materials; making traditional healers partners in malaria control; promoting within-village rapid diagnosis and treatment; increasing ITN distribution and promoting their use as potential strategies to decrease infection rates in these communities” have been recognised as vital solutions for existing challenges in the malaria response for marginalised populations.(63)

5.4 Access to Malaria services and information

Services for malaria prevention, control, and treatment are primarily provided by ASHAs at the community level. About 89% of villages in Meghalaya have ASHAs in position and the remaining villages, especially the remote and hard-to-reach villages in the Garo Hills suffer from service inaccessibility.

Data from state HMIS revealed gaps in fever prevalence, malaria testing, and access to diagnostic services for malaria. The gap has remained constant between 2012-2017. Despite these gaps, access to malaria treatment has improved considerably in the same period and in 2017, nearly all malaria cases were treated with antimalarials. (Figure)

Survey findings based on interviews from ASHAs in Meghalaya

- 67% ASHAs believe providing mother and child services is their primary role. All ASHAs devote most of their time for maternal and child health related services (registration of pregnancy, ANC, PNC, immunization, etc).
- 60% ASHAs reported respect from the community as a primary motivating factor for their work.
- ASHAs being female worker, expressed their difficulty in reaching out to communities, especially in geographically hard-to-reach areas and inaccessible pockets. They felt that providing services to the communities was a challenge for them especially since transportation is a major issue in hilly terrains.
- ASHAs reported devoting 60 minutes a day to malaria services; moreover almost all of them provide diagnostic services for malaria (approximately 50% of them provide treatment services and malaria awareness; 50% of them refer patients to hospitals or health facilities).
- Average distance of the facilities where ASHAs refer patients is about 13.8 kms.
- One third ASHAs reported fear when testing fever patients (fear is either for blood/needles); 1/3 ASHAs reported community distrust in treatment. Those who do not trust ASHAs prefer hospital for malaria treatment.
- Communities reporting to ASHAs for fever have either no preference for oral/injectables/prefer oral antimalarials. Preference for syrup is reported in child cases.
- 40% ASHAs reported alternative service providers within the community; majority of them are pharmacists. Although the communities do not prefer pharmacists, one village's female population had a preference for dispensaries.

Gaps were recorded in ASHA's perception and community's response on utilisation of vector control tools in the state.

Health worker's perception on utilisation of vector control tools

Availability of vector control methods in the community	Perception on Community Utilisation of LLINs and IRS
• LLINs are available in all villages • IRS is conducted in 2 out of 15 villages • Larval control measures are available in 4 out of 15 villages	• 13 out of 15 ASHAs perceive that 100%of the community sleep under LLINs • The villages that do not have 100% perceived utilisation of LLIN are covered by IRS as well • In one village ASHA perceives that LLIN utilisation is only 20%and do not the cause of poor utilisation • Perceived acceptance for IRS is also 20%in the same village

Community response on utilisation of vector control tools

Community level utilisation of LLINs from KAPsurvey	Community utilisation of IRS from KAP Survey
• 98% of the respondents slept under bednet last night • Only 60.8% of the respondents slept under insecticide treated net • 67.6% individuals were informed about how to use the LLIN at the time of distribution • 21% individuals reported usage of bednets for purpose other than sleeping • Of those who use bednets for other purposes, use them mostly for fishing (77.8%) and fencing (28.6%)	• 28% of the respondents reported their HH to be sprayed in last one year • Of the HH sprayed, 31% conducted spray in outdoor • 16.8% of respondents rejected spraying ant time • Primary reason for rejection was inconvenience (56%). Fear of danger and health problem was the reason for rejection for 16% and 12% respectively • 15.3% of the community perceive that IRS is not effective

Figure 6. Gaps in ASHA's perceptions and community's response on vector control tool utilisation

The gap in perception is a potential risk to ASHAs performance in ensuring the community utilisation of vector control services and commodities.

Access to malaria information

- 89% community members preferred health workers as source of health information
- Only 45.3% respondents met with a health worker in the previous month.
- Only 25% respondents interacted with heath workers on malaria
- Importance of early diagnosis and treatment (9.6%), availability of treatment facilities (15.4%), measures for vector control (34.6%), benefits of bednet (28.8%) are not primary focuse areas for health education communication during medical interactions
- TV is the preferred media source for health information in 66% population; only 48% of the population have daily exposure to TV
- Although 79% population had access to mobile phones, <5% had access to internet at home

6. Assessment of Toolkit

The Malaria Matchbox Toolkit is useful in extracting data critical to the assessment of CRG barriers in malaria response in a country or province. The practical operational approaches to working across sectors using the toolkit for assessment of CRG barriers, requires understanding of stakeholders' capacities and tailoring the toolkit to the specific country/ provincial context.

The assessment of the Toolkit, therefore, comprises assessment of modular questions in the country/ province perspective; identification of methodological limitations and risk to data driven decision making; and analysis of stakeholder environment, including the capacity of local CBOs (civil society, faith-based organisations and other local NGOs) in understanding and finalising decisions and actions based on identified barriers.

6.1 Assessment of modular questions

The first three modules of the toolkit aim to identify the human rights and gender related barriers to malaria response, identifying the most affected and those which are at highest risk; and delineating the biological, socio-cultural, environmental and programmatic factors that determine the risk or vulnerability. Module 4 is for identification of rights-based, gender responsive actions to improve malaria programming by addressing barriers identified through Module 1-3 assessment.

Module 1 seeks to identify the groups at higher risk of malaria, as well as populations having limited access or those who are not covered under the current malaria programming. This module, however, needs to be tailored to a country specific strategy for universal coverage of population with targeted interventions. For example, under the NSPME, the malaria programme targets to cover 100% households in all sub-centres with API>1 per 1000 population. Therefore, individuals in sub-centre areas with API 1 or less are not eligible for receiving free supply of LLINs. An initiative to identify gaps in proportion of households that received LLINs, without considering the eligibility for certain interventions in the national context, would result in over-estimation of CRG gaps and therefore, advocate for resourcing misdirected interventions.

Another limitation intrinsic to the tool is its inability to identify populations which are not covered through supplies, that occur in cycles, e.g. the lifespan of LLINs is assumed to be upto 3 years or 20 washes in India. Therefore, a household that received LLINs more than three years back, but did not receive any timely replacement, are not identified by the toolkit, inspite of existence of coverage gap. Similarly, areas eligible for IRS, are supposed to receive rounds of spray based on the type of insecticide used. The

national strategy, however, does not specify the number of rounds and there is no state specific strategy for the same as well. The toolkit, through its generic questionnaire, cannot identify the irregularity in IRS, which is as important as the overall coverage of IRS.

While coverage and utilisation of case management and vector control interventions are important for programmatic output, the outcome and impact of interventions depends on the quality of interventions. The toolkit, however, does not focus on identifying populations in which quality assurance mechanisms are lacking, despite adequate coverage. Quality assurance for malaria microscopy and RDTs, quality assured spraying and anti-malarial drug quality, are important to understanding the proportion of effectively covered population.

Module 2 is intended to assess the human related biological factors; physical or environmental factors; and socio-cultural, particularly gender related factors, that function as determinants of malaria risk and vulnerability.

The sub-component of biological factors is too broad under the module and encompasses physiological, pathological, genetic and inherited conditions, apart from unmodifiable risk factors such as age and sex, amongst others. The non-response among stakeholders the interview with regard to this component is also higher. For example, pregnancy is a normal physiological phenomenon, unlike HIV, which is an important communicable disease, targeted for prevention and control under the national programme. While the Reproductive and Child Health component of National Health Mission (NHM) targets to promote positive health in pregnancy, lactation, infancy and childhood; the National AIDS Control Programme (NACP) intends to minimise risk and transmission of HIV/ AIDS itself, thereby preventing new cases. A false sense of synonymising normal physiological and pathological conditions under this sub-component limits the scope of highlighting the need of intensification of the implementation mechanism under other disease control programmes.

This module also has limited scope in identifying complex relationships among determinants, including tribality, occupation, forested ecology and climatic risks. The questions attempt to stratify each risk on the basis of age, sex, education, occupation, etc. while focusing heavily on seasonality as a singular modifier of risk. However, the determinants mentioned above are included as discrete risk factors, with mere stratification/ grouping of variables only.

Our assessment provides an understanding of the complex relationship of several factors and the theoretical framework that can be used to strengthen the tool for better understanding of the complexity of risk and based on that, identify necessary interventions.

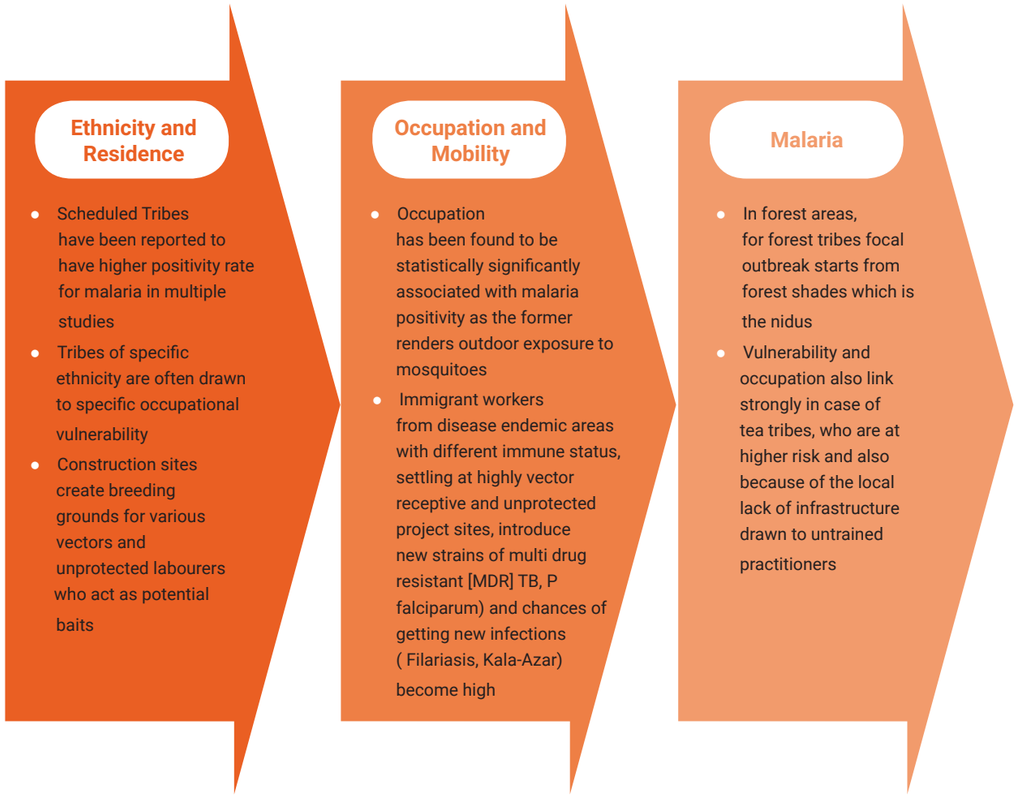


Figure 7. The relationship among various risk factors in malaria

Human habits are also linked to ethnicity, physical environment, occupation and numerous other factors. Moreover, they are heavily dependent on local cultural practices, taboos and norms. An example of such a relationship is seen in the state of Meghalaya and the same is highlighted in Figure 8 below.

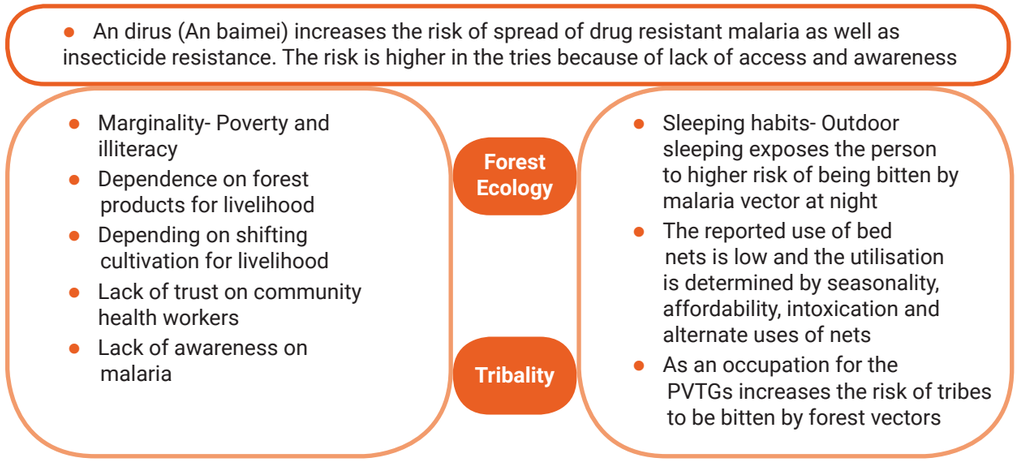


Figure 8. Complex relationship of ethnicity, physical environment, and socio-cultural factors in malaria

Module 2 and 3 tend to identify all the factors discretely and fail to focus on the linkage of various factors, as they play together in enhancing the risk of malaria.

6.2 Limited source of data

Data for such assessment is scarce in India and more so, in Meghalaya. Although malaria reporting is systematic and vertical from village to National Programme (ASHA -> Sub-centre -> Primary Health Centre -> District VBD Office -> State VBD Office/ State Health Department -> Directorate of NVBDCP), District Health Information System 2 (DHIS 2) is still not operational and stucfk mostly in the pilot stage in few of the isolated districts/ states.

Apart from collated number of total malaria cases and deaths across the population, malaria epidemiological information is more or less limited in the open source. The state Health Management Information System (HMIS) data tends to identify the group specific disease burden along with other tests and treatments. Data on coverage and access to vector control are not available through a single format, though separate vector control reports are available through various VC formats. The segregation of reporting and compilation of data at various levels limits the scope to assess the overall coverage of all programmatic interventions. Scientific literatures, identifying CRG barriers are also scanty in the region, as we identified less than 10 studies, eligible for inclusion in the desk review from the province.

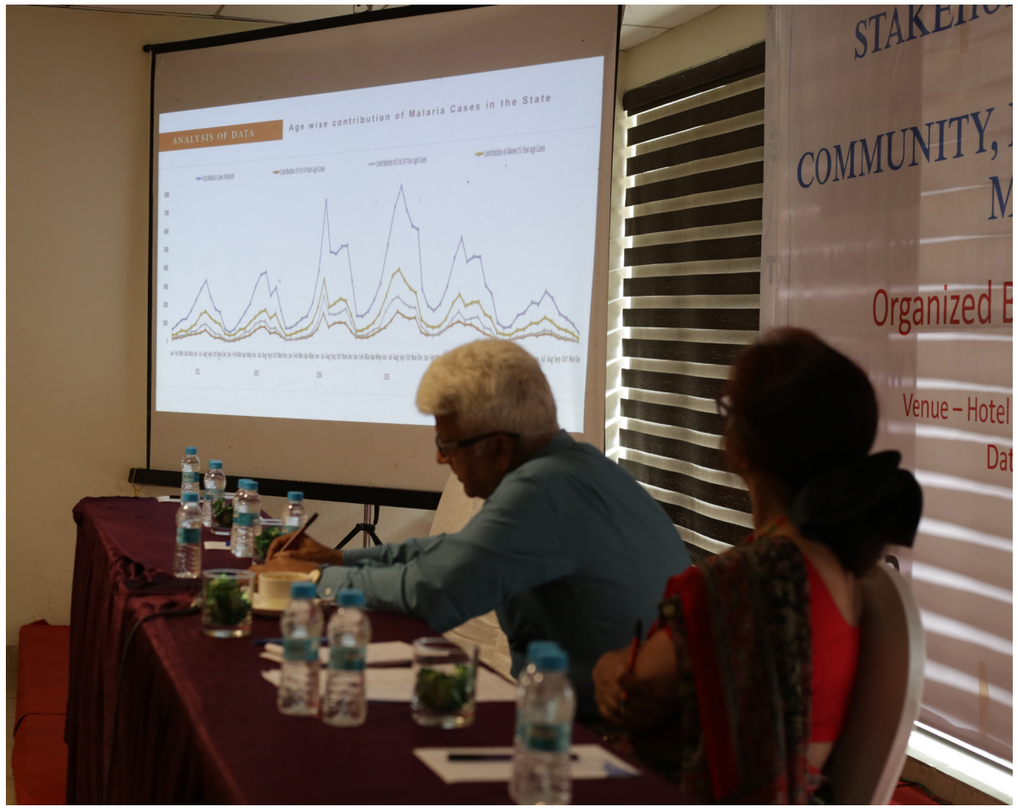
The modular assessment therefore, should align with the M formats (through which malaria surveillance and case management data are reported) and VC formats (through which vector management data are reported). Large household surveys, although has been conducted in the province and reviewed under this assessment, the variables for assessment of CRG barriers are little aligned with the variables included in the

household survey. Therefore, whenever a CRG barrier assessment is planned using the toolkit, the variables should either be aligned with variables of already conducted large-scale household surveys or separate large-scale household survey in a representative sample should be planned for completion of data extraction.

Overall, the data identified during the assessment are only eligible for descriptive reporting of findings. Quantitative gap estimation requires large scale surveys targeting purposively the population-at-highest risk, identified in this report.

6.3 Assessment of stakeholder environment

Only a limited number of NGOs, including CBOs, FBOs and civil society have worked or are working in the province for prevention and control of malaria. Overall, the focus area of work of the non-government sectors include HIV, human trafficking and other development areas. Among the stakeholders interviewed, only one NGO is currently supporting the national programme through engagement in malaria services. The capacity and understanding of the barriers among the non-government agencies are also extremely limited.



Some examples of inappropriate responses.

Common questions:
What specific activities of women, including women's household, community, or workplace responsibilities influence the risk of or vulnerability to malaria?
What about young (6-9 years of age) and adolescent girls (10-18 years of age)?
What about for young women (19-24 years)?

Typical response:
"Women do not have much time to spend on hygiene plus they have multiple household work to do and have a tendency to urinate anywhere."

Common questions:
What beliefs are held by men that prevent a woman from accessing malaria services (seeking treatment, using prevention tools, receiving care, etc.)?
Do these beliefs have different impact on different age groups (adolescent girls, young women and adult women), income and educational levels and or by region? If so, How?

Typical response:
"Women are not allowed to access contraceptive pills as men do not allow the same, since they feel they are being cheated and that children are a gift of god."

Common question:
Are there physical barriers to accessing health and/or malaria services?

Typical response:
"There is, but they train the ASHAs accordingly."

In the absence of basic understanding of determinants of broader health and malaria in particular, the local non-government agencies often fail to identify focus areas to support, voice appropriate community level barriers, recommend appropriate action during decision-making. Hence, the grassroot level challenges are often not reflected, either in their planning or through their voices in multi-stakeholder platforms.

For the non-government agencies to contribute effectively in removing CRG barriers, local civil societies, FBOs and other NGOs need to be trained and a knowledge platform established for dissemination of policy and strategic focus as best practices across sectors. The need of overall NGO sector involvement should be reflected in the country's intersectoral coordination and strategic communication initiatives via inclusive approaches.

6.4 Gap Analysis

Key populations and vulnerabilities have been identified by civil society and NGOs.

Key Populations	Vulnerabilities/ Exclusions
Urban slums	Do not have access to free services for other health conditions Unavailability of MHIS card The population perceives malaria services as costly and therefore does not seek treatment from the public sector
Communities in remote villages	Three challenges in availing transport facilities: • Unavailability of suitable transportation • High transportation costs • Delays and extra time lost in availing transport Communities seek treatment from traditional healers or unskilled practitioners/ informal private providers
Communities in remote villages	Do not participate during IEC activities

Table 3. Key populations and vulnerabilities identified by civil society and NGOs

6.5 Key Challenges

Some of the challenges which the study team faced while collating information and carrying out the stakeholder interviews have been summarised below.

Poor awareness levels amongst members of civil society: The most important challenge in conducting the toolkit assessment pertained to engaging with civil society. The majority of the CSOs/ NGOs did not have basic knowledge on malaria or working experience. Those who have worked on malaria, have experiences limited to general programmatic health efforts in high-risk areas. Therefore, the team had to provide the organisations they interviewed and engaged in the workshop with enough background information and evidence so they could participate in a meaningful way.

Limited existing information on ecological studies and big data analysis: To have high quality data on malaria transmission and moving trends has not been a national priority. This inevitably highlights CRG barriers through data evidence as also challenging. Unavailability of gender focused reports was seen (male vulnerability for forest malaria, female vulnerability related to delay in treatment seeking, household decision making for treatment seeking and malaria in HIV patients and sex workers) and found to be conspicuously absent.

Gross mismatch in estimated and reported malaria burden: The mismatch in data by the government combined with lack of data from private health sector including private health providers resulted in misunderstandings and/or misperceptions of the age-sex malaria distribution burden and treatment seeking pattern.

7. Recommendations

The expert panel suggested a set of recommendations to mitigate CRG risks.

Improving access: Regular intersectoral coordination to improve infrastructure and access to transportation services.

Provisioning alternative service providers: In inaccessible areas and villages with no ASHAs, most of the malaria cases are Pf. A major problem relates to delay in case detection and treatment, especially for pregnant women. Alternative providers from the local community can be explored and trained to provide services.

Increasing NGO capacity and participation: Need of the hour is to develop *an increased CSO capacity and CSO inclusivity in malaria programming based on areas of felt need by the programme.* In order to provide tailored solutions rather than a one-size-fits-all strategy, NGOs/ CSOs capacity must be strengthened as they engage in collaborative problem solving with government.

Improving programme quality and capacity: Point-of-care tests such as RDTs is important as it is equally sensitive to microscopy and should be relied on to ensure early diagnosis. To ensure quality, tests must be carried according to the manufacturers' instruction. Moreover, Microscopy and other SoPs need to be followed. ASHAs have limited capacity in their districts for point-of-care diagnosis. To remedy this issue, skill-building exercises will be essential. In inaccessible areas, communication between the ASHA and Malaria Technical Supervisor must be strengthened to ensure timely treatment.

Strengthening the IEC and BCC efforts with focused approach: Quality programmes are linked to trust and changing perception through individualised SBCC strategies. Focus areas include – informing individuals about availability of free malaria services and using SBCC to promote IRS acceptance.

Designing a bottom-up communication strategy with tailored mediums: Messaging must be drawn from the district and state, after it is determined what messages will be effective in a particularly vulnerable community. Videos and new visual messages may be effective for communities in areas with low literacy rates. Moreover, wall painting may be helpful to raise community awareness. Identifying malaria champions or heroes to engage communities and convey accurate messages will be essential. Engaging local media will also play a vital role in promoting overall malaria awareness.

Advocacy for gender-based reporting at all levels: *The toolkit should ideally be piloted at a unit level that is large enough to have gender-wise collated data. The focus must be on gender as also other excluded groups. Further, formative research must be conducted to assess true malaria burden and age/ gender distribution.*

Tailoring indicators to existing policies: *Rather than identifying policy exclusions, the toolkit assessment can be more useful if indicators remain tailored to existing policies and the toolkit focuses on identifying the gap in the process of policy culminating to interventions and actions required to ensure rights and equity.*

Identifying policy level gaps: *The toolkit must be implemented at the country level; if gaps in policy translation to action are focused, the toolkit must be applied at the provincial or sub-country level that is directly responsible for implementation.*

8. Conclusions & Next Steps

Malaria is one of the longest standing scourges of the country, the lasting nature of which is influenced by various community level barriers in disease response. To end malaria epidemics and stop the transmission altogether, the malaria prevention and control strategies need to be tailored right from the local level to the grassroot level, attending to gender and rights disparities and differences as well as addressing several other challenges, especially linked to marginality, tribality and occupational exposure.

Community based and civil society organisations have a larger role to play in supporting India's malaria programme towards minimising the risk and vulnerability of the population that is at highest risk. However, they lack the essential capacities and resources to take up the role. In this context, an all-inclusive approach of the malaria programme with strengthened community-level advocacy, donor community's support for capacity building and increased engagement of CSOs and CBOs in malaria programming as well as provision of technical assistance to CSOs and CBOs are essential for their greater participation in approaches to minimise access, coverage and utilisation gaps.

Two major applications of the CRG assessment will include the following:

a. Malaria No More, towards its organisational mission in India will continue to support the country's initiative to eliminate malaria by 2030 and is currently developing a National IEC BCC Strategic Plan for the NVBDCP with focus on malaria. Findings of the provincial CRG assessment in Meghalaya will inform MNM's IEC BCC Strategy for NVBDCP. Moreover, the learnings and strategic approaches required to optimise community's response to end malaria will be integrated within this strategy.

b. The present pilot assessment provides a detailed account of the steps and challenges in CRG barrier assessment using The Malaria Matchbox Toolkit, which can now be used for formative research/ assessment/ review in other countries/ provinces following the steps of current assessment.

References

1. National Vector Borne Disease Control Programme, MoHFW, Government of India. 2014. "Malaria situation in India from 2014."
2. National Vector Borne Disease Control Programme , MoHFW, Government of Meghalaya. 2104. "HMIS Reports."
3. Department of Personnel & Training, Government of India. https://dopt.gov.in/sites/default/files/ch-11.pdf
4. Ministry of Health & Family Welfare, Government of India. 2017. "National Health Policy".
5. National Vector Borne Disease Control Programme, MoHFW, Government of India. (2017). "National Strategic Plan for Malaria Elimination in India: 2017-2022".
6. Sharma SK, Tyagi PK, Padhan K, Adak T, Subbarao SK. 2004. "Malarial morbidity in tribal communities living in the forest and plain ecotypes of Orissa, India". Trop Med Parasitol. 2004 Jul;98(5):459-68
7. Rajagopalan PK, Pani SP, Das PK, Jambulingam P. 1989 "Malaria in Koraput district of Orissa". Indian J Pediatr. 1989 May-Jun;56(3):355-64.
8. Kumar A, Chery L, Biswas C, Dubhashi N, Dutta P, Dua VK, Kacchap M, Kakati S, Khandeparkar A, Kour D, Mahajan SN, Maji A, Majumder P, Mohanta J, Mohapatra PK, Narayanasamy K, Roy K, Shastri J, Valecha N, Vikash R, Wani R, White J, Rathod PK. 2012."Malaria in South Asia: prevalence and control." Acta Trop. 2012 Mar;121(3):246-55. doi: 10.1016/j.actatropica.2012.01.004. Epub 2012 Jan 8.
9. Basu S Sahi PK. 2017. "Malaria: An update." (Access on: https://www.ncbi.nlm.nih.gov/pubmed/28357581)
10. Christophers, S. R. 1911. "Malaria in the Punjab. Scientific memoirs by officers of the Medical and Sanitary Departments of the Government of India. Government of India, Calcutta, India".
11. Gill, C. A. 1914. "Epidemic or fulminant malaria together with a preliminary study of the part played by immunity to malaria". Indian J. Med. Res. 2:268-315
12. Byam, W., and R. G. Archibald. 1921. "The practice of medicine in the tropics". p.1513-1514. Henry Frowde and Hodder and Stoughton, London, United Kingdom.
13. Christophers, S. R. 1924. "The mechanism of immunity against malaria in communities living under hyperendemic conditions". Indian J. Med. Res. 12:273-294.
14. Covell, G., and J. D. Baily. 1932. "The study of a regional epidemic of malaria in northern Sind". Rec. Mal. Surv. India 3:279-322.
15. "Changes in cause-specific neonatal and 1-59-month child mortality in India from 2000 to 2015: a nationally representative survey". 2017. Lanchet (Access on https://www.ncbi.nlm.nih.gov/pubmed/28939096)
16. http://www.tifr.res.in/~dbs/faculty/sslab/papers/sulabhaplosone2012-1.pdf

17. Das NG, Baruah I, Kamal S, Sarkar PK, Das SC, Santhanam K. 1997." An epidemiological and Entomological investigation on malaria outbreak at Tamalpur PHC, Assam". Indian J Malariol. 34:164–170.
18. Dev V, Sharma VP. 1995. "Persistent transmission of malaria in Sonapur PHC, Kamrup district, Assam." J Parasitic Dis.;19:65–68.
19. Prakash A, Mohapatra PK, Bhattacharyya DR, Doloi P, Ma-hanta J. 2997. "Changing malaria endemicity–a village based study in Sonitpur, Assam." J Com Dis.; 29:175–178.
20. Dutta P, Khan AM, Mahanta J. 1999. "Problem of malaria in relation to Socio-cultural diversity in some ethnic communities of Assam and Arunachal Pradesh." J Parasitic Dis.;23:101–104.
21. Shukla RP, Pandey AC, Mathur A. 1995. "Investigations of malaria outbreak in Rajasthan." Indian J Malariol.; 32:119–128.
22. Dhiman RC, Pillai CR, Subbarao SK. 2001. "Investigation of malaria outbreak in Bahraich district." Indian J Med Res.;113:186–191.
23. Srivastava HC, Kant R, Bhatt RM, Sharma SK, Sharma VP. 1995. "Epidemiological observations on malaria in villages of Buhari PHC, Surat, Gujarat." Indian J Malariol.; 32:140–152.
24. Mary McCauley, Barbara Madaj, Sarah A White, Fiona Dickinson, Sarah Bar-Zev, Mamuda Aminu, Pamela Godia, Pratima Mittal, Shamsa Zafar, and Nynke van den Broek. 2018."Burden of physical, psychological and social ill-health during and after pregnancy among women in India, Pakistan, Kenya and Malawi." BMJ Glob Health. 2018; 3(3): e000625. (Access on https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5935159/)
25. (Access on https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5481034/)
26. (Access on https://www.ncbi.nlm.nih.gov/pubmed/25627878)
27. (Access on https://www.ncbi.nlm.nih.gov/pubmed/23372285)
28. (Access on https://www.ncbi.nlm.nih.gov/pubmed/22882903)
29. (Access on https://www.ncbi.nlm.nih.gov/pubmed/29602073)
30. (Access on https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4691455/)
31. (Access on https://www.ncbi.nlm.nih.gov/pubmed/24825265)
32. (Access on https://www.ncbi.nlm.nih.gov/pubmed/23372285)
33. .....
34. .....
35. Pinikahana J. 1992. "Socio-cultural factors associated with malaria transmission: a review". Indian J Malariol. 29(2):121-6.
36. Brinda EM1, Rajkumar AP, Enemark U, Prince M, Jacob KS. 2012. "Nature and determinants of out-of-pocket health expenditure among older people in a rural Indian community." Int Psychogeriatr. 24(10):1664-73.
37. Sharma SK1, Pradhan P, Padhi DM. 2012. "Socio-economic factors associated with malaria in a tribal area of Orissa, India."
38. Kant R1, Haq S, Srivastava HC, Sharma VP. 2013. "Review of the bioenvironmental methods for malaria control with special reference to the use of larvivorous fishes and composite fish culture in central Gujarat, India." J Vector Borne Dis. 50(1):1-12.

39. Srivastava HC1, Kant R, Sharma SK. 2007. "Relationship between malaria and sociocultural aspects in villages along the river Mahi in central Gujarat." J Indian Med Assoc.;105(6):304-6.
40. Yadav SP1, Kalundha RK, Sharma RC. 2007."Sociocultural factors and malaria in the desert part of Rajasthan, India." J Vector Borne Dis.;44(3):205-12
41. Rama Shankar, Rawat MS. 2007. "Medicinal plants vis a vis forest management in Arunachal Pradesh: Ayurveda and Drugs for all. New Delhi & Itanagar: Himalayan Publisher"; pp. 110–8.
42. Rama Shankar, Rawat MS. 1995. "Ethno-midico-botanical aspect of some plants of Arunachal Pradesh." Bull Medico Ethno Bot Res;16:83–9.
43. Rama Shankar, Rawat MS, Singh VK. 2003. "In: Ethnomedicinal plants of Papumpare district: Ethnomedicines of the tribes of Arunachal Pradesh." Mibang T, editor. New Delhi & Itanagar: Himalyayan publishers; pp. 30–5.
44. Sharma UK. 2004. "Medicinal plant of Assam. In": Singh B, Singh MP, editors. Dehradun
45. Lalramnghinglova H. 2003. "In: Ethno medicinal plants of Mizoram." Singh B, Singh MP, editors. Dehradun
46. Sinha SC. 1996. "Medicinal Plants of Manipur". Mass and Sinha. Imphal: Manipur Cultural Integration Conference.
47. Malhotra SC. 1996. "Pharmacological Investigations of certain medicinal plants and compound formulations used in Ayurveda and Siddha." 1st ed. New Delhi: Central Council for Reseach in Ayurveda and Siddha (CCRAS); pp. 409–13.
48. New Delhi, India: Central Council for Research in Ayurveda and Siddha; 1999. Anonymus. "An Appraisal of Tribal folk medicines"; pp. 331–5.
49. Biswas K, Chopra RN. 1982. "Common medicinal plants of Darjeeling and the Sikkim Himalayas." Vivek Vihar, Delhi: Periodical experts book agency.
50. Borthakur SK, Gogoi PD. 2003. "In: Household remedies of Tai Khamptis: Ethnomedicines of the tribes of Arunachal Pradesh." Mibang T, editor. New Delhi ' Itanagar: Himalayan publishers; pp. 90–8.
51. Rama Shankar, Rawat MS. 1996. "Medicinal plants and some folklore from East and West Siang district Arunachal Pradesh) their utilisation." Bull Medico Ethno Bot Res.17:1–7.
52. Purkayastha P, Dutta M, Nath SC. Ethno-medicinal plants from Dibru-Saikhowa biosphere reserve, Assam. Ind J of Trad Knowl. 2007;6:477–80.
53. Issar RK. Medico-Ethno-Botanical Exploration of Sikkim Himalayas. New Delhi, India: Central Council for Research in Ayurveda and Sidha; 1991. pp. 117–21.
54. Das AK, Tag H. 2006. "Ethnomediicinal studies of the Khamti tribe of Arunachal Pradesh." Indian J Tradit Knowl. 5:317–22.
55. Mahanti N. 1994. "Tribal ethno-botany of Mizoram, tribal Studies of India Series". T 171. New Delhi, India: Inter India Publication.
56. Das AK. 2003. "In: Some notes on the folk medicines of the Adis of Arunachal Pradesh. Ethnomedicines of the tribes of Arunachal Pradesh." Mibang T, editor. New Delhi & Itanagar: Himalyayan publishers; pp. 41–8.
57. Lalfakzuala R, Lalramnghinglova H, Kayang H. 2007. "Ethnobotanical usage of plants in western Mizoram." Indian J Tradit Knowl;6:486–93.

58. Kumar S. 2002. "The Medicinal Plants of North East India. Jodhpur, India". Scientific Publishers.
59. Sikdar M, Dutta U. 2008. "Traditional Phytotherapy among the Nath People of Assam." Ethno-Medicine;2:39–45.
60. Kohli YP. 2003. "Ethnomedicines in the service of tani tribes". In: Mibang T, Chaudhuri SK, editors. Ethnomedicines of the tribes of Arunachal Pradesh. Itanagar: Himalayan publishers; pp. 13–7.
61. Yonggam D. 2005. "Ethno Medico-Botany on the Mishing tribe of East Siang district of Arunachal Pradesh." Arun Forest News; 21:44–9.
62. Rama Shankar, Sourabh Deb, and B K Sharma. 2012."Antimalarial plants of northeast India: An overview". (Access on https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3326788/)
63. Sundararajan R1, Kalkonde Y2, Gokhale C2, Greenough PG1, Bang A2. 2018. "Barriers to malaria control among marginalized tribal communities: a qualitative study". Acta Trop. 2018 May;181:60-68.